United Nations Educational, Scientific and Cultural Organization

The ITEC Project
Information Technology in Education of Children

Final Report of Phase 1

Documents compiled by
Dr. Betty COLLIS
Co-Principal Investigator ITEC
University of Twente, The Netherlands
under contract with UNESCO

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Division of Higher Education
The opinions expressed in this document are those of the authors and do not necessarily reflect the views of the UNESCO Secretariat.
INTRODUCTION

CHAPTER 1. Background, Preliminary Period, and Preparation for Phase 1: 1987-1989

1.1 Project Antecedents, Prior to May 1988 ......................................................... 3

1.2 Project Launch, May 1988

1.2.1 Experts Meeting, Bulgaria ................................................................................. 4

1.2.2 Summary Report and Recommendations ......................................................... 4

1.3 Preliminary Papers, Commissioned at the Experts Meeting

1.3.1 Vygotsky’s Theory as a Methodological Basis for a Cross-Cultural Study on the Impact of Information Technology in Education on Child Psychological Development, O.K. Tikhomirov, Russia .................................................. 8

1.3.2 Genetic and Modelling Method and its Usage for Studying Cognitive Development in Cross-Cultural Research, V.V. Rubtsov, Russia .................................................. 13

1.3.3 Aspects of Process Measurement, P. Light, UK, and J. Rogalski, France ........ 19

1.3.4 Some Methodological Issues about the Introduction of Computers in the Classroom, J. Rogalski, France .................................................. 21

1.3.5 Observations and Interviewing Combined as Assessment Techniques for Family Variables, M. Csako, Hungary .................................................. 23

1.3.6 Assessment Procedures for Family and Home Environment, T. Tomov, Bulgaria .................................................. 25

1.3.7 Developing a Scoring Procedure for ‘Frequency of Computer Use’ ................. 26

1.3.8 Specification of Information Technologies in Education, E. Peled, Z. Peled and G. Alexander, Israel .................................................. 29

1.3.9 Defining Different Aspects of Hardware and Configuration Variables, T. Sakamoto and K. Akahori, Japan .................................................. 33

1.3.10 In-service Training for School Teachers who are Going to Participate in the Field Studies of the Cross-Cultural Project in Primary and Secondary Schools, B. Lindahl, Sweden .................................................. 37


1.3.12 Observations and Protocols on Children and Classroom Behaviour, Z. Peled, Israel .................................................. 53

1.4 Project Evolution, 1988-1989

1.4.1 First Refinement of Theoretical Framework and Project Design, January 1989 .... 75

1.4.2 Project Announcement, March 1989 ................................................................. 76

1.4.3 First Project Presentation, UNESCO International Congress, April 1989, B. Collis, Netherlands and A. Jablensky, Bulgaria .................................................. 76

1.4.4 Second Refinement of Theoretical Framework and Project Design, November 1989 .................................................. 80

1.4.5 Final Preparations, 1989 .................................................................................... 82

1.5 ITEC Phase 1: Final Version of Instrumentation, Planning, and Project Conceptualization

1.5.1 Procedure and Instrumentation ......................................................................... 84

1.5.2 Final Phase 1 Project and Short Summary Documents ....................................... 118

1 All sections written by B. Collis, The Netherlands, unless otherwise noted
1.6 Summary and Reflections on ITEC Phase 1 from Conception to Start of Phase 1

1.6.1 Compromises on Causality ......................................................... 131
1.6.2 The Two-Phase Approach: Postponing the Difficulties .................. 131
1.6.3 Practical Constraints ............................................................... 131
1.6.4 International Logistics .......................................................... 132
1.6.5 Procedural, not Motivational Changes ....................................... 132

CHAPTER 2. Phase 1 "Results": A Cross-Cultural Analysis of the Settings in Computer-Use Environments

2.1 Introduction and Overview of the Sample and Procedures
2.1.1 Review of Procedures for Selecting Teachers, Schools, and Students for ITEC Phase 1 .......................................................... 133
2.1.2 Review of Observation Procedure, Phase 1 .................................. 134
2.1.3 Form A: A Brief Look at the Participants .................................... 134

2.2 A Closer Look at the Schools in ITEC Phase 1
2.2.1 Special Circumstances in the Schools Relative to Computers ............ 138
2.2.2 Form B Summary ................................................................. 139
2.2.4 Narrative Descriptions of Four of the Schools, C. Fonseca, Costa Rica and B. Bengtssen, Sweden ...................................................... 158

2.3 The Principals in ITEC Phase 1 Schools
2.3.1 Summary of Principals’ Responses: Costa Rica Perspective C. Fonseca and R. Murillo, Costa Rica ........................................... 163
2.3.2 Summary of Principals’ Responses: Canadian Perspective, L. Ollila, L. Francis, P. Farragher and T. Riecken, Canada .............................................. 171

2.4 The Students in the ITEC Phase 1 Classes
2.4.1 Number of Children in Participating Classes ................................ 181
2.4.2 Age Range of Children .......................................................... 181
2.4.3 Are the Children Exceptional? .................................................. 181
2.4.4 What Computer Experience do the Children Have? ....................... 181
2.4.5 Summary of Responses to Form D ........................................... 182

2.5 The Teachers in the ITEC Phase 1 Classes
2.5.1 Summary of Teacher Experience .............................................. 185
2.5.2 Summary of Interviews with the Teachers (Form E) ....................... 186

2.6 Descriptive Videotapes for ITEC Phase 1
2.6.1 Samples of Video Summaries ................................................... 210

2.7 Summarizing the Descriptive Data: What are The ITEC Phase 1 Settings Like? How are They Similar? How are they Different?
2.7.1 Summary of Software Use in ITEC Phase 1 Classes, V. Tsoneva, Bulgaria .......................................................... 220
2.7.2 Contexts of Computer Use in Elementary School Learning Processes, G. M. Habermann and M. Csako, Hungary ........................................... 223

CHAPTER 3. Measuring Children’s Metacognitive Development in the Context of School Computer Use

3.1 Introduction: Review of Issues and Procedures
3.1.1 Issues ........................................................................ 234
3.1.2 ITEC Phase 1 Procedures Relative to the “Quest for the Dependent Variable” .......................................................... 235

3.2 Videotaping “Observable” Evidence of Metacognitive Processing
3.2.1 Characteristics of Submitted Videotaped Segments ....................... 237
3.2.2 Coding and Synthesizing the Videotapes ................................... 238
CHAPTER 4. Reflections on Phase 1 of the ITEC Project

4.1 Introduction to Chapter 4: "Reflections" ........................................................................ 257

4.2 Cross-Cultural Assessment of the Impact of Computer Use in Education: Reflections from the ITEC Project, B. Collis, The Netherlands and A. Jablensky, Bulgaria .......................................................... 257

4.3 International Trends in Computer Use in Primary Schools, P. Gabriel, France ................................................................................................................................. 262

4.4 Computer Use in Schools: Reflections on the Impact of Econometrics, Politics, and Culture, M. Murray-Lasso, Mexico ......................................................... 265


4.6 On the Uses of Computers in Schools: Is the Cup Half Empty or Half Full?, J. Oliveira, Brazil .............................................................................................................. 271

4.7 National Reflections

4.7.1 Canada, L. Francis and L. Ollila ............................................................................... 274

4.7.2 China, Hou-can Zhang ............................................................................................... 277

4.7.3 Costa Rica, R. Murillo, C. Fonseca and A. Brenes ..................................................... 279

4.7.4 France, P. Gabriel ...................................................................................................... 286

4.7.5 Hungary, M. Csako and G. M. Habermann ............................................................... 290

4.7.6 Japan, T. Sakamoto .................................................................................................. 294

4.7.7 Mexico, M. Murray-Lasso .......................................................................................... 296

4.7.8 New Zealand, K. W. Lai ........................................................................................... 299

4.7.9 Romania, I. Diamandi ............................................................................................... 301

4.7.10 Russia, V. Rubtsov and V. N. Kaptelinin ................................................................. 310

4.7.11 USA, A. Pilz, G. Levis-Pilz and P. Resta .................................................................. 314

4.7.12 Bulgaria, V. Tsoneva ............................................................................................... 318

4.8 Reflections on the Reflections ..................................................................................... 320

CHAPTER 5. Other Perspectives, Stimulated by ITEC Phase 1

5.1 Introduction ................................................................................................................... 5.1-1

5.2 "International Perspectives: Education and Technology", Preface ................................ 5.2-1

5.2.1 The French Educational System: Demands, Issues and the Place of Information Technology, P. Gabriel, France ................................................................. 5.2-2

5.2.2 The Dutch Educational System and its Support to Information Technology, J. Moonen, The Netherlands ................................................................. 5.2-6

5.2.3 Educational Computing in Mexico, M. Murray-Lasso, Mexico ................................ 5.2-9

5.2.4 The Computer as a Pedagogical Tool at Rannebergens Centrumskola, B. Bengtsson, Sweden .............................................................................................. 5.2-14

5.2.5 The Implications of Technology for School Reform, P. Resta, U.S.A ................... 5.2-16

5.2.6 Educational Perspectives in Hungary after 40 years of Communist rule, M. Csako, Hungary ................................................................. 5.2-22

( iii )
5.2.7 Using Computers in Education: The Romanian Experience, ............................... 5.2-26
I. Diamandi, Romania

5.2.8 Educational Issues of Technology Use in Bulgarian Schools, .......................... 5.2-30
V. Tsoneva, Bulgaria

5.2.9 Costa Rica: Facilitating Educational Change through a Computer Program ............... 5.2-35
the Young, C. Fonseca, Costa Rica

5.2.10 Blooming Late in Information Technology: Education and Computing in New-Zealand, K.W. Lai and B. MacMillan, New Zealand ....................... 5.2-42

5.2.11 Computers in Canadian Schools: A Review of Events in the 1990s, ....................... 5.2-48
D. Wighton and L. Ollila

5.3. Selected Papers from the Fourth International Conference, "Children in the Information Age", Albena, Bulgaria, May 1991

5.3.1 Possibilities and Restrictions of Computers Usage in Instruction as a Problem of Developmental Psychology, V. V. Rubtsov, Russia ....................... 5.3-1

5.3.2 Evaluation of Pupils' and Teachers' Conceptions and of Their Cognitive Behaviours in the Domain of Information Technology, G. Chiappini, E. Lemut and L. Parenti, Italy ....................... 5.3-7

5.3.3 Implementation of Computer Use in Mathematics Instruction, ....................... 5.3-13
E. A. Friedman, M. P. Jurkat, R. S. Pinkham, I. Charischak, L. V. Morris and K. F. Allum, USA

5.3.4 Psychological Impacts of Children..., T. Sakamoto, ............................... 5.3-18
Zhao J-L and A. Sakamoto, Japan

5.3.5 Culture as a Context and Determinant of Educational Uses of Information Technology, M. Murray-Lasso, Mexico ....................... 5.3-23

5.3.6 Informatics Games for Developing Children's Thinking Ability, ....................... 5.3-28
F. Karoly and M. Koros-Mikis, Hungary

5.3.7 Assessing Computer-Use Impact within an Interactive Network of Variables: Assessing the Impact of Different Types of Computer Use in Mathematics Teaching at the Secondary Level, P. Gabriel, France ....................... 5.3-32

5.3.8 Metacognition and Strategic Use of Computers: A Study of Creative Writing with Grade Four Children, L. O. Ollila, E. Schwartz and L. Francis, Canada ....................... 5.3-38

5.3.9 Study on the Development of Programming Ability and Cognitive Skills of Junior High Students, Hong Liu and Qi Chen, China ....................... 5.3-47

5.3.10 Computer-Related Attitudes of Primary School Students in Japan and the USA: First Year Longitudinal Results, G. Knezek, USA and K. Miyashita, Japan ....................... 5.3-52

5.3.11 "Computer Corners" as a Stimulus for Students' Activity at Mathematics Classes, B. Lazarov and M. Bekyarova, Bulgaria ....................... 5.3-60

5.3.12 The School as a Communications Center: Proposed Innovation for the Information Age, H. Hartman, D. Gornon, A. Aviram, G. Alexander, A. Kainan, E. Barkai and Z. Shemesh, Israel ....................... 5.3-66

5.3.13 The "Young Children's Computer Inventory": A Likert Scale for Assessing Attitudes toward Computers in Instruction, K. Miyashita, Japan and G. Knezek, USA ....................... 5.3-73

Appendices

Appendix A. ITEC Document Series ................................................................. Annex - 1
Appendix B. ITEC Variables, May 1988 .......................................................... Annex - 5
Appendix C. ITEC Phase 1, Addresses of Researchers, Teachers, and Principals .......... Annex - 9
INTRODUCTION

This report is a summary of the First Phase of the ITEC Project. ITEC stands for "Information Technology in Education and Children" and is the name of a long-term international research project, associated with UNESCO as well as many other institutions. The history of this project, its ambitions, evolution, and contributions, make an important story from a number of perspectives scientific, methodological, educational, procedural, and finally, human. In this report we often let the documents stimulated by ITEC over the period 1987 to 1992 speak for themselves, in that the voices of more than 30 researchers from 25 countries communicate more than their scientific perspectives as they address a common theme in many different ways.

What is this common theme? At one level we can describe it compactly: what is the metacognitive impact of computer use in school on children's metacognitive development and how is this impact related to culture and educational practice? But, as will be seen in these pages, elucidating the theme and finding a cross-culturally valid and manageable way to study it soon became subthemes of the project itself. This is one of the stories which emerges in this report - the story of how researchers from around the world agreed on a common concern but then had to find a way to describe and study it in a way which would both facilitate synthesis and respect individual and national differences, in style, setting and interpretation.

But the main point of the story should always be the children who are the project's focus - how can we tell if they are benefiting from computer use in education? Are resource-scarce countries at a critical disadvantage compared to wealthier countries in equipping their children for productive functioning in an increasingly technological world economy? Can we find a sort of teacher or teaching method or type of software or type of hardware that can be available to less-developed countries and that will give their children an intellectual experience equal to that available in wealthier countries with their relative abundance of computer-related resources, in both home and school? This, after all, is the main story of ITEC.

This report is organized in the following way. In Chapter 1 we look at the origins of the ITEC Project, stretching back to the relationship between UNESCO and various scientific and humanitarian groups in Bulgaria prior to 1985, moving through the establishment of an international scientific project "Children in the Information Age", the different steps in the birth of the ITEC Project (formally identified in May 1988), the early perspectives that contributed to the shape of the Project, and the final launching of the Project in 1989.

In Chapter 2 we describe the settings we studied in Phase 1, their human and cultural aspects, as well as their instructional and computer-related characteristics. In Chapter 3 we discuss the findings of Phase 1, relative to the so-called "dependent variable" of the study children's metacognitive development. Chapter 4 consists of reflections on the study, from the overall project level through reflective commentaries by various researchers involved in the study and also through national reports from 12 of the countries participating throughout Phase 1.

As with all good science, one of the goals of ITEC was to stimulate comment and associated reflection from scientists outside of the Project but also interested in its objectives and problem space. Chapter 5 gives a selection of articles in this category, selected from papers presented at two international meetings: the "International Perspective: Education and Technology" conference sponsored by the Education Technology Centre of British Columbia, Canada, October 1990; and the Fourth International Conference "Children in the Information Age", Bulgaria, May 1990, a conference that was closely connected to the ITEC Project. The connection of these two international conferences with ITEC will be explained in Chapter 5.

Appendices are provided which give names of addresses of participants-researchers, participating teachers and principals (although not of the 665 children who were involved in the project.) Also, the extensive library of videotapes of classroom use of computers by the children in the study is described. Additional papers in the ITEC Project archives but not included in this Final Report are listed.

As editor, I take responsibility for the selection of source and summary documents for the Final Reports; much written material has been submitted to the Project over its years - transcripts of interviews with teachers and principals, of videotaped conversations between teachers and students, of first or
Introduction

Final Report of ITEC Phase 1

Partial versions of reports, of associated documents important to the development and execution of the Project. Together these fill a shelf of boxes. One of the decisions for this Final Report of Phase 1 was how to exercise this editorial responsibility in order to select a rich but concise collection of Project documents, and sometimes to edit these documents further, in order to produce a readable but scientifically compelling entity. General decisions about editing and the composition of this Final Report were taken by ITEC Co-Chair Dr. Betty Collis and UNESCO Project Officer, Dr. Evgueni Khvilon, Programme Specialist, Higher Education and Research, in January 1992.

The production of this Final Report also reflects the political consequences of the world-change that has occurred in so many of the countries participating in ITEC even as its First Phase was in effect. In particular, preparation of the Final Report had to take place without the active participation of Project Co-Chair Dr. Assen Jablenisky, a source of immense intellectual stimulation to the Project throughout its evolution. Because of changing circumstances for support of scientific work in his home country of Bulgaria, it became difficult to find appropriate communication methods to enable the two Co-Chairs to work in collaboration on the Final Report preparation. Thus, in order to facilitate timely appearance of the Final Report, I have edited the Final Report without the opportunity to consult with Co-Chair Jablenisky over the many decisions involved in its compilation. However, as a compensation I have been efficiently helped in the task by the fortunate arrival in The Netherlands of Prof. Ivan Stanchev, Director of the Research Center for Educational Informatics in Bulgaria, Scientific Chairman of the International Programme: Children in the Information Age, and a long-time key figure in computer use in education, both in Bulgaria and world-wide. Through his help, the Final Report received important critical and factual support.

So now the story, only hinted at in the above remarks, can unfold. What happens when scientists from around the world find they share a common concern for the impact of computer use on children’s metacognitive development and are brought together by UNESCO to, as a team, address this issue? What do they do and what do they find out?

Thus, the Final Report of ITEC Phase 1.

Betty Collis
Co-Chair ITEC
Department of Education
University of Twente
Enschede, Netherlands
CHAPTER 1


In this chapter we look at the origins of The ITEC Project (Section 1.1); the launching of the Project, May 1988 in Bulgaria (Section 1.2); a sampling of preliminary papers commissioned for the Project to stimulate its conceptual and methodological development (Section 1.3); an overview of the Project evolution up until its operational start in late 1989 (Section 1.4); and the Phase 1 procedures, instrumentation, and final documentation (Section 1.5). We conclude the chapter with a comment on this development period (Section 1.6).

1.1. Project Antecedents, Prior to May 1988

In May 1985 a First International Conference, “Children in the Information Age” was held in Bulgaria. This conference was organized by the Cyrillus and Methodus International Foundation, with assistance from UNESCO, the International Institute for Applied Systems Analysis, the (Bulgarian) State Committee for Science and Technical Progress, and the Education Ministry of Bulgaria. The conference came about because of the expertise already strongly developed in Bulgaria with respect to computer technology in general and computer applications in education in particular.

In response to recommendations unanimously adopted by the participants at this conference, preparation began for an international scientific project entitled, “Children in an Information Age,” to be co-sponsored by UNESCO and other international organizations and institutes. The scope of this project was to include:

- An international research and information centre where scientists from different countries will be able to experiment with the data from their research, can compare inventions, and will exchange information on the "child-computer" issue;
- An international comparative study of the psychological consequences of computer introduction in the world of children of different cultures and traditions;
- A meeting of magazine publishers of specialized literature in the field of informatics and education, intended to probe possibilities for data exchange on the impact of computers on children;
- A setting in which possibilities to standardize computer technology and software for educational needs in order to facilitate international co-operation and exchange in the field could be explored.

The XXIII Session of the UNESCO General Conference adopted a proposal to include this international scientific programme in the planned intergovernmental information programme of the organization.

In this framework, the second "Children in the Information Age" Conference was held in Bulgaria in May 1987. Following this, an initial planning meeting was held in November 1987 to further discuss the second aspect of the overall "Children in the Information Age" project, an international comparative study of the long-term effects on child development of the use of computers. In this context, the Secretariat (UNESCO) asked Mrs. F. Winnykamen of the Rene Descartes University, Paris, France, to prepare a first draft of a project proposal. (This draft, entitled, "Pre-Project for a Longitudinal, Comparative and Cross-cultural Study of the Effects of Computer Technology on Child Development" is available as ITEC Document 1 in the ITEC Phase 1 Project Archives, available at UNESCO. Titles and brief descriptions of all documents in the Archives are given in Appendix A.)

A draft of Mrs. Winnykamen's proposal was circulated by UNESCO to a number of international experts in the area of children and computer use. Written responses were submitted, some of which are available as ITEC Document 2 (see Appendix A).
1.2. Project Launch, May 1988

1.2.1. "Experts Meeting", Bulgaria

Under the support of the Cyrillus and Methodus International Foundation, the Committee for Science of the Bulgarian Council of Ministers, and UNESCO, an "International Experts Meeting" was held in Tolboukhin, Bulgaria, 23-27 May, 1988. At this meeting were 32 experts from 14 countries. A complete summary of the meeting appears as ITEC Document 3 (See Appendix A). Dr. Betty Collis (then at the University of Victoria, Canada, and now at the University of Twente, The Netherlands) and Prof. Assen Jablensky, President, Bulgarian Medical Academy) were invited by UNESCO to be the Co-Principal Investigators of the Project, and a six-person Task Force was named to assist in the preliminary organization of the Project. A number of the researchers present at this International Experts Meeting have stayed active with ITEC throughout its first phase. The following list gives the names and countries of those attending the May 1988 International Experts Meeting. Asterisks indicate those who remained active with the project throughout Phase 1.

Dr. B. Lindahl, Sweden
Dr. B. Collis, Canada (now, The Netherlands)
* Dr. M. Murray-Lasso, Mexico
* Dr. T. Sakamoto, Japan
* Prof. Zhang Hou-can, China
Dr. Catrin Lsenco, Russia
Prof. O. Tichomirov, Russia
* Prof. V. Rubtsov
Mrs. K. Melick-Chahnazarov, Russia
Prof. L. Dahlgren, Sweden
* Dr. A. C. Mundy-Castle, Zimbabwe (now, UK)
Prof. P. Light, UK
* Dr. M. Csako, Hungary
Dr. E. Neuwirth, Austria
Mrs. G. Langenbuch, Germany
* Dr. Z. Peled, Israel
* Dr. E. Peled, Israel
Prof. F. Winnykamen, France
Prof. J. Rogalski, France
Prof. S. Tarlund, Sweden
Mr. P. Gonda, (representing UNESCO)
* Prof. A. Jablensky, Bulgaria
Dr. B. Handjiev, Bulgaria
* Dr. L. Lazarova, Bulgaria
* Dr. Violeta Tsonova, Bulgaria
Dr. N. Semova, Bulgaria
Dr. P. Pavlova, Bulgaria
Mrs. E. Jouzmanova, Bulgaria
Mr. Z. Varhanov, Bulgaria
Prof. V. Gatev, Bulgaria
Mrs. I. Vodenicharova-Panevska, Bulgaria
Prof. T. Tomov, Bulgaria

During this meeting, the name "ITEC" was born, and major decisions about the design, theoretical framework, research questions, variables of interest, and the methodology of the Project were discussed and agreed upon. These aspects are also described in ITEC Document 3. In the following section, key aspects of this document are reproduced.

1.2.2. Summary Report and Recommendations

The 21-page report began with a general summary about the ITEC Project:

**Overall Summary.** The ITEC project will involve the systematic examination of interactions among factors influencing the effects of information technology on child development using common variables, methodologies, and instrumentation and through simultaneous focus on children in specific age groups in countries throughout the world. Initial decisions have been made concerning the
underlying premises of the study, the research questions to be addressed, the dependent and independent variables, the overall design paradigm of the study, some characteristics of the units of analysis for the study, and a procedural infrastructure to continue the realization of the study. Strong interest in continued participation in the study was expressed by all participants. (p. 1)

**General Rationale.** The May 1988 Summary Report also gave the first statement of the general rationale of the ITEC Project:

Information technology, primarily involving the application of computers in the educational setting, is capable of having a profound effect on the developing child. The study of this effect - what mediates it and how it may be channelled to the best advantage of the child - are topics of major interest to researchers throughout the world. Despite this extensive research activity, it remains difficult to synthesize understanding of this effect. Partly this is because the domain of information technology itself is continually changing in its characteristics; partly it is because "the effect" cannot be captured through a unitary measure but instead can only be expressed in terms of the state of a complicated network of interdependent variables which conjointly influence and are influenced by each other. However, the lack of research synthesis is also a reflection of incomparable aspects of the particular studies comprising the research literature in this field. As a most obvious example, culture as a mediating variable in any examination of effects is not given a careful description in the majority of studies. Also, studies render operational dependent and independent variables in such a variety of ways that synthesis becomes virtually impossible.

For these reasons, a major contribution to the field could be made by a carefully conceptualized research project in which component studies share common definitions of salient independent and dependent variables; operationalize these variables using common instruments; share a common timeline and data-capturing protocol; focus on a common cohort of children; and maintain an appropriate respect for naturally occurring differences in embedding school, social, and cultural environments. In addition, such a project should be grounded in an appropriate conceptual theory and must reflect the accumulated research evidence already available in the area of computer applications in education. Finally, a major recommendation emerging from critiques of this research - that brief, episodic, "artificial" interventions involving technology are not likely either to transfer to the realities of the naturally occurring school setting or to have meaningful impact on important higher-order aspects of child development - should be reflected. As a consequence, a well-designed research project on ITE needs to include adequate time for repeated child/computer interactions in natural school settings.

**Project Assumptions.** In summary, the participants at the May 1988 Experts Meeting in Bulgaria agreed that:

1. The general interest of the study will be the relationships between the use of information technology in education and child development.
2. The study will be international and will involve a general framework of cross-cultural comparisons.
3. The study will involve the use of a variety of applications of ITE within the school setting.
4. The study will consider the child in the context of his environment - as defined at least by variables relating to teacher characteristics, instructional strategies, school, family, cultural, and computer-use characteristics. It will be accepted that change in aspects of any of these variable clusters can influence the overall system encompassing the variables, and therefore that a consideration of the child in isolation with a computer is not appropriate.
5. The study will be longitudinal.
6. The study will involve a core set of common research questions, variables, instruments, and other measurement techniques, applied to a same-age cohort at specific points in time identical in each culture. (p. 3 - 4)

**Research Questions.** Reflecting the above rationale and core assumptions of the project, a first statement of the research questions for the ITEC Project was also given in the May 1988 Summary Report document. Those questions were grouped as Primary and Subsidiary Questions and included:
Primary Questions:

1. Are there measurable cognitive, metacognitive, and social effects on child development that are associated with the use of different types of applications of information technology in education?

2. If there are measurable effects, how are they mediated by the child's culture, family, school, and society?

3. Can a generalization be made about the impact of information technology in education on child development, or does the consideration of cultural differences and differences of situation preclude generalizations?

Subsidiary Questions:

1. How do different cultures make use of IT in schools?

2. What factors facilitate or constrain the diffusion of IT usage in schools? Do these factors follow a pattern across cultures or are they individualized by culture?

3. How does the family both affect and be affected by the use of different types of IT in education?

4. How does the teacher both affect and be affected by the use of different types of IT in education?

Project Variables. It was agreed that instrumentation for various categories of variables would have to be selected for common use throughout the project. Discussion focused on what should be the "core" dependent variables:

- Cognitive development
- Metacognitive development
- Social, or communicative/communicative development

For these variables, it was noted that "careful consideration must be given to the following questions":

- Are the domains being measured by existing instruments for these concepts adequate to reflect the possible impacts of new information technologies on children?
- Are current instruments sensitive to the developmental impact of various computer applications and experiences?
- Can instruments be validated for use in different countries?
- Are any available instruments reliable and manageable for large-scale field application?" (pp. 4-5)

Relative to independent, or contextual variables, it was decided that the "primary mediating variable in the study will be culture" (p. 5). Nested within culture will be a nominal variable describing type of computer/IT application. Nested within type of computer usage will be certain combinations of: teacher characteristics, instructional strategies, child-related characteristics such as gender or ability level, school characteristics both social and physical, software and hardware characteristics related to computer use, and family characteristics. In ITEC Document 3 (the Summary Report and Recommendations of the May 1988 Experts Meeting) and also in Appendix B of this Final Report the list of variables suggested by the participants as being important for ITEC to include within its measurement frame appears. The variables were grouped as (a) dependent variables - 15 variable clusters related to cognitive and affective aspects; (b) 11 variable clusters related to the teacher; (c) seven variables related to instructional integration of computer use; (d) 21 variables related to the family; (e) three categories of variables relating to type of computer use; and (f) seven clusters of cultural variables.

Other Considerations. In addition, many other complex questions related to the variables in the project were considered. These included:

1. Is there a hierarchy of cognitive demand embedded within the different categories of computer use?
2. Should we make a distinction between producing, consuming, and manipulating knowledge in terms of computer use?

3. Is it relevant to consider the degree of teacher dependence or independence involved in the use of the computer applications?

4. Is it relevant to consider the integrative aspects of the computer use, with respect to integrating different subject areas or methodologies of instruction?

5. How can time allocated to computer use be categorized?

6. What are variables particularly pertinent in developing countries, such as power of the computer?

7. What human-computer of human-software interfact characteristics affect learning?

8. What software design characteristics affect learning?

Initial Design Decisions. After much discussion various decisions were made about the design of the study. "Culture" was seen, temporarily, to be equated with "country", although all recognized the difficulties with such a simple approach. An initial design diagram was developed. In the design, each country would be free to choose its own types of "technology applications" (i.e., drill and practice, robotic, programming). It was also hoped that random assignment of intact classes to various types of computer applications might be made in different countries and that there would be "control" classrooms where no computer use was taking place. The target group of students for the study was selected - a cohort with mean age 8 years as of September 1989. If a second age cohort could be handled, a 12-to-13 year old group was identified for comparison purposes. It was also hoped that each participating country would commit itself to approximately four intact classes of 8-9 year olds, randomly assigned to different types of computer application use, as "a minimal condition for involvement in the study" (p. 8). The study was seen as lasting three years, within which a full year of observation in each class was to occur and baseline testing would occur at the start and at the end of each of the three years.

Action Points. Finally, many areas of project concern were identified. Among these were:

1. Identifying a reduced set of measurable variables.
2. Pilot testing or otherwise validating dependent variable measures.
3. Clarifying the conceptual framework of the study.
4. Developing a procedure to code and describe "process" variables and to describe change in an interactive system.
5. Refining the definition of "culture" and developing procedures to code its salient characteristics in different settings.
6. Developing teacher support materials to accompany a common initial experience with IT, especially in settings new to IT use.
7. Developing coding procedures for situational variable related to computer use, institutional characteristics, family and teacher characteristics.

The report concluded with recommendations for the support and maintenance of the study. It ended with the following concluding remarks that convey the sense of challenge and vision permeating the meeting:

Concluding Remarks

"The ITEC Project has the potential to make a strong contribution to both research and practice in the application of information technology in education. The application is occurring world-wide despite the lack of a synthesized base of information about its impact on child development or on the system of culturally sensitive variables surrounding the child in his experiences with ITE. We have the opportunity to make a significant contribution, on behalf of the child, to the eventual recommendation of uses of ITE most likely to be of positive impact to him and his development. The scope of the study is highly ambitious and sophisticated and will require involvement from its international research participants at a level to match this complexity. The expertise present at the International Experts Meeting in Tolboukhin (Bulgaria) and the collaborative output of the meeting suggest the aims, although ambitious, are within the capability of experienced researchers in the field. What is needed is strong central support and an incentive to participate. We believe the ITEC Project offers both of those" (p. 10).
1.3. Preliminary Papers, Commissioned at the Experts Meeting

The researchers parted company with a first round of tasks - to contribute by September 1988 assigned "reflection papers" to the Project and to stimulate local dialogue and commitment to the study within their countries. The assigned reflection papers were chosen to deal with topics indicated as being particularly important to subsequent project development. The list of papers that were assigned can be found in ITEC Document 3 (see Appendix A); the papers that were received by September 1988 are also identified in Appendix A, collectively described as ITEC Document 4. A selection of 12 of these papers follows, each of which contributed in some substantial way to the subsequent evolution of the ITEC Project.

1.3.1. VYGOTSKY'S THEORY AS A METHODOLOGICAL BASIS FOR A CROSS-CULTURAL STUDY ON THE IMPACT OF INFORMATION TECHNOLOGY IN EDUCATION ON CHILD PSYCHOLOGICAL DEVELOPMENT

Prof. O. K. Tikhomirov, Russia

Analysis of child development in condition of the application of information technology (IT) should proceed, giving due regard to cultural peculiarities, from certain notions about the psyche, its evolution and mechanics as well as about ways of influencing this evolution. In modern science, these notions differ considerably from each other. This article is an attempt to show how Lev Vygotsky's ideas can promote the solution of the problem under discussion.

Viewing the general structure of human mind, Vygotsky distinguished between higher and lower psychic functions, paying special attention to the latter and regarding them as specifically human formations. Higher psychic functions are instrumental in their structure, historical by their origin and flexible as regards their means of functioning. Following the tradition established by Vygotsky, in our study of IT influence we should, first and foremost, analysis higher psychic functions: tendencies of their historical development, specific features of their instrumentation and their flexibility level.

One of the key ideas of Vygotsky was his concept of human mind's systematic structure. Vygotsky's works are directly relevant to major theoretical questions: specific features of the systems observed in psychology, correlation of the systems studied by different sciences, the nature of relations existing between psychological theories and the general thesis about the systemic character of human mind.

Vygotsky analysed several different systemic objects. Among them are systems of notions comprehended by man. According to Vygotsky, a notion can become comprehensible and flexible only within a system. Dynamic systems of meanings form another class of systemic objects; Vygotsky considered them to be of special importance. The term "system of meanings" signifies the unity of intellectual and affective processes. The third systemic object was named "psychological system". An instance of such system is visual thinking, which emerges from a combination of "perception" and "notion". Memory and attention of the modern man are also treated by Vygotsky as psychological systems. The notions "psychological system" and "systemic function" are used by him as synonyms. In Vygotsky's view, "psychological systems" are characterized through the unity of separate functions, through the dominance, within them, of interfunctional ties and relations.

Psychological systems have their own development. Changeability of interfunctional ties and relations, as well as reorganization of mental systems - that is, the emergence of new relations between functions - constitute, in Vygotsky's opinion, the main content of all psychological development. An important law of psychological systems' development is, that first they emerge as forms of interaction and cooperation among people, and then as intrapsychological phenomena peculiar to one or another individual.

Thus, Vygotsky used "systemic approach", which is closely connected with the idea of development. "Comprehensiveness", "flexibility" and "unity of intellect and affect" are systemic qualities for Vygotsky. His treatment of psychological systems as a separate class is of special importance. This can be qualified as a significant discovery.

Vygotsky is the author of the theory of higher psychic functions as well as of the theory of cultural-historical development. He also created the theory of psychological systems. Interpretation of this part of Vygotsky's work has a tendency towards emphasizing the unity of his position with those of other scientific schools which also use the notion "system". In our view, of greatest importance here is Vygotsky's original contribution to the elaboration of ideas concerning the systemic structure of mentality. The originality of his position is particularly seen from the analysis of the oppositions formulated by Vygotsky himself in regard to other champions of the systemic approach.
Gestalt psychology is an influential school which has opposed the principle of unity and structureality (gestalt) to the "psychology of elements" based on association and explaining the origin of complex psychic formations as a sum of more elementary phenomena. Vygotsky stressed that gestalt psychology was trying to revise radically the very foundations of traditional psychology and, at the same time, to preserve psychology as a single science.

Simultaneously, it is important to note that gestalt psychology, the most "systemic" psychological doctrine, was not only a subject but also an object of sharp criticism, which can be summarized in the following way. First, the system concept has been reduced by some gestalt psychologists to physicalism: integral psychic structures were treated by them as those isomorphic to physical structures. Second, the emphasis on integrity and structureality was often accompanied by lack of differentiation between animal and human minds. Third, integrity was considered to be an initial (inborn) quality which cannot (or does not need to) be explained. Vygotsky wrote: "The very notion of structure as the initial, universal and irreducible principle of being and consciousness acquires, sometimes, a metaphysical character; it isn't always dialectical. This produces a real danger of general reduction of all phenomena to structure as some universal basis" (3, p. 119). So, just as gestalt psychologists, Vygotsky acknowledges the systemic nature of human mind; but, unlike champions of this doctrine, he tries to analyse the specificity of psychological systems.

Charles Darwin's name is rightly associated with the widespread systemic approach. He authored both general biological theory, which explains living nature's expediency, and a number of specific psychological theories. Among the latter is the so-called "rudimentary theory of emotions", according to which man's affective reactions constitute remnants of his animal existence weakened externally and internally. This theory was justly criticized by Vygotsky for its naturalism and for its complete negation of the possibility to imagine the genesis of human emotions, the emergence of any new emotions. Comparison between Darwin's and Vygotsky's positions allows us to see another important aspect of the latter's work: Vygotsky differs from other defenders of the systemic approach in psychology not only by his idea of development (which Darwin also advocated) but also by his attempt to comprehend the specific (socio-historical) laws of human mind's evolution.

Widely known is Vygotsky's criticism of Jean Piaget's theory of egocentric speech. In our opinion, of no less importance is his criticism of Piaget for his ignoring the systemic organization of human mind. "Piaget distinguishes between spontaneous and non-spontaneous notions. He doesn't see what unites them into a single system of notions which forms in the course of the child's mental development. He sees the gap but not the connection. Therefore he presents the development of notions as something that evolves mechanically from two separate processes which have nothing in common and which take two absolutely isolated and separate courses (2, p. 222). Piaget's theory cannot give the answer to the question: how comprehension is actualized? Following Vygotsky, "This happens because this theory avoids scientific notions and reflects the laws of notions' movement outside the system. Piaget advocates the following point: to make a child's notion an object of psychological study one must clear it from any trace of systemic approach. This is an obstacle on the road to explaining how comprehension is actualized; moreover, it excludes any future possibility for this, because comprehension is actualized systematically, and elimination of all traces of systemic approach is Alpha and Omega of Piaget's whole theory, which has a narrow significance limited to non-systemic notions. To solve the problem raised by Piaget - how comprehension is actualized - one must centre the attention on the very thing Piaget initially rejects: the system"(1, p. 251).

Vygotsky's critical comment on the ideas of other psychologists who advocate the systemic approach also throws light on his understanding of nature of psychological systems.

Let us examine Vygotsky's treatment of the problem of correlation between psychological and non-psychological systems. Ivan Pavlov's theory is also connected with the study of systems. He regards man as a system with the highest degree of self-regulation. The term "signal system" was used by Pavlov to designate the organism's interaction with the environment, and the term "second signal system" - the specifically human in higher nervous activity.

Vygotsky clearly separates the systemic principles common for man and animals and those specifically human: "While the main and most general activity of the larger hemispheres of both animals and man is signalization, man's main and most general activity, which distinguishes him from the animals psychologically, is signification, that is, creation and use of signs." (3, p. 111).

Explaining further his thought about the essence of signification principle, Vygotsky says that man creates ties within his mind, controls his mind and, through it, his body: "The use of a sign denotes a departure beyond the limits of the organic systems of activeness existing for every psychic function", writes Vygotsky (3, p. 126). Working out the principle of signification and distinguishing it from the principle of signalization he based himself on the Marxian idea about the change of human nature in the course of man's influencing the environment and bringing about changes in this environment (3, p. 12).
Developing the basic concept of the social conditioning of man's psyche, Vygotsky did not identify proper social and psychological systems; he did not try to sociologize the psyche. Here it is important to distinguish between "intrapsychic" and "interpsychic" functions. The difference between them was described by Vygotsky in a particularly detailed way in the course of comparison of the outer (dialogic) and inner speech, of analyzing transitional forms (egocentric speech); it concerns both function of speech and its structure. Sense formation is one of the most significant distinctions of the psychological systems from the social ones.

If we analyze the ideas about the nature of psychological systems formulated by Vygotsky in the context of the following development of systemic notions in psychology, we can clearly see two tendencies: 1) further elaboration of the concept of psyche's specific character, 2) refusal to consider this idea. The first tendency is distinct in the works of Alexander Luria, Aleksey Leontiev, and some of their disciples. Luria (5) has elaborated the concept of systemic localization of psychic functions. Leontiev (4) has made a significant contribution to the theory of psychic functions, by formulating ideas about the systemic nature of activity, consciousness and personality. At the same time, modern psychological science has a wide tendency to regard mind as a system, ignoring the specific features of psychological systems. A particular instance of this tendency is the refusal to distinguish between cybernetic and psychological systems. It manifests itself in the studies on perception, memory, attention, cognition in general, on the sphere of emotions. Psychology is treated sometimes as a science studying the processing of information.

The theory of psychological systems put forward by Vygotsky constitutes a basis for comprehending the psychological consequences of IT's use. On the other hand, we cannot forget that IT of the present day didn't exist in Vygotsky's time. It is a new technical and cultural phenomenon, a new factor determining the development of human mind.

According to one of Vygotsky's central hypothesis, man's psychic processes are changing just as the processes of his practical activity; they become instrumental. Language, mathematical signs and mnemotechnical means perform the function of inner "psychological instruments" analogous to the tools of physical work. The principle of activity's adjustment should be, in our view, treated not only within the context of human mind's organizational differences from that of the animals, but also in the context of the historical development of human activity (6). Information technology applied for educational purposes, is an instrument of human activity which has important features different from those analysed by Vygotsky. If we compare IT both with the tools of physical work and to the "instruments of spiritual production" (a process studied by Vygotsky), the IT use could be considered as a process of further development of the external means of human activity (including that connected with spiritual production) and the means of sign activity.

Comparing IT with the "instruments of spiritual production", one easily sees that IT implies doubling of "psychological instruments": today we have artificial languages and new mathematical signs (whole sections of Mathematics). As a mnemotechnical means IT is comparable with the notches and "memory knots" analysed by Vygotsky. New psychological instruments participate both in interpsychological and intrapsychological functions. The developing external instrumentation (function "divided" between man and IT) is not indifferent for the internal instrumentation, for those "psychological instruments" which were described by Vygotsky. The distinctive feature of the new information technology is constituted by the fact that it makes instrumental the activity already rendered instrumental by "psychological instruments", as if partially relieving man from the latter. One can say that the use of IT actualizes the principle of double instrumentation, creating conditions for a further development of psychological systems (higher psychic functions), for the emergence of new psychic functions of still higher quality.

Psychological consequences of the use of IT are a total of the changes produced by this technology in human mind. These are significant changes; they belong to both cognitive and motivational-emotional processes, to consciousness and the unconscious, to man's personality and individuality. They can be situational or stable, direct or indirect. We should regard as psychological effects the image of technology itself, as well as the image of man and his psyche produced by the IT-saturated world. Regrettably, mass utilization of information technology often begins without any preliminary study (for instance, in experimental schools) of the psychological consequences of its use; this means that we may face unexpected problems. Psychological (and social) consequences of computerization have a contradictory character. Besides being an universal means of data processing, IT is an universal means of influencing man's psyche, a means which may be goal-oriented or spontaneous.

The widening use of IT has put before psychologists a new theoretical problem: to study the specific features of creative and routine processes - that is, as it were, two levels of functioning within the higher psychic functions. The task of analyzing psychological effects of the IT use is concretized, to a great degree, as the task of analyzing IT's influence on the development of creativity. In this context, Vygotsky's criticism of the attempts to reduce creative imagination to reproductive one (3) preserves its topicality.
Special psychological research has shown that creativity can also develop in the context of the application of IT. There appear forms of creative work, education and play which are simply impossible without the use of computers. At the same time, there may appear new forms of stereotyped, routine thinking. Fear of IT or unbridled optimism regarding its use are two opposite emotions which can be born within "dynamic systems of meanings". We witness both a sharp rise of external, prestige motivation for the use of IT and an intensive development of cognitive motivation under IT's influence. Let us note that Vygotsky attached great significance to the "sphere of motivation" as a determinant of thinking processes (2). IT has promoted the interest for studying specifically human features in personality and man's creative activity. On the other hand, IT is a source of new technocratic thinking, according to which man is computer's analogue possessing only quantitative differences from the machine.

This way of thinking wrongly reduces creativity to the realization of an algorithm. Limited opportunities for analyzing IT impact in classrooms make us pay more close attention to laboratory experimental psychological research into creative activity performed in conditions of the IT application. Studies of goal formation as a display of creativity in the dialogue with the computer have demonstrated the potential possibility to broaden the range of man's creative activity. This manifests itself in a larger total of formulated goals, as well as in their increased originality. It has been also shown that the use of computer data leads to a qualitative change in the goal formation processes: to revealing absolutely new qualities of object situation which are inaccessible without computers; to changes in the object content of the goals formulated in the process of solution, changes in its structure; to a wider field and higher level of independent selective search. At the same time, the research has shown that the effect of creativity development in computerized conditions can be considerably enhanced by providing psychological support to IT. In opposite case there is a high probability of stereotyped, trite thinking based on IT's "authority".

The fact that, according to Vygotsky, higher psychic functions come into existence twice, makes us pay particular attention to the new characteristics of "interpsychic" functions: along with the functions divided among people there have appeared functions divided between man and IT. Certainly, dialogue with the computer is but a specific fragment of computerized man-to-man intercourse, but one must not underestimate its specific character.

Dialogue with IT is determined by such parameters as mutual activity, mutual understanding, mutual protection and mutual control. The psychological model of this dialogue is based on its participants' different qualities. Man as a partner in the dialogue with IT has real needs, motives and goals. IT has only those motives and goals which are attributed to it by man. The model of man as a participant in the dialogue, which does not take into account his needs, emotions, sets and "dynamic systems of meanings", is very far from the modelled reality (9).

The experience of creating dialogue systems shows that man may trust or distrust IT messages. In the first case, he may trust them too much, i.e. to form an uncritical attitude towards such messages. So it is necessary to "sort out" forms of function distribution and of cooperation between man and IT in the course of problem solution, the forms which will eliminate the above-mentioned phenomena. These problems will have different solutions in regard to users with different styles of thinking. There have also emerged complex psychological problems of understanding and accepting explanations, of accounting the requirements in different types of explanations, of carrying out psychological studies on the "business prose" language, of working out criteria for full understanding of texts.

As shown by special studies, individualization of programmes as regards their object and content, allows to vary messages received by the user from the computer and their functioning as explanations, according to the degree of their particularization, direction, frequency of inclusion, orientation and the educating or controlling effect, which has been determined by specific characteristics of the user's cognitive style. Thus, individualization of the communicative plan to organize interaction consisted in: (i) the introduction of special procedures of stimulating control over the choice and realization of the computer's algorithm; (ii) the activization of the processes of preliminary planning of the search strategy; (iii) the differentiated presentation of evaluating messages; (iv) the insertion of search-directing influences (1).

Psychological effects of the use of IT depend on the goals of this use. At present, considerable psychological consequences take the form of secondary effects of attaining the goals of IT use; these effects do not produce desirable changes in man's psyche. The system which is applied in this country for studying the bases of informatics and computer science in high schools and colleges first of all provides for the mastering of programming skills. It is not aimed at the development of creativity or at forming notions about the possibility to use computers for such development.

Education includes the planning of higher psychic functions' future performance. A clear idea of psychological conceptual models is to be the basis for planning the application of information systems for educational purposes. Let us, proceeding from Vygotsky's concept and the experience accumulated in the course of its further elaboration, formulate some relevant theses.
Man performs some activity (for example, educational activity) with IT. Usually it is a joint activity including intercourse between the participants, with its active, gnostic, emotional and communicative components. Both individuals and groups of individuals can participate in this activity, which is characterized by a certain degree of activeness. Transformation of the joint intellectual activity by IT gives a potential opportunity for realizing a qualitatively new activity, for broadening man's creative abilities and developing his personality.

Psychological effects of the IT use greatly depend on the type of IT and its "intellectual" level. Existing ITs do not possess such features of human intellectual activity as motivation, emotional regulation and goal formation, so we can speak about their intellect only metaphorically. The tasks of psychological expertise in regard to projects to improve today's ITs are becoming more and more complex, because work is under way to create computers of new generations. As for fifth generation systems, we have all grounds to maintain that they will not reproduce human thinking. Expert systems, or systems based on knowledge, now occupy the first place in the sphere of artificial intelligence, so it is appropriate to recall how Vygotsky treated knowledge.

According to Vygotsky, knowledge - i.e. generalizations, notions - is qualitatively heterogeneous; it includes syncretic formations, complexes, pseudo-notions and notions; everyday and scientific notions. Knowledge is characterized, among other things, by the degree of its comprehensiveness. A distinction was drawn by Vygotsky between words' meaning and their sense. He emphasized the systemic character of notions' organization.

Today there are no scientific grounds to assert that IT possesses a psyche. At the same time, psychic qualities are often considered IT attributes. IT personification can be consciously employed for introducing non-programming users to information technologies.

Thus, Vygotsky's concept leads to viewing IT's psychological effects in the educational sphere in the general context of mind's development and its functioning. As for a proper education and cross-cultural approach, one should take into account the following.

One of Vygotsky's important ideas is about the leading role of education in the processes of child's mental development; therefore, we must speak not only about the use of IT in education, but also about the important enhancement of education's leading role by IT, about such effects of IT's use that could not be possible following the traditional educational ways. Naturally, IT must be a means of controlling educational activity rather than an object of education (7).

Thesis about the "zone of child's nearest development" preserves its validity. It also acquires a new aspect: a child can use IT to do what it cannot do alone or even with adult's help.

If Vygotsky's concept is applied consistently, then the problem of cross-cultural differences in IT's impact on human mind must be replaced by the problem of analyzing the peculiarities of mind's historical development effected by IT in different cultures. Among the expected changes are the realization by man of his own thinking and his broader control over thinking processes.

These are some results of the analysis of the possibilities connected with the application of Vygotsky's concept in the time which sees a constantly broadening use of its creation - information technology.

References

1.3.2. GENETIC AND MODELLING METHOD AND ITS USAGE FOR STUDYING COGNITIVE DEVELOPMENT IN CROSS-CULTURAL RESEARCH

Prof. V.V. Rubtsov, Russia

1. General Characteristic

The genetic and modelling method (synonyms: causal and genetic method, experimental and genetic method, forming experiment) is based upon the two general principles, in accordance with which studying an object should be realized 1) not by way of decomposing the whole but by distinguishing the units that include all contradictions and specific properties of the object on the whole; 2) beginning with the analysis of the developed form of the object existence and then back to the history of its emergence and disintegration. This method enables to study the phenomenon genesis and its development.

In the history of psychology the experimental and genetic method was elaborated by L.S. Vygotsky and it was related to his cultural and historical theory of higher psychological functions development. The fundamental property of the method is active modelling and reconstructing under special conditions the very stages of psychic development to disclose their psychological nature. Thus, the essence of the method lies in elaborating artificial experimental conditions favourable for the creation of the very process of psychic functions' higher forms' formations.

According to L.S. Vygotsky, experimental investigations of genesis of psychic phenomena is based upon two points: first, specifically human psychic processes are actually the mediated process, which use various, worked out in the process of historical development of the human culture tools (means) - signs, symbols, language, measures and so on; second, any psychic process arises and acts on two planes: social and psychical, or, firstly, as an interpsychic category, and then as intrapsychic one.

For the first time the experimental and genetic method was used by L.S. Vygotsky and A.N. Leontiev in forming higher mediated forms of attention and memory. So, for example, the process of forming mediated memorising in children evolves in two ways: by perfecting supporting devices and by way of the transition from outer means to inner means (A.N. Leontiev, 1983). Further the method was used in forming the soundpitch ear by A.N. Leontiev (1958), in the study of voluntary movements by A.B. Zaporoschets (1980), in the process of investigating the regularities of perception development by L.A. Venger (1977) and others.

A special direction of elaborations was connected with the usage of the experimental and genetic method to study the games of pre-school children particularly with forming the transition from a subject game to the role one, forming in the game the "conditional and dynamical position" and so on. It should be noted that experimental research of the game was built on the base of longitudinal forming of game activity of the same children collective with a special aim to direct its development under which the principal task consisted in disclosing the possibilities and conditions of the transition from one level of the game development to another (D.B. El'Conin, 1978, p.174). The essential contribution to the development of a research strategy, based on the genetic and modelling method, was put by P.Y. Galperin who worked out the theory and procedure of the stage by stage formation of mental actions, and then purposeful forming of psychic processes with pre-given properties: attention, simultaneous perception and so on. (P.J. Galperin, 1966, 1974). In the sixties, beside laboratory experiments, there appeared investigations conducted in the form of experimental organization of the teaching process of the whole classes, in which the effect of teaching on psychic development was studied (P.Y. Galperin, V.V. Davidov, N.F. Talizina and others).

Such a teaching sets the task of forming the specific types of activity, first of all, the cognitive one, but not the abstract functions of the memory, thinking, attention and so on. Experimental teaching enables not only to determine the preformed peculiarities of psychic processes, but purposefully to form them, reaching a certain level and quality. This enables the experimental study of the genesis of the perception, attention, memory, thinking and other psychic processes. V.V. Davidov and his followers' works made a considerable contribution to elaborating the problem of the usage of experimental and genetic method for collective teaching processes. The development of scientific thinking of children is investigated in this works by purposeful forming of theoretical conceptions in the process of the adult-children (the children themselves) mutual activities.

Experiments were realized on a whole class scale. This kind of teaching solves the following tasks: 1) profound study of the influence of teaching on the psychic development; 2) the study of age peculiarities of human psyche under various conditions of the activity; 3) considerable change and variety of learning activity's forms determine the effect of these changes on the rate and peculiarities of development, perception, attention, memory, thinking and formation of will. Thus, we investigated inner connections between learning and development and the conditions, which are favourable for psychic development. Purposeful systematic
and regular character of the necessary learning impacts is ensured in the process of such learning. The methodology of experimental learning has the following peculiarities: 1) its content and realization modes are pre-planned; 2) peculiarities and results of such learning are fixed in details; 3) both the level of mastering the subject matter and the psychic development level on various stages of the experimental learning are being tested; 4) the data obtained is compared with the results collected in the survey of control groups and classes.

2. Theoretical Background of Learning Activity and Computer Functions in Organizing and Controlling it

Computer usage as a carrier of programmed and informative systems in the organization of multi-level learning processes is of considerable importance for the conditions of extensive informatization of modern society. The role of this equipment (and first of all of the personal computer) can be justly compared to the role of books, paper, and pens in the process of learning. However, the essence of this role of the computer is being differently characterized in various conceptions, which have come to function in psychological and pedagogical science. A widespread point of view states, that the most effective computer use for learning purposes embodies such an understanding of the learning process, which is based on the psychological theory of the learning activity and the genetic and modelling related to the cultural and historical theory of human activity (L.S. Vygotsky), on the activity approach (A.N. Leontiev, S.L. Rubinstein) to the origin of the human psyche. The positive contribution of the psychological theory of the learning activity' lies in the fact that it is oriented to the regularities of the formation and development of the real object and subject matter directed activity of a school-child within which he forms his consciousness and personality. A.N. Leontiev's, D.B. El 'Conin's, P.Y. Galperin's, V.V. Davidov's and others' theoretical and experimental research works pointed to the existence of a connection between specially organized children's activity and the zone of their "proximal development".

In the modern development stage of society the learning activity is considered to be a new form of practice, a new system of reproducing activity, directed to the formation of the human's general psychic abilities, and not to separate psychical functions only.

Acting towards an individual person as a) a method of forming a system of scientific knowledge and as b) a method of active constructing (inside the process of generalized modes of actions), learning activity lays the basis of creative thinking, i.e. of the ability to change creatively subjective conditions and action scheme. Hence the learning activity forms the grounds and concrete mechanisms of "self-development" (self-transformation and self-activity). They are provided for by the fact that the knowledge obtained is mastered by school-children via disclosing the conditions of its origin on the basis of analysis, planning and reflecting the actions performed. Due to this mastering the way of obtaining knowledge precedes the knowledge in its particular manifestations. If the given condition is not observed, then an empirical type of instruction takes place which gives formal knowledge (information, general conceptions) because subjective activity is not fo-'used upon systematized objects, but upon random ones not relating to the context of the action analysis aimed at constructing the objects.

The aim of the learning activity is to reveal the sense of learning itself, i.e. to teach children "the skill to study", the skill to think of their own. It is achieved with the help of the fully determined structure of learning activity.

The principle structural components of learning activity are: a learning action, a learning task and also an act of control and evaluation. Learning tasks in contrast to other types of tasks solved by man, provide mastering generalized ways of solving a certain class of concrete and pragmatic tasks. Learning task directed at solving problems is connected with performing of a special system of learning actions, which includes:

- transformation of the situation to reveal the general structural principle of this system;
- modelling of the disclosed principle in a graphical and sign form;
- transformation of the model principle for studying its properties;
- deducing and building up series of specific, concrete and pragmatic tasks which can be solved with the help of the general method;
- control over the preceding actions' performance;
- evaluation of the process in mastering the general method of solving. (V.V. Davidov, 1986).

The considered statements enable to put the problem of evaluating of the new technology effectiveness, based upon the computer usage. Such evaluations include grounding of the role, scope and limits of computer usage as a means of forming (organization and control) of the learning activity, that is, setting up and solving of a learning task, performing learning actions in the full set of their components. Here computer has the function of mediating learning activity, i.e. takes part into the process which creates the pre-requisites for the development of the most important cognitive processes - reflection, analysis, planning and understanding. To realize this fundamental function one should elaborate special computer educational microworlds (CEMs), directed at computer usage with some specific functions: a) as a means of learning modelling of the subject...
matter contents of objects; b) as a means for performing the appropriate generalized patterns of actions; c) as a means of realizing of the forms of control and evaluation the pupils actions' performance (actions, which are adequate to activity structure and to mastering of the object's contents); d) as a means of organizing of collectively shared learning activity in the system "teacher-pupil" and "pupil-pupil". In a computer instructive programme as one of the organizational and object-oriented units of the new education technology there can be realized all of the above noted computer functions or a part of them. Thus, there can be made a classification of CEMs, based on the integral structure of the learning activity:

- CEMs for forming separate learning actions, that is, analysis, modelling, planning, reflection; modes of solving learning tasks systems and acquisition of science concepts on this basis; integral learning activity structures;

- CEMs for diagnostics (enable to evaluate the levels of learning activity components' formation and their dynamics in the process of use of CEMs for forming learning activity;

- CEMs for control-evaluation (include CEMs for testing).

For developing any type of computer educational microworld one should take into consideration the computer's potential for control of the user's activity; for the availability of a dialogue system that decreases the subjective difficulty of the presented tasks; for differentiation and study of separate components of an information image without destructing its integrity; for the adaptability of the computer system with regard to sufficient scope of automatized and automatic control modes.

Observing of the communication principle of the learning situation (including a computer or modelled via computer) is essential in designing a CEM. The direction of the main research here could be determined by the necessity to create a situation appropriate for the independent solution of the learning task by the pupils. This task should force them to analyse the object material, to reveal some certain general principle in it, and next on the basis of its contents generalization - particular regularities of the given material, to unite them into a certain integral object.

Ample potential of modern computers enables to put the question of adequate realization in the learning activity of the principles and modes of developing education - on a new scale. These principles have been poorly introduced due to the lack of efficient technical equipment. Computer usage opens up new prospects to organize for example the learning activity in game forms (individual and collective). In this case pupil's activity is of investigating and investigating-constructive type. The positive effect of such an organization is very important. It is connected with increasing of the motivational aspect of the learning process, with the stimulating of the formation of investigating and constructive skills under mutual activity modes, with the decreasing of formal mastering of knowledge and results finally in the development of creative thinking of children.

The complex of questions related to developing computer system for children's learning, is presented in the works of the new trend. Seymour Papert develops the idea, that the future education with new information technologies, is not the equipment development problem only, because computers do not determine the real culture and learning environment. One should speak of pedagogical technologies of a new type, ensuring conditions for the creative activity of the child and the introduction of innovations into the process of the learning activity. As an opposition to technocracy choosing constructivism as a new principle of creating constructive objects on the basis of a microcomputer, S. Papert points out the fact, that it is activity of the child himself that should become the centre of the future pedagogical technologies.

Today, however, there does not exist a unified theoretically grounded position of programmers and educators enabling to realize the activity approach to developing new education technologies. The pedagogical experiment has revealed low effectiveness of the majority of teaching programmes of the first generation (of the type "Questionnaire", or "Simulator"), whereas the second generation of such programmes has not been yet formed. At the same time spontaneous processes of programmer's creative work and pedagogical initiatives have lead to the emergence of a number of orientations in the sphere of designing programmed pedagogical software, among which the most effective are those designed by S. Papert (USA), B. Sendov (Bulgaria) and others. Developing computer microworlds of this type makes it available for the teacher and the pupil to master some concrete subject matter that could be a part of any of the school subjects, or could combine together a number of various subjects (such as atom structure in Physics and Chemistry, landscape zones in Geometry and Biology, etc.). Such kind of mastering takes place in the process of performing numerous "experiments" with objects of the selected sphere. Here the contents of these "experiments" is becoming more complicated while the user (teacher and pupil) masters more new actions, performed in the given learning environment.

Numerous investigations show that the use of object-oriented learning means permits to build up a non-formal learning setting of open "child-child", as well as "adult-child" interaction. Under this type of interaction the adult finds himself in the position of a practically taught person (for example, in searching and detecting programme bugs, which cannot be avoided by the most experienced programmers).

S. Papert's conception, based on the idea of a spontaneous and self-directed action goes back to J. Piaget's theory of interaction as the basis of child psychological development. Based on this conception, S. Papert is pointing out two stages of the action development process: a) a real action with objects and
b) actions in the special quasi-object environment, when an opportunity to control the object with the computer is taken by an action of the subject himself. The transition from one stage to another in computer microworlds can be considered as one of the important principles of designing of new educational technologies. It should be noted, that recently there appeared quite a lot of works, in which S. Papert's central idea of spontaneous learning via computer usage has been heavily criticized. Various investigators showed the importance of adequate organization for creative learning. This organization enables intercourse and contents rich communication of children and determines the child’s "social situation of development".

The designing and developing of educational microworlds constitutes a necessary, but quite not sufficient condition for creating the new pedagogical technologies. In connection with this, special significance is attributed to grounding and elaborating integral systems of learning activity, mediated by a computer, retaining all the stages of adequate learning actions performed by the child himself. The process requires "child-adult" and "child-child" mutual actions’ organization.

3. Requirements to Computer Educational Microworlds (CEMs)

Considering computer as a means, mediating process, mechanisms and structure of the learning activity, one could formulate initial requirements to the models of computer learning technologies.

They could be divided into two groups: requirements to the contents of the microworld and requirements to the learning activity organization.

3.1. The requirements to selecting and content of the mastered material (a system of concepts, learning tasks and actions; the contents of the mastering - dynamic or discrete).

This group of requirements is the basis for elaborating a microworld and could be reduced to the following short list:

- unity of logical and object basis of forming practical skills and theoretical concepts, including setting up of a task, the analysis of the modelled situation, programming the user’s actions - that is the working out of some "model of a pupil";
- revealing the knowledge, constituting a concrete school subject or its section (a system of concepts, schemata, models, structures, concrete units of the mastered material);
- defining of the logical and object context of the mastered object existence (the conditions of its origin and transformation);
- determining the types of models, permitting to study the object’s properties "per use" (object, graphical, sign-symbolic models);
- the problematization of a task contents in the way, that, on one hand, excludes some of the conditions or considerably limits empirical search strategies, and, on the other hand - gives an opportunity of accessibility of solution tools.

The forms and nature of computer-based object imitation are determined by the requirements for a full description of the objectivity, and the contents to be mastered. One can correctly specify the studied object via an appropriate computer model, if there have been determined: a) the initial elements and their relationship which characterize the object as a certain system (for example, the interaction relation determines the physical object content, the quantity relation defines the notion of number, the geometrical elements relation - plane geometry axioms); b) the elements types relations (axiomatic), characterizing the object’s properties and determining, in fact, the tasks variety, solved via the given mode; c) the type of the sign means provided for the realization of all kind of relations displayed on a computer screen.

The specificity of instructive subject matter material brings about additional demands for computer representation of the microworld dynamic structure. In particular, a discrete object (for example, the language as verbal communication) can be presented on a display in the line - table form, whereas a dynamic object (for example, interaction) should be given in the form of successive transformations. To represent a complex of discrete elements of a microworld one needs separate signs, symbols and graphic elements of images whereas a dynamic object is manifested in integral graphical pictures of its elements, transformations and so on.

3.2. Requirements for the User-Computer Swapping Mode

The second group of requirements provides, first of all, the transformations performed by the subject and their modelling. The models of computer instruction should provide the user with access to the operative contents of the notion. That is why when making and mastering such models one should distinguish between the objective and operative aspects of building up an action. Both aspects should be represented equally, but with the leading role of the operative aspect, providing for detailed analysis of the object’s contents by the pupils themselves. Thus, instruction should combine the potential of the dynamic and semiotic models usage,
the application of which should be made on the basis of active - operative principle. This requires certain means of fixing transformations performed, development of the means to provide the following opportunities:

- representing on a display the pupils' actions and their connections with the change in the operated object;
- a convolution of actions' systems to the level of operations' systems in the structure of new and more complex actions and a sign fixing of some of them;
- selecting a discrete or non-stop mode of objects transformation on a display and providing a possibility to combine both modes;
- an automatizational and automatic regulation of the rate of performing actions with the object that depend on the learning activity stage.

The concrete realization of a computer teaching programme, satisfying the requirements listed above should be based upon the adequate organizational forms of introducing pupils to the learning situations and acting in them. These forms are based upon such computer functions, which permit to build effective modes of interaction of the system "teacher-computer-pupil". First of all they include:

- demonstrating models of computer use to pupils, and besides - different variants of "teacher-pupils" interactions;
- actions distribution in the structure of the task solved between different pupils and their cooperation;
- mutual control and evaluation of pupils' actions in the process of solving learning tasks of certain sequence;
- mutual modelling of the object mastered which is given by the teacher;
- reflecting and representing by a pupil of the task solving mode, used by another pupil.

The regulation of the instructive cooperation could be achieved via programming different degrees of pupils' individual actions autonomy: from their complete independence to a significant limitations of the mutual influences.

One of the productive modes of interaction organization under collective-shared activity conditions could be the socio-cognitive conflict, given objectively or operationally. Here it is desirable to provide the presence of constant and simultaneous representation of a mutual and individual actions' results and operative control of them. For this purpose it is necessary to provide the transmission of information about the group's work results from the teacher's display to the group members' displays or to the whole class and besides an opportunity for pupils' group work at various monitors via local net with a task, which is common to the whole group.

Let's formulate a number of statements, that make concrete the strategy of elaborating models of computer education technologies for cross-cultural investigations:

1. Computer education technologies should be created on the basis of the preceding analysis of the operators' contents of appropriate knowledge and abilities as mastered objects with the help of computer as a means of teaching/learning; various contents should correspond to various computer programmes.

2. Computer education technologies should unite the properties of dynamical and semiotic models; thus, mastering these models, a child performs corresponding learning actions and operations and masters the contents he discloses in a subject matter area; working with such computer technologies, a child is not adapted to computer, but acts together with it, actualizing some object material transformation and besides controls such transformations keeping in mind the tasks set.

3. Computer education technologies should take into consideration age aspects of human's development; various age stages require various forms of contents of use of computers at school (from object game forms for juniors and senior pupils to research creative forms).

4. Creating new education computer technologies should be realized via detailed study of their usage modes in various learning situations ("adult-child", "adult-child-child", etc.), appropriate elaborations and studies should be the basis for investigating the capacities of each technology and its use in teaching/learning.

5. Computer education technologies application in cross-cultural investigations should reveal the regularities of development of the given children contingent of the basis of theoretical creative thinking, which in a sense could be named "programmer's" thinking, enabling the human to use logical and mathematical means for programming and planning his cognitive actions, realizing reflexive evaluation of opportunities of performing them under new conditions of his activity.
The ITEC Project: Background, Preliminary Period

Literature


* Papers developed by researchers of the Computer Teaching Laboratory are used (See Nevueva L.Y., N.I. Polivanova, I.V. Rivina, I.M. Ulanovskaja, Problems of Psychology, + . 3, 1988).
1.3.3. ASPECTS OF PROCESS MEASUREMENT

P. Light, UK, and J. Rogalski, France

Introduction

Discussions to date concerning the ITEC project for a longitudinal / comparative / cross-cultural study of the effects of educational computer use on child development have focussed upon the broad framework of the study. This has included consideration of some of the major "independent variables" (age, educational setting, type of software) and of candidates for pretest and outcome measures. Little consideration has thus far been given to the types of data which might be obtained throughout the course of the study to illuminate "what goes on" while the children are working with computers and to offer indications of possible modernizing factors and mediating processes. It is our contention that rich descriptive data on these issues will prove at least as valuable within the context of the study as data on overall pre- to post-test changes and "outcomes". Indeed the latter will not be readily interpretable without the former, while the descriptive "process" data may be of considerable interest in their own right.

This brief working paper (which should be read in conjunction with the Working Paper by Zimra Peled) outlines some of the approaches to measurement which may be most appropriate.

Diary Methods

It will be necessary to gather basic information concerning how much the computers are used and what they are used for. Since this information must be gathered over a considerable period of time, the most practicable way of obtaining it is by having the teacher(s) and/or the children maintain a diary or log book of computer use. For example, the teacher might maintain a record (comparable to the "cahier de classe" which French teachers keep) recording the date, duration of use, which children were involved, the curricular context and specific software used etc. Information about the mode of work or classroom organization (see below) might be briefly coded too, and the diary could include space for any comments on, for example, particular difficulties encountered by the teacher or the children. Diaries of this kind, maintained across the duration of the study, will allow comparisons of patterns of use in different settings and also index changes in patterns of use over time within one setting.

Direct Observation Methods

The classroom organization of computer use is of particular interest in cross-cultural perspective. We will need detailed information on how the computer is "inserted" into prevailing pedagogic styles, and this will require direct observation of both computer-based and non-computer-based sessions. The key dimension is control. In some cases the computer(s) will stay under the teacher's control, interactions between the child and the computer being mediated by the teacher. In other class the computer(s) may be used as a common resource in the classroom, interactions between the child and the computer being shared but not controlled by the teacher. Finally, the computer may be used by children directly, with the teacher being essentially a background resource to be used in case of difficulty. Rogalski (1988, paper attached) has analyzed some of the patterns of control which may emerge in these various situations.

When children are working directly with the computer they may be doing so individually or in small groups, and when in groups may be pursuing parallel/individual activities on a turn-taking basis or may be involved in fully joint activities. The ways in which such collaborations are managed by the children, general differences, the quality of verbal exchanges, and the ways in which the computer interface facilitates or inhibits collaborative learning are all of interest. Here again, comparison with other, non-computer based activities involving the same children are important, as are changes over time as the study progresses. Clearly it is not possible to specify an appropriate systematic observation schedule at this stage, but the objectives outlined could only be satisfied by the use of trained observers (with or without the assistance of videotaped records) and would require considerable pilot work. Observation could only be undertaken on the basis of random time samples, preferably fairly frequent but brief. A number of studies in the literature offer indications of appropriate observational categories (see Working Paper by J. Rogalski; P. H. Light, C. J. Colbourn & D. J. Smith. Peer Interaction and Logic Programming. - Occasional Paper, ESRC, ITE/17/87).

Interview/Questionnaire Methods

We are (or at least we ought to be) interested not only in what teachers and children do with computers in the classroom, but also in why they do it, in what that model or representation of the computer is, and of
how this evolves. From the teachers we need to know why they make the choices they do in terms of the classroom management of computer use. From the children we need to know about their attitudes and motivation, and how these change over time.

Interviews and questionnaires are the appropriate methods here and will need to be used not only at the beginning and end of the research period but also during the course of the study. A number of studies in the existing literature on educational computer use have employed questionnaires of various forms (see P. H. Light, C. J. Colbourn & D. J. Smith paper). These can be adapted and developed for present purposes. The use of standard interviews/questionnaires across several diverse settings promises to produce some extremely interesting findings on how the educational possibilities of computers are conceptualized by children and their teachers in a range of cultures, and on how these conceptualization are changing.

Conclusion

This paper offers no more than a sketch of some of the more obvious questions which need to be asked and some of the appropriate methods of gathering the relevant data. The outline can be refined into a precise protocol only when the broader framework and objectives of the study are more fully defined. But in general we can say that the methods we have considered are available, have already been used to a greater or lesser extent in this domain, and can be fairly readily tailored to meet the particular needs of the study as they emerge.
1.3.4. SOME METHODOLOGICAL ISSUES ABOUT INTRODUCTION OF COMPUTER IN THE CLASSROOM

J. Rogalski, France

Introduction

We want to propose a classification for the situations of introducing computer in the classroom. For each of the defined situations, we analyse the problems of "how and who", for controlling the computer (ergonomy and software content), the issues about how can teacher control relationship between student and knowledge, how can teacher manage time, relationships between types of didactical situations and types of implementation of computer in the classroom.

1. Classification of situations where computer is intervening in the classroom

Three main types of situations may be described:

- situation 1: the computer stays under teacher's control; interaction between students and computer are mediated by teacher;
- situation 2: computer is a common resource for the classroom; interactions between students and computer are direct, eventually shared (but not controlled) by teacher;
- situation 3: computer is used by individual or small groups; interaction between computer and student(s) is direct.
- It could be possible to consider a 4th situation, where computer is used in free access; we think that in such a situation, it is not realistic to speak of "computer in the classroom".

2. Problems encountered by teacher and/or students in controlling computer (depending on the type of situations)

We will say that teacher controls the computer when s/he is controlling the enters. In this case s/he is deciding about commands or about responses to computer instructions, even if students have to propose responses or commands.

We will say that students control the computer when they have the responsibility for decision-making and commands' execution.

In Figure 1, modelling control relationships depending on situations, double arrows towards computer represent control of computer. We have added relationship concerning the "reading" of outputs produced by the computer: arrows from computer towards users (students; classroom and/or teacher). The "waved" arrows represent how teacher may intervene on the control managed by students and more generally how s/he can help in the communication between student(s) and computer. This communication involves ergonomic issues, questions on mental representations (by user) of the informational device and proper communication about the content of cognitive activity.

3. How can a teacher control relationship between students and knowledge?

Most of the teacher's decision making depends on her/his knowledge about what is happening in the classroom. Students' answers to questions, or content of their own questions, are elements used - perhaps unconsciously - in the control of relationships between students and knowledge content.

When introducing computer in the classroom, it may happen that some of these relationships cannot be expressed or observed in the same way.

- In situation 1 the communication between teacher and classroom is conserved; using computer as a dynamical blackboard or tool may require more precisions from students, allowing teacher to get more knowledge and control. The possibility offered by software to record the sequence of interaction between computer and classroom allows better "a posteriori" control, and reliable memory on "classroom history". This can also be used as a means of provoking and supporting a meta-cognitive activity for students.

- In situation 3, teacher as "resource", as actor for validation of students results or strategies is replaced by the computer. Some important elements concerning students/knowledge relationships are no more under teacher's control. This situation gives to the group the responsibility of information purchase, strategies and results validation. The possibility of recording students' interaction with the computer allows to use a delayed control, perhaps more efficient than "on-line" teacher's control. A condition seems to us to include with the software some analysis of students' productions.
Situation 2 shares properties with situations 1 and 3, depending on the way of introducing computer in the classroom.

Implementing a function of management of students/knowledge relationship on one hand allows new possibilities for delayed control and metacognitive activities with students; on another hand it requires elicitation of nature and ways of control, involving in most domains a noticeable development of didactical knowledge.

4. Time managing

Time managing is an important part of decision making in the classroom. Regulation of the teaching process is implemented under two ways: long-term control, using teachers' experiment on given didactical sequences; short-term, "on-line" control, supported by feedbacks constituted by students' reactions.

Long-term regulation of computer-based didactical situations is difficult to analyse and to manage because of the scarcity of such situations in present teaching. "On-line" regulation differs more or less from traditional teaching situations and depending on computer use. It depends on the way by which the function of control on student/knowledge relationship is fulfilled. At the moment, software design does not take into account the long-term temporal dimension which is needed for time management in a classroom sequence.

At last, situations of type 2 or 3, where students directly interact with computers require more efforts of "resynchronisation" in the classroom, outside of the students/computer interaction. Thus, analysis of the temporal dimension appears as an important and difficult component of issues raised by introducing computer in the classroom.

5. Didactical situations, computer in the classroom and cognitive issues

A rough classification of didactical situations can be done depending on the type of question asked about a new notion:

- "Why" this notion: to what problems does the notion give answers? What are the relationships between known notions and known issues;
- "How" does the notion act: What are the properties of the notion, what type of operations are supported by it.

An analysis conducted by Françoise Trehard on mathematical software for primary school shows that didactical stakes depend on the properties of software. Her typology can be extended to other levels, and combined with our typology of situation introducing computer in the classroom.

Our hypothesis is that the "way" questions, developed in the situations of "action, formulation, validation and institutionalisation" as defined by Guy Brousseau(1) can be handled in situations of type 1, "how" questions can be handled in situations of type 3.

Analysis of the didactical situation involving computer in the classroom, requires to pay attention to the cognitive difficulties students may encounter when interacting with a computer.

When this student directly interacts with a computer (situation 3) s/he may encounter difficulties linked to the interaction between content and communication with the computer. Nevertheless, on the other hand s/he can have a direct feedback of her/his proper actions.

In situation 1, where the teacher has in charge the communication task, the first type of cognitive difficulty disappears. However, students have no more the control on hypotheses' trials and feedback: the question of how they can "internalise" information about a notion or a problem if they were not directly involved by a proper action is open.

Conclusion

We have tried to classify the way by which computer is introduced in the classroom, in order to define some variables possibly affecting the "impact" of computer on teaching and learning.

Teacher's position with respect to classroom and computer, is a crucial variable. It interacts with the variables related to the properties of the software themselves.

One conclusion is that evaluation of software considered as a didactical question, takes into account the interactions of the "triplet" teacher/students knowledge with the computer, and the central fact that these interactions concern the long-term dimension of conceptual learning.

1.3.5. OBSERVATIONS AND INTERVIEWING COMBINED AS ASSESSMENT TECHNIQUES FOR FAMILY VARIABLES

Dr. M. Csako, Hungary

This paper summarizes the techniques utilized to assess family background variables in a project on the social and cultural factors affecting the national school computer programme (NSCP) in Hungary, in 1986-1987. The NSCP's general scheme, the policy of the country council, the relationships between the schools and their socio-economic environment, headmasters' philosophy on and attitude towards computers in schools, teachers' and children's attitudes as well as children's family background were introduced as main categories into the project.

Family was supposed to play a facilitating role in the child's interest in computer. The family variables to be assessed were: (1) general sensibility to new phenomena - as manifested in the family history by migration, occupational and educational mobility (inter- and intragenerational), the parents' actual educational level and profession; (2) the parents' attitude towards computers; (3) the child's place in the parents' value system - as manifested in the use of time and distribution of the work and the goods in the family; (4) the family's income and budgeting strategies and the weight of the child's needs and demands in the budget; (5) the "style" and problems of child-rearing in the family; (6) the parents' expectation concerning the child's future educational and occupational carrier as well as the role they take in forming the child's personality and interest; (7) the parents' relationships with the school; (8) the parents' knowledge and opinion about NSCP and computers in the child's school. The family structure, i.e. the number of all the people living together and their parental relationships was assessed as well.

In order to assess all these variables the techniques of observation and interview were combined. The items to be observed were:

1. Travel (means, time, comfort, etc.)
2. The physical and cultural environment of the house
3. The house or flat (surface, number of rooms, spatial structure of the activities)
4. Furniture, decoration and other objects in the house (TV, video and tape recorder, books, music instruments, handmade covers, etc.)
5. The style of contacting the interviewer (the room chosen for the talk, the seats, eventual drink or meal, easy/hard access to current, etc.)

The interviewers were advised to use these observations and the inferences they drew from them as topics for discussion in the interview.

The interview had 12 large topics as follows:

1. A short history of the family (profession and education of grandparents and parents, geographic mobility of the families).
2. The parents' biographies: educational and professional carrier, jobs, early ambitions and realization, life strategy, attitude towards learning and work.
3. The present structure of the family: people living together, their relationships; the use of the flat as a room of life; planned/spontaneous distribution of the work in the family, children's duty and their actual participation in family activities.
5. History of housing conditions. Housing strategies and plans (if any) for the children.
6. The family and the school. Contacts, motivation and regularity. The parents' participation in activities organized by the school. The parents' attitude towards their children's learning and achievements.
7. The parents' contacts with computers. Details of circumstances, institutions involved, impressions. Their actual attitude. Do they have/plan to buy a home computer or not? And why?
8. General attitudes towards changes in technology. Opinions, personal fears and hopes. Outlooks for 10-15 years in the economy, education, culture and society following these changes.
The ITEC Project: Background, Preliminary Period

(9) Knowledge about the computer use in their child's school, in other schools, and about the school computer programme.

(10) Had they experienced any change in their child's interests, behaviour, relationships following the arrival of computers into the school? And in the teachers' work and expectations? In the relationships between children and school?

(11) The parents' opinion of the school, of its computer use, and its grade as compared to other schools in this regard and in general.

(12) Any other topic they desire to discuss.

The interviews were tape recorded and typed. A report of observation should be joint to the end of each interview by the interviewer.

Practically, families were selected for interviewing regarding children's computing activity in school. A message was sent to them asking for a date when they could accept the interviewer's visit. In most cases, they considered the interview as an honour and tried to do their best (e.g. processed the best way to get to their address, served coffee, meal, etc). They showed their house/flat and garden voluntarily to the interviewer/observer.

Observation data offered valuable enrichment especially to the 1st to 5th, and 7th points of the interview. As children were observed previously in classroom situations the observer had got this way plenty of cross-references for further analysis and a rich ethnographic picture of the family background of computer use in schools could be drown. Interviewers were experienced field workers and the row analysis of the interviews and observations was made by themselves. They summarized their experiences in case studies by schools. A secondary analysis of the information was carried out following special topics, the role of the family background among them. Results are published in Hungarian as a chapter of the project report.
Several hypotheses regarding the mediating effect of the family on the impact of new information technologies in education on child development could be tentatively formulated in order to guide speculations as to what selection of family variables would be most justly for the ITEC project.

(i) The family is instrumental in developing the child's attitude and motivation towards computer technologies in education: a positive sanctioning on part of the family would generally cause a child of eight to embrace the idea of computer technologies. To capture this relationship an attitudinal measure needs to be introduced e.g. Osgood's semantic differential.

(ii) The family construes the social environment in ways that equip the child with paradigms that make him receptive or non-receptive to the impact of new information technologies, e.g. a fundamental belief that the environment is controllable (Olivery & Reiss, 1982) is likely to result in enhanced receptiveness to computerized learning. This dimension is best evidenced in the family's problem solving behaviour (e.g. Kuethe's felt-figure technique, 1962).

(iii) Vis-a-vis new information technologies the family will behave as in the face of major challenge demanding accommodation through change: coping will be a function of the family's characteristics as a system, e.g. too much or too little cohesion and/or adaptability will be a disadvantage resulting in poor adjustment and, therefore, negligible effect of computer technologies on the child, development. A technique for sorting families on this dimension is Olson's FACES-II 30 item questionnaire (Olson & al.)

(iv) The family's value orientation (e.g. aspirations towards child's future) is likely to have a strong mediating influence on the impact of computer technologies on the child's development. Apparent values' survey (e.g. Melvin) can control this source of variance.

(v) Pretty straight forward mediating effects can be hypothesized regarding a long list of family characteristics such as:

- Age of parents
- Level of education of parents
- Availability of home computer
- Economic indices
- Overcrowding
- Level of home media use
- Computer subculture available
- Mental illness in the family

Most of the above need to be recorded.

References

1.3.7 DEVELOPING A SCORING PROCEDURE FOR 
"FREQUENCY OF COMPUTER USE"

B. Collis, The Netherlands

1. Introduction

A major problem in research relative to comparative analysis of computer use in different school settings is specifying a scoring procedure to codify such use. Such a procedure should have some sensitivity to the type of computer use involved, both for descriptive purposes and because experience suggests that qualitatively different levels of cognitive engagement may be likely to occur within a given unit of time dependent on the type of computer activity being experienced. For example, a certain time’s worth of entering prepared text into a word processor may be logically less likely to impact on metacognitive development - an important dependent variable of the ITEC Project - than the same time spent engaged in interacting with a simulation programme requiring generation and verification of hypotheses based on data projections. It would also be desirable if a coding procedure for computer use could capture some measure of the duration of such use and some aspect of the student’s intensity of engagement during such use.

However, practical constraints must also shape the specification of a measuring procedure for the ITEC Project. Teachers in many classrooms in different countries with different frames or reference with regard to describing computer use will be asked to use the same coding procedure. Therefore a balance must be struck between specificity and mutually understandable descriptive procedures. Also, teachers will be asked to collect data on student computer usage at repeated intervals during their time of involvement in the Project; it is clear that such data collection must be kept as simple and unobtrusive as possible in order, so that teachers could remain positively oriented toward participation in the Project. The following note suggests a strategy for a coding procedure for “Frequency of Computer Use” for the ITEC Project that attempts to reflect each of the considerations mentioned in this introductory paragraph.

2. Unit of Analysis for "Frequency of Use" Measure

A first consideration prior to defining a metric unit for frequency of computer use is to anticipate what the unit of analysis will be with respect to using this metric unit. A general decision was made at the meeting in Bulgaria in May that the individual child rather than the class would be the unit of analysis for the ITEC Project; what was not decided, however, was if every child in particular classes involved in the study would serve as a data point or if some sample of the children - either a purposeful sample or a random sample - would be selected. This is a point for discussion at the January meeting of the Steering Committee. There are statistical advantages to having the same size sample from each intact class; however, there are practical objectives to the idea of collecting data only for certain students in a class when a study is meant to operate over a long term-basis. At the moment I think it is advisable to plan on every child in the participating classes serving as a data point. Given this premise, sweeps of data collection on all students must be planned at standardized intervals. As commented before, efficient and relatively unobtrusive procedures for this data capture are especially important as more children become involved in the samples. Teachers will have to do this collection and coding themselves for the majority of the time and therefore it must fit quickly and easily into their other responsibilities.

3. Frequency of Data Collection

It is unrealistic to expect teachers to capture information on a daily basis over one, two, or three years; instead a regular but less frequent time interval should be chosen. There are advantages to establishing a set day each week for data collection, in that teachers can establish a habit and perhaps reinforce the habit around some routines associated with a particular day of the week in their classrooms. However, a disadvantage of maintaining a set day is that teachers may establish a pattern of using a computer on some days of week but not others; data collection on a set day may be unrepresentative if it happens that the set day is atypical of computer activity during the rest of the week. However, I think for simplicity of expectations a "once-a-week" habit might be best. I suggest that teachers choose a particular day of the week for this data collection, on this basis of that day being "most like" a "typical" day relative to computer use, but that they would be encouraged to vary this day if it happens that the day is clearly atypical on a given week. If computer use occurs routinely on a particular day of the week but not on others (for example, a class has time in the "computer room" only on Tuesdays), then I suggest this "usage" day to be chosen for data collection and an explicit comment to be added by the teacher to indicate that such activity should not be projected onto other days of the week. We should have a statement on the data collection form that asks teachers to indicate if the activity for each week is typical of that for other days in the week, and if not, if it represents more or less usage that is typical of the other days. I am uncomfortable with my recommendation here and suggest we discuss this in particular in January.
4. Usage Categories

After dealing with the issues of on whom and how often data should be collected, we next need to consider the categories of computer use that we would like to capture in our data. There are many different lists of types of classroom computer activities, but again our decision must reflect a compromise between richness of description and practicality. For the age cohort we have selected for the Project I suggest the following categories are adequate:

a. "Learning and Reviewing" with programmes where students are attempting to master fixed content. This category includes drill and practice, tutorials, and some simulations.

b. "Learning by Exploring," where the student rather than the programme makes choices within the software, usually in terms of exploring some learning environment (for example, this category includes Logo programming).

c. "Using Computer as a Tool," where this will be primarily for word processing with our 8-to-9 year-old cohort.

d. "Other"

With this, or any other data reduction scheme, teachers will need training prior to classroom data collection, and the resource persons within each country who supply this training will need similar training themselves, as a group, so that we can move toward some level of common understandings with regard to coding. In order to generate additional information (as well as serving as a reliability check) teachers would be asked to elaborate, with one-or two-word descriptors what types of activities they mean if they choose "Other." In addition, local resource persons should be present on a number of data collection days at the start of the Project in order to compare their coding of student usage with those of the teachers and to discuss any inconsistencies that occur. As the Project continues, these corroborative visits could be reduced to intervals such as 4- to 6-weeks, but should continue to occur to some degree as support of the reliability of data capture procedures across the Project (and as an on-going incentive for teacher commitment to the data capturing process).

5. Time and Intensity of Computer Engagement

As was noted earlier, it would be helpful to be able to make sensitive differentiation of the duration and intensity of computer use among children. However, after considerable thought, I am not convinced it is feasible to attempt to standardize subjective perceptions of intensity of engagement beyond a very general level. Also, from experience, I know that asking teachers to register repeatedly the time involved with computer use for individual children frequently becomes unmanageable, especially in "open" classroom environments typical in many countries for young children. Rather than burdening the teachers with an expectation of data specificity which will probably not be reliable across settings anyhow, I suggest the following rough baseline-type criterion: "Indicate for each child and for each category of computer use a 'check' if that child participated in that type of computer use for at least five minutes during the day."

I acknowledge immediately that this standard calls for reporting skills on the part of teachers may not be consistently applied across particular classrooms, or some countries, as teachers will inevitably overlook some children or misremember their involvement. The criterion of five minutes is not meant to be taken strictly, but as a rule-of-thumb to represent a minimal length of time that is likely to be associated with a meaningful learning experience. However, again, this would have to be discussed and practiced during teacher training sessions prior to as well as during the Project. I base my recommendation on the overall importance of making the data collection procedures quick and reasonably attractive so that data collection will continue to occur in classrooms over time.

Whatever procedure we specify it will be interpreted differently by individual teachers no matter how carefully we delineate a procedure. So I suggest to content ourselves with a procedure as simple as possible in order to maximize a sustained data flow.

In terms of duration of computer participation, I am undecided between two approaches. One is to make no additional attempt to record duration, other than as a minimal aggregate based on the number of children participating in a given activity multiplied by five minutes. This requires no further effort on the part of the teacher but clearly yields a statistic of limited power. A second approach could be to ask the teacher to make a rough estimate of the average amount of time, perhaps in multiples of five or ten minutes, spent by those children as a group who did participate in a certain activity. This could enrich our descriptive data base and possibly help us in our hypothesis testing. However, I am not recommending making this sort of estimate for each individual child, because of the extra demands this would impose on the teacher. Asking for a group estimate of average involvement is limited in its reliability by the estimation skills of the teacher; this may seriously constrain the usefulness of the measure.
6. Measures Produced by This Coding Approach

A monthly data collection form could be given form in a variety of ways. One such procedure generates a bounded range of checkmarks per child, per class, and per type of computer activity for each monthly period. These sums can range from 0 to 5 times the number of week in the month for each child (perhaps we should only tally four week per month so that monthly comparisons do not need to be prorated for 4- or 5-week months). For type of computer use, sums can range from 0 to (the number of children in the class times the number of weeks in the month) if every child participated "for at least five minutes" in a particular type of computer use at least once a day during each day of data capture in a month. With the information we have about the "representativeness" of the usage during the days involved in data collection, we can extrapolate these weekly sums to monthly projecting of computer use for comparative purposes if we wish. In addition, this simple quantitative measure allows us to rank-order users and/or types of use within classrooms as well as between classroom and countries and thereby create categories of usage frequency ("High," "Medium," and "Low") for subsequent investigations of the relationship between type and frequency of computer use and measures of our dependent variables relating to cognitive and metacognitive development.

7. Summary

I present these strategies as suggestions for discussion and I welcome your comments. Let me reiterate that I recognize I am relinquishing considerable detail with these procedures; however, it has been borne out by prior experience that the cost of trying to obtain more and richer data is likely to be less teacher commitment to the data collection procedure and more unreliability within the data that are collected. I do recommend that the local researchers augment these data with interviews and their own descriptions of classroom computer usage. Such augmentation will not only help to compensate for the collapsed data within the suggested teacher coding procedures but can also be used as a reliability check on the teachers' coding. As a final thought, I suggest we reinvestigate the viability of using the individual student rather than the class as an unit of analysis in terms of the burden that individual data coding places on the teacher on an on-going basis during the project. Perhaps we could ask simply for an estimate of the number of children during a given day who participated in a particular type of computer activity at least five minutes?
1.3.8. SPECIFICATION OF INFORMATION TECHNOLOGIES IN EDUCATION

E. Peled, Z. Peled, and G. Alexander, Israel

IT Usage in Education as Independent Variables

In studying the effects of the IT in education on child development the type and characteristics of computer use have been considered critical independent variables. We submit, however, that NIT in education is too vague and ambiguous a concept and should be brought down to specifics, which is our intention in this paper.

We argue that IT should be used in education after explicitly clarifying and stating the underlying educational philosophy of the particular school and/or school system involved. Their philosophic clarification should be followed by a clear definition of the "sound use" selected, aimed with the objective of achieving specific educational aims.

Consequently, IT uses in education will be categorized according to aims and/or modes of operation. In addition the preconditions essential for the experiment should also be designated in detail.

IT Policy in Education

The decision with respect to the "appropriate" and "sound" use of computers in education is crucial to our design. Pogrow (1983) proposes several criteria by which this can be determined. They include the skills education must impart to serve society in the IT era, the improvement of basic skills and the stimulation of higher-order skills in handling information (Pogrow, 101-103). Winkler, Shavelson et. al. (1985) argue that "pedagogically sound classroom microcomputers use results from the appropriate integration of microcomputer-based learning activities with teachers' instructional goals and with the on-going curriculum, which changes and improves on the basis of feedback that indicates whether desired outcomes are achieved" (ibid, 288).

One can characterize "appropriate" and "sound" use of IT in education as follows:

a. It enables teachers and students to acquire IT basic skills and high-order skills of handling information (acting within "computer culture").

b. It is integrated with the instructional aims and on-going curriculum in order to increase their effectiveness.

Educational Philosophies and NIT Policy

Educational philosophy deals with questions about the process of education (Smith, 1960 , 957). As such its task is to formulate means and ends of education (ibid, ibid). It affects teachers' beliefs and attitudes, thereby influencing their teaching activities (Alexander, 1976, 2 - 3). Although there is no "one" educational philosophy, there is a consensus with respect to the general broad aims of education. Within this broad consensus there are different views regarding more specific objectives and how to attain them. Philosophies of education are commonly categorized as an educational conservatism, educational liberalism, and educational anarchism (O' Neill, 1981).

Educational conservatism regards school as the main agent for acquiring basic skills and transmitting cultural heritage. The traditional teaching method is frontal lecturing. Learning is based mainly on rote learning, drill and practice.

Educational liberalism considers the development of the student's autonomous personality as education's principal task and regards school as an important agent for such development. This approach adopts 'progressive' teaching and learning styles (Bennett, 1976,38).

Traditional frontal teaching is replaced by active, participatory, individualized and group learning.

Educational anarchism aims to "deschool" society (Illich, 1970).

Each "philosophy" has a correspondent strategy that includes the use of New Information Technology in schools. The different philosophies affect the use of Information Technology in education in diverse ways as each formulates its aims and objectives differently and establishes different operational guidelines for the incorporation of IT into the curriculum.

Conservatism leads to computer-assisted instruction (CAI) within the traditional curriculum. Its principal criterion is improving learning achievements, measured by the test scores. Its most appropriate, although not exclusive strategy, in drill-and-practice.
It also makes some room for other usage, in particular those designed to increase students' motivation. Conservatism tends to view computers as interactive textbooks (Solomon, 1986, 4).

Liberalism (Progressivism) considers the computer as a tool for reinforcing the student's autonomous personality through open, creative use of the instrument. For the "liberals" NIT is an "expressive medium" controlled by its user. For them the most appropriate use is LOGO (Papert) or "open tools" (word-processor, data-base, spreadsheet, templates, simulations) (Hunter, 1987). In this approach learning achievements are not measured exclusively by the basic skills test scores. However, the "liberals" find it difficult to specify success criteria.

Anarchists may perceive the computer as offering an alternative to "schooling" by using it for "distant learning".

**Policy Aims**

Mentioning of aims immediately confronts us with a semantic problem. In general, the terms goals, aims, targets and objectives are used interchangeably and should be specifically defined. For our purpose we have decided to follow a clear typology (Brown, 1980, xvi-xvii): Aim is a generic name, including within it "ideal" and "objective"; Ideal is an aim which is unattainable, remote and potentially directive; Objective implies aims that are attainable and potentially directive; they may be simple quick and easy or complex and difficult to attain. Five aims were formulated and established for educational use of IT (Becker, 1987):

1. Improvement of learning and teaching, in both conventional (traditional) and innovative frameworks;
2. Improvement of analytical thinking;
3. Improvement of learning management through diagnosis and recording;
4. Acquisition of basic and high-level computer skills.
5. Use of computers as a lever for innovating educational systems.

We submit that in view of evidence pertaining to their attainability, these aims should be classified along a scale ranging from unattainable "ideals" and attainable "objectives".

Discussion of educational aims raises the question of whether they should be the same for all student populations or differentiated, pursuant to the different levels of students. In Japan the teachers are divided into three groups for computer training: "elementary" - those able to use computers as a "black box"; "intermediate" - those able to write computer programmes and evaluate their educational worth; "advanced" - those who can be competent instructors (CERI, 1986, 40). Applying this "level-competence" approach and in view of the needs of the labour market, it seems to us that there should be three levels of "NIT competence:" "basic" - familiarity with NIT and its basic uses, and use of IT to improve learning of basic skills (reading, writing, arithmetics); "intermediate" - ability to use major NIT applications (word processing, basic use of data base, structured friendly software and electronic mail), and use of IT to improve thinking abilities; "advanced" - mastery of NIT and the ability to control it through programming; development of high-order thinking skills.

In determining the aims of NIT one should also choose between a "technological-vocational" approach, primarily intended to introduce NIT mainly to vocational education as further technological training, and a "comprehensive" approach, that views NIT "literacy" as a requirement for all students at all levels (CERI, 1986, 19-24).

**Strategies of Computer Use in Education**

The strategies of computer use in education draw upon two sources. The first is the school's general "educational philosophy", the second is the school's knowledge and conception of computers and their potential for assisting both teacher and student to fulfill their respective commitments. Recently conducted comprehensive surveys note two conceptions of the computer as a didactic tool encompassing four cognitive teaching styles (OTA, US Congress, 1987; Winkler, Stasz, Shavelson, 1986; Solomon, 1986; Becker, 1986). The first conception views the computer as an interactive textbook which gives rise to two "strategies": drill and practice and rote learning (Suppes & Morningstar, 1969) and Socratic Interactions and Discovery Learning (Davis, 1964, 1967). The second conception views the computer as an expressive medium which implies two ways of functioning: eclectic and heuristic learning (Dwyer, 1975) and constructivism and Piagetian learning (Papert, 1980).

The choice of the appropriate strategy depends on one's specific aims and general educational philosophy.
Preconditions for Implementation

No matter which of the above-mentioned aims have been selected, and what correspondent strategies have been used, there are certain preconditions for the "sound", "appropriate" and effective use of NIT in education. We consider the following as the most important preconditions for "pedagogically sound" use of NIT in schools:

1. Integrating varied computer applications into as many subject-matters as possible.
2. Accessibility of computers and optimal IT Exposure Time affording each student access to a computer 2 to 3 hours per week.
3. Location of computers: in a computer laboratory as well as in the regular classroom.
4. Teachers training, both pre-service and in-service training preparing them to operate computers in their regular teaching.
5. Involvement of teachers and school administrators in the planning and preparation of the specific learning materials.
6. Availability of appropriate learning materials.

In a study of policies for increasing the use of microcomputers in instruction, researchers (Winkler, Stasz, Shavelson, 1986,16) have claimed that expanding their use as an instructional tool in courses on traditional subject matters can expose students of all levels to more advanced use of microcomputers. Furthermore it may better prepare students to use microcomputers at jobs after they finish school (ibid, ibid). This study also claims that "once microcomputers are used by more teachers, for more subjects, in more grades, students will be given more opportunities to receive computer-based instruction of pedagogical value (ibid,17).

This conception also applies to the location of computers. Using computers exclusively in computer-laboratories is not compatible with their "pedagogically sound" use. Only by introducing a few (3-5) microcomputers into the regular classroom, can we generate an innovative approach on the part of teachers and ensure their active involvement in the teaching/learning processes.

Schools operate various types of computerized materials, thereby expressing different educational philosophies and concepts of computer use and reflecting pluralistic approaches on the part of the teachers. We do not aspire to radically change existing systems. On the contrary, it is our aim to introduce the innovative process most effectively generated by the properly used computer into what already exists. For this purpose, we propose integrating the computer into the conventional operating methods, while taking full advantage of the exceptional new possibilities it can offer.

Typologies of NIT in Education

NIT uses in education can be viewed from various different perspectives: [a] following their aims and objectives; [b] following their didactic mode of operation; [c] following teachers and students involvement in the teaching/learning processes; [d] following their curricular function. The decision on a specific way of using NIT and their applications requires a preliminary conscious selection in each of these categories. In the coming lines we shall expand on the aforesaid.

Aims and Objectives.

Five aims were formulated and established for educational use of IT (Becker, 1987):

1. Improvement of learning and teaching, in both conventional (traditional) and innovative frameworks;
2. Improvement of analytic thinking;
3. Improvement of learning management through diagnostics and recording;
4. Acquisition of basic and high-level computer skills.
5. Use of computers as a lever for innovating educational systems.

Didactic Modes of Operation and Teacher and Student Involvement.

There are six major recognized didactic modes of IT operation in education:

1. Drill and Practice. Based on the premise that in order to achieve a normative standard different students need different amount of drill and practice. Highly structured and "teachers proof" courseware. Teacher's active involvement is minimal. Maximized time on task, but rarely linked to the on-going curriculum of the classroom. Its efficiency for the gifted and the slow learners is doubtful. Enables individualized control and follow up. Rarely explains mistakes and fosters mechanical learning.
The ITEC Project: Background, Preliminary Period

2. Tutoring of New Learning Material. Based on the premise that the computer can substitute for the teacher in teaching new topics. Indeed it can individualize learning. On the other hand, the involvement of the teacher in the teaching/learning process is minimal.

3. Educational Games. Aim to teach children through playing games. As such it enhances students' motivation, increases social interaction in the learning process, stimulates thinking strategies, can be integrated into many subject-matters. After a while many students refrain from playing for learning. "Losers are sometimes frustrated.

4. Simulations. Enhance learning by active discovery. Facilitate solution of complex problems by controlling and manipulating their variables. Appropriate for individualized as well as group learning. Stimulates creativity of students and teachers. There is a danger that models may be substituted for reality. Extends learning beyond computerized environment.

5. Computer-Application-Generators. Using "open-computer-tools" integrated into various stages of the learning processes. Their use is flexible, requires maximum involvement of teachers and students. Calls for learning through "scientific discovery". Enables maximum integration into various subject-matters. Appropriate for individualized as well as group learning. The computer is perceived as a tool, the closest to its "real life" function. It also has some deficiencies: no automatic feed-back, increases the work-load of teachers, requires technical skill in operating the "tools".

6. Educational Programming. It is considered a high level cognitive and meta-cognitive instrument of teaching/learning. The student has to understand processes, to think logically in algorithms, and to think in a creative way. It fits individual as well as group activity, and may increase teacher-student interaction. However, it requires high proficiency of teachers and high cognitive level of students. The measurement of its outcomes is still problematic.

Curricular Function

NIT (hardware and software) may have various curricular functions described by various sets of possibilities:
- To support school management or to support teaching and learning
- Within existing curriculum or to extend existing curriculum
- For CAI, or Open computer applications, or Information Handling, or Computer Literacy (and within the last two of these, Educational Programming)

Conclusion

As a necessary precondition for any comparative study the specific IT interventions, being major independent variables should be clearly indicated according to the above categories.

Also, the following should be taken into account before deciding which strategy is preferable and what mode of computer use should be selected:
1. the range between closed-structured and open-flexible.
2. teacher's involvement in the teaching/learning process.
3. the kind of feed-back.
4. student's activity.
5. measurement of outcomes.
6. user-friendly operation.

Each of these can be represented by a scale or matrix. Closed-open ranges from rigidly structured (such as a drill) to maximum openness (such as a programming language.) Teacher's involvement can range from supervising only to intense involvement, such as when the teacher creates the software himself. Feedback can range from that between the teacher and student to that built in by the programmer. Student activity has many possibilities, including rigid and structured to role play and discovery. Many effects from computers are as yet unmeasurable, while others can be measured. And finally, the operational simplicity of a specific computer use is also an important factor.
1.3.9. DEFINING DIFFERENT EDUCATIONAL ASPECTS OF HARDWARE
AND CONFIGURATION VARIABLES

T. SAKAMOTO and K. AKAHORI, Japan

The authors categorize hardware variables as multimedia. CD-ROM, Interface, computers for
educational use, and configuration variables as LAN and types of teaching-learning situation. This report
describes educational aspects of these variables.

1. Introduction

The recent trend in informatics technology is to render all data in computer-readable form. Thus, data
should be represented in digital form rather than analogue form so that it can be used by computers. For
example, photographs are analogue, but animated pictures are digital. Hand written characters and human
voices are analogue, but printed letters and synthesized voices are digital. Introducing analogue data into
computers means the transformation of the data representation from the analogue form such as photographs,
hand written characters, and speaking voices to the digital form such as animated pictures, typed letters,
synthesized voices.

The main reason for transforming data from analogue to digital form is to simplify information
processing using computers. In digital type media it is possible to process an image itself. For example, it is
easy to make the animated pictures in variable directions by programming.

The main purpose for introducing data which has been transformed from natural and raw forms to
artificial forms into computers is to assist human learning and information processing activities by simplifying
the manipulation of data.

Teaching materials are regarded as products transformed from natural and raw materials by developers
such as teachers in order to facilitate student learning. Natural and raw materials exist in the environment
around us, including nature and society.

Information can be gathered from the environment and easily transformed for human processing with
computers. This can help to make learning comprehensible.

2. Hardware variables

2.1. Multimedia

Information in the surrounding environment can be thought of as being composed of numerals,
characters, graphs, voices, sounds, still pictures and moving pictures.

1. Numerals, Characters and Graphs

Numerals, characters and graphs can be easily processed by computers. For example, numerical
data can be calculated with spread sheet, characters can be edited with word processors and
graphic pictures can be drawn by graphic tool software.

2. Voices and Sounds

There are two methods of voice transformation: voice synthesis and voice recognition. Voice
synthesis means transformation from characters to voice, and voice recognition is transformation
from voice to characters. Recent computer technology incorporates voice synthesis, but not voice
recognition.

In general, computer capabilities are suited for synthesis, but less so for recognition. The
technology of voice synthesis is likely to enrich the learning environment. It is expected that the
educational effectiveness of computers will be improved by adding synthesized voices to
characters, graphics, and so on.

There are differences in input and edit operations between a keyboard and a voice editor. The
voice editor indicates a low ratio of completion for input as well as edit operations, but a low ratio
of errors.

Voice synthesis will also be useful for handicapped people as learning tools. The blind can learn
through keyboard operations with synthesized voices and can expand their sensory world, because
character data stored in computer memory can be translated to voice output.
3. **Still pictures and Moving pictures**

Still pictures and moving pictures can be stored in two different media formats. One format is analogue such as photographs, videotapes, and videodisks; the other is digital such as CD-ROM and CD-I.

Digital media are effective for learning by simulation, because they are computer-readable. Simulations are applied mainly to phenomena which one can't experience or realize because of time and space limitations, or high danger. As digital media such as animated pictures require a large capacity of memory, new media such as CD-ROM should be developed.

4. **Educational aspects**

In general, instructional materials include modified and raw materials. Modified materials are used in most school subjects, but raw materials are used in some subjects. For example, art appreciation, field work, field study, and physical training require natural and raw materials. Since educational objectives in these subjects require directly touching natural and raw objects, such educational objectives may not be as readily accomplished by modifying information using computers. In those cases, using analogue information may be more useful. Teachers should select modes of analogue or digital media according to educational objectives. The current trend in computer technology is to make all information computer-readable and accessible. However, it is important to consider the educational effectiveness of all possible types of media.

2.2. **CD-ROM and CD-I**

1. **CD-ROM and CD-I**

CD-ROM (Compact Disk Read Only Memory) stores mainly the memory of digitally transformed characters, sounds, graphs, and still pictures and also analogue moving pictures. CD-I (CD-Interactive) is a stand-alone type of computer which was developed for education and home use. As these devices use optical disks as memory, they have such characteristics as large capacities, high speed accessibility, and compact size. However, they are used only for data reading. For example, arbitrary words can be retrieved using CD-ROM stored Shakespearian plays. Reference dictionaries and illustrated book databases has been developed using CD-ROM.

2. **Videodisks**

Videodisks are memory devices which store analogue information using the same optical disk system as CD-ROM. Videodisks are mainly used for storing both still pictures and moving pictures, and can randomly access pictures at a higher speed than videotapes are useful for database type CAL.

3. **Educational aspects**

The retrieval function of CD-ROM and CD-I is important for learners. Because learners can select and generate information using CD-ROM and CD-I, such a retrieval process itself is a kind of learning process. It reflects the learners' cognition processes such as problem representation and problem solving strategies. These devices with large memory enable learners to conduct information searches.

2.3. **Interface**

One of the important functions of hardware is easy operativeness based on improvement of the man-machine interface. Easy operativeness evidenced in printed materials has also been required for computers. The computer interface is mainly on input and output device, that is, a keyboard and screen.

1. **Screen**

As presentation by a screen has been restricted to an image, the function of the interface in computer has been inferior to that of printed materials. The new "multi-window" concept has permitted the display of multi-images on the computer screen. It increases "good operativeness".

2. **Editor, Command and Menu**

The line editor dealing with only one line has been replaced by the screen editor which permits access to the full screen. Command line procedures have been replaced by menu procedures, and these are about to be replaced by icon procedures.

3. **Keyboard**

Various pointing devices have been invented in order to improve the keyboard interface. The touch screen, tablet, optical plastic ball, joy-stick, mouse and track-ball permit the cursor to move to any screen position without using the cursor keys.
4. Educational aspects

Good interface design is necessary so that people can interact with computers and use them as tools in education.

2.4. Computers for education

As mentioned above, some special functions are necessary for computers intended for educational use. The specifications of the CEC (Computer Educational Centre in Japan) Concept model '87 for educational computers is described below:

1. Compatibility
   (1) software (memory device, file format, character code etc.)
   (2) peripheral equipment (screen, printer, control code etc.)
   (3) operation (file processing, Japanese character etc.)

2. Educational Consideration
   (1) floppy disk (3,5 inches etc.)
   (2) keyboard (new JIS arrangement, function key etc.)
   (3) display (Japanese character, 24x24 dot etc.)
   (4) local area network (transmission of files etc.)
   (5) main memory (over 512 KB etc.)
   (6) colour (over 16 kinds etc.)
   (7) command (16 bit microprocessor etc.)

3. New Technology
   (1) multi window (usable for beginners etc.)
   (2) multi task (print task compile etc.)
   (3) word and figure processing (word, figure etc.)
   (4) operating system (32 bit micro processor etc.)

3. Configuration Variables

3.1. LAN

There are two kinds of communication network systems. One is Local Area Network (LAN) system available for small, well-defined, local areas, while the other is a Wide Area Network (WAN) using telecommunication and data networks across wider, more dispersed distances. However, both LAN and WAN share the problems of high cost and compatibility and these have shown a low diffusion rate. Soon Integrated Service Digital Network (ISDN) system will be implemented. This new type of network system will integrate digital data, sounds, voices, pictures etc. Since communication in all areas of society is oriented to networking, this trend affects and facilitates networking applications in schools.

1. Classroom networks

A network available for CAI, computer literacy education, and other subject teaching can transmit files or data immediately and automatically without the necessity of students taking floppy disks to a central, controlling computer. Teachers can view students' computer screens and offer advice if problems are apparent. Also, besides teacher-student communication, data can be exchanged among students or they can share and access database information stored in the central file server.

Not only communication through screen but also discussion and cooperative works among students are important for learning processes. Configuration of terminal computers and desks are also necessary for activating classroom.

2. Campus networks

A campus network links each classroom, staff room, reading room and medical care room. Its purpose is to facilitate sharing and accessing of attendance data, reference books, medical data files, etc.

3. Wide Area Network

Distance education networks are available to link, for example, campus networks, school district networks, and networks among research laboratories/information service centres.

4. Educational aspects

There are two main educational aspects of computer networks. One is that people can share information, while the other is that networks can bring new, inter-personal communication tools. Using the former application, people can more easily share information as they need it. The latter
application means that people living in diverse areas will be able to reach more easily understanding through information exchange.

As mentioned above, computer-mediated communication has the potential to benefit education.

3.2. Types of Teaching-Learning

Three types of classroom computer configurations are: (1) one computer, (2) several computers and (3) many computers in a classroom.

1. One computer in a classroom
   - Teachers can use the computer as an Overhead Projector (OHP) or VTR to present material to the class as a whole.
   - Individual students use the computers for remedial learning.

2. Several computers in a classroom
   - Groups of students can work together on identical tasks and the teacher can monitor and advise each group as needed.
   - Groups of students can work on different tasks at each computer. When a student has finished a particular task at one computer, s/he can move to another machine and work on another task. The teacher can advise each group as needed.

3. Many computers in a classroom
   - Each student uses each computer for CAI.
   - A teacher and students can use computers through a LAN.

4. Educational aspects

The role of the teacher in education is very important because s/he has a profound influence on learning. The effect is also the case in computerized classrooms.

4. Summary

The educational aspects of hardware and configuration variables can be summarized as follows:

1. Hardware variables

   New information technology is oriented to making all information, including pictures and sound computer-readable. Further, new technologies such as CD-ROM enable computers to store huge amounts of information. Therefore, it is important to teach students to search, select, and create objectives among a wide variety of differing information sources.

2. Configuration variables

   Teachers need to develop various new types of teaching-learning strategies to correspond to the number of computers in their classroom. In any computerized setting however, the role of the teacher is of prime importance. Computer network systems bring new ways of communication and have the potential to improve educational methods).

References

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4. Centre for Educational Computing, Utilization of computer and network, Japan, Tokyo, 1988
5. Takashi Sakamoto, Hardware and Software in Distance Education, Proceeding of the Regional Seminar on Distance Education, Asian Development Bank, pp. 303-416, 1986
1.3.10. IN-SERVICE TRAINING FOR SCHOOL TEACHERS WHO ARE GOING TO PARTICIPATE IN THE FIELD STUDIES OF THE CROSS-CULTURAL PROJECT IN PRIMARY AND SECONDARY SCHOOLS

B. Lindahl, Sweden

Introduction

The in-service training I propose is supposed to give an overview of high technology field and a pre-understanding of how information technology can be used in schools in order to increase quality and for failure reduction.

The general interest of the cross-cultural study will be the relationships between the use of information technology in education and the development of the child. The study will involve the use of a variety of applications from THE INFORMATION AND COMMUNICATION FIELD. The main purpose with the study is to get best possible opportunities to study the child in the context of his/her information technology environment (Information Society).

From this point of view it is very urgent that teachers who are willing to join the project also get prepared/trained before they do get engaged in the field studies. They need to get familiar with different possibilities of computer aided education before they can start their own creative work in the classrooms.

Stockholm Institute of Education and the Computing Science Department at Uppsala University have developed and practised the proposed course during the autumn 1988. Teachers from primary and secondary schools have done two weeks courses. It will be three weeks courses 1989/90. The results are so far very good. All participating teachers have got ideas how to get started in their own classrooms and they are all interested in further education in the computer field. The teachers have also got an idea of tomorrow classrooms and an overview of the information field.

I. The Computer as a Teaching Aid

1.1. Swedish Background

The use of the computer as a teaching aid in schools is being discussed in many parts of the world. There is no obvious, axiomatic method. Instead each country, and perhaps each school, has to find its own way ahead. If computer applications in schools are forced into traditional teaching the result is teaching which entails shortage of time and, frequently, poor retention. To achieve good results with the computer as a teaching aid, the teacher must be prepared to accept the methodological consequences.

The fundamental purpose for using computers in teaching should be the development and improvement of teaching. Sometimes motives are self-evident, as for example when computer use forms part of vocational education in upper secondary schools. Another possible motive is that of facilitating and improving teaching. Or again, it may be to enable the teacher, in his preparations, to produce more individualized material for the pupils. The value of a computer application in teaching should hinge on the purpose for which the computer is used and on the pedagogics practised by the individual teacher.

Computers and software should not be procured unless the improve teaching opportunities in some respect, since schools cannot reasonably be expected to buy expensive equipment without educational justification. The computer can be used in school as a teaching aid, e.g. to:

- Reinforce the relevance and updating of different kinds of information. In this connection both teachers and pupils can find the computer a useful means of coping with the flood of information around us.

- Make lessons more variable and stimulating. The use of computers is frequently an enjoyable experience, and schools should utilize this fact in order to enhance pupil motivation in difficult fields of study.

- Develop the pupils' basic skills, in combination with other methods. There is, for example, reason to suppose that pupils' writing ability and their interest in written work can be improved through the use of word processing programmes.

- Retrieve, collect, process and present information.

- Rid lessons of time-consuming, humdrum tasks.
Computers should not be used as a means of re-introducing outmoded teaching methods, putting pupils in a computer-controlled teaching situation or squandering classroom time on pointless computer exercises.

II. Computer Support in a School for Everybody

Goals for an introductory course for all teachers engaged in the longitudinal, comparative, and cross-cultural study of the effects of information technology in education on child development (the ITEC project).

2.1. Goals of the Instruction

- To interest teachers at all levels of compulsory school in computer-assisted activities.
- To encourage teachers to develop a knowledge of ways in which the computer can be used as a quality-elevating implement in the learning process - one of many supportive tools for learning, for qualitative improvement and for failure reduction in schools.
- To make teachers appreciate the computer as a communicative medium.
- To introduce the computer as a neutral working implement in schools.
- To provide an overview of computer applications in schools.
- To introduce information and media technology as a potential for the development of different teaching materials and aids.
- To create preparedness for more advanced methods, such as the use of expert systems in school work.
- To enable teachers to achieve personal proficiency in word processing.

2.2. Content of the course

In A SCHOOL FOR EVERYBODY, pupils are to obtain knowledge of facts and arrive at an understanding of relationships and contexts, and they are to be able to utilize the knowledge they acquire. Capacity for analysis, synthesis, evaluation and critical appraisal has an important bearing on educational success. The use of information and media technology in schools must not be made an end in itself but must be integrated with the total educational perspective. Which aids do we need to introduce in order to activate all pupils more efficiently? How can teaching be made more variable, enjoyable and relevant? What is our best way of supporting weak pupils?

2.2.1. Use of Information and Media Technology as a teaching Aid

Teaching materials must make it easier for the pupil/student to acquire knowledge and skills. Teaching materials must motivate, involve and activate pupils in their school work. They must tie in with the pupils' various interests and they must be serviceable regardless of the working procedures adopted. Pupils must be able to work individually or in groups. Pupils must learn to handle information from many different sources. They must also learn to look for information on one and the same matter in an interdisciplinary perspective.

Different subject fields can contribute knowledge which will improve the pupils' understanding. Teaching materials to be used in practical subjects and in art, music and drama must provide scope for imagination and creativity and must encourage the development of practical skills in the subject concerned.

Information and media technology has a positive potential for developing a wide variety of teaching materials and aids. This technology can be used to:

- create an overview,
- systematize,
- simplify and put in concrete form different bodies of subject matter,
- facilitate the pupils' learning processes.

Information technology presents great opportunity visualizing theoretical subject matter and simulating different situations. Educational software in different subject fields has been introduced on the market, but we still have a long way to go before software can make it possible to work on a particular topic in a particular subject field.

Word processing programmes and spread-sheet programmes, however, are two examples of commercial software which can be useful aid to teaching.

A word processing programme with a dictionary can be a great help to pupils at different stages of the writing process. It can be used as a notepad and as an implement for editing, designing, storing text. Word processing programmes make it easier for pupils to produce reports and school magazines.
Experimental activities with word processing for pupils with reading and writing disabilities at all levels of compulsory school have proved to have a powerful boosting effect on their written work. The pupils have developed a positive interest in writing and have acquired structured thinking habits.

Writing is more a permanent way of displaying our thoughts. Writing makes it possible for us to analyse our own thinking. Information technology can also provide pupils with functional impairments of different kinds with an implement enabling them to complete their schooling on the same terms as handicapped pupils. Programmes of high educational quality are essential in order for the disabled to be able to utilize the learning potential which information and media technology has to offer.

2.3. Specified Content of the Course

- Overriding aims of schools
- Cognitive attitude - superficial versus in-depth learning
- Motivation - the desire to learn
- Learning processes
- Educational implements
- Language development - communication
- Word processing - production of written text
- Mathematics in school - how we develop the pupils' mathematical thinking
- Calculation and graphic production
- Information retrieval from databases
- Production of databases in school - collect, process and present information
- Music and art education
- Multimedia
- Expert systems
- Hardware and software - selection based on educational values.

2.4. Structure of the Course

Lectures, demonstrations, seminars and individual work at the computer. Practical work at the computer includes concrete assignments, in keeping with the above description.

Assignments are adapted in such a way that all teachers, at whatever level they serve, will be able to acquire ideas and sufficient practical proficiency to test computer support in their own teaching. Theoretical studies of the learning process and the overriding aims of school are integrated with practical work.
The ITEC Project: Background, Preliminary Period

1.3.11. EVALUATION OF BEHAVIOUR IN COMPUTERIZED CLASSROOMS CONCEPTS, INSTRUMENTS

Prof. Zimra PELED, Prof. Elad PELED
& Dr. Gad ALEXANDER, Israël

Appropriate and Sound Use of Information Technology (IT) in Classrooms

The concepts of "pedagogical soundness of classroom microcomputer use" (Winkler et. al., 1985) and "appropriate" IT policy (Pogrow, 1983) are used frequently by teachers, educational policy makers and educational researchers. According to these concepts a "pedagogically sound" use of computers in a classroom "results from the appropriate integration of microcomputer-based learning activities with teachers' instructional goals and with the on-going curriculum, which changes and improves on the basis of feedback that indicates whether desired outcomes are achieved" (ibid, 288).

The Agenda and Criteria of Research and Evaluation

The agenda of research and evaluation of IT corresponds to IT goals in education. It has to ascertain whether the following goals formulated and established for educational use of IT have been realized (Becker, 1987):.

1. Improvement of learning and teaching, in both conventional (traditional) and innovative frameworks;
2. Improvement of analytical thinking;
3. Improvement of learning management through diagnosis and recording;
4. Acquisition of basic and high-level computer skills;
5. Use of computers as a level for innovating educational systems.

Evaluation and Research

Studies of computers in educational contexts can be classified into four groups. Each group represents an approach, an issue, or an argument that relates to IT and provides information relevant to the incorporation of IT in the educational process. However, none of these studies address all the levels and entire scope of issues to be studied.

The first group of studies consists of Broad Surveys. These studies focus on the description of practices but make little claim to measure the effectiveness of those practices (e.g. Becker, 1987a; Becker, 1987b).

The second group consists of Systematic Qualitative Observations of teachers and schools known to be effective. Generally, it lacks explicit measurement of student outcome and comparisons with other instructional practices (e.g. Shavelson et al, 1984; Hawkins, 1985; Diem, 1986).

The third group consists of Evaluations of Specific Instructional Programmes implemented on a large scale, but without equivalent control groups. (e.g. Millar & McLeod, 1984; Gourgey, et al, 1984).

The fourth group consists of Experiments with Control Groups. They focus on explicit, systematic instructional activities over a brief period of time. (e.g., Wainwright, 1985; MacArthur, et al, 1987; Forsight & Lancy, 1987).

We propose that the evaluation of an IT intervention in education be guided by a comprehensive design, and that the level, context and educational content of each study within the IT intervention should be derived from this "master design". The three components of the proposed design are as follows:

(a) The first component relates to the level of the study. We distinguish among three possible levels of evaluation studies:

(1) Descriptive level that is conducted without control groups or experimental manipulations; it describes the operations carried on in their natural context.

(2) Quasi-Analytical level that is conducted with contrasting groups, but without controlled manipulations.

(3) Analytical level that is conducted with contrast groups and with controlled experimental manipulations.
The second component relates to the context of the designed evaluation. We distinguish among three possible contexts, that elicit three sets of questions:

1. An **Implementation** context that generates questions referring to the correspondence between the planned and the achieved goals.

2. A **Change** context that generates questions referring to the impact of IT in the classroom on teaching styles, content of curriculum, teachers' behaviour, students' behaviour, classroom organization, teachers' planning and decision making processes.

3. An **Innovation** context that generates questions referring to the quantitative, qualitative, or combined aspects of the innovations enhanced by the changes.

The combination of the level of evaluation together with its context is summarized in the following table:

<table>
<thead>
<tr>
<th>LEVEL OF EVALUATION</th>
<th>DESCRIPTION</th>
<th>QUASI-ANALYTICAL</th>
<th>ANALYTICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation</td>
<td></td>
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</tbody>
</table>

The third component of the comprehensive design refers to the educational content. This component distinguishes among learning outcome, computer skills and literacy, and social attainments (expressed by social interactions).

From this standpoint we have to look closely at the different stages of the teaching/learning processes: starting from the environment within which these processes take place (classroom setting and "climate"), through the ways and means of these processes (teaching styles and learning styles) to their outcomes (learning outcomes, computer-skills, patterns and content of interactions in the classroom and at the computers).

We assume that the multifaceted nature of IT calls for the comprehensive design that we suggest. We propose that design should be applied to individual students, teachers and educational administrators as well as to the entire classroom and school system.

The target populations of research and evaluation of IT in education are: students, teachers, educational administrators and classrooms.

**Evaluation: Construction, Procedures and Instruments**

In view of the theoretical needs that characterize IT research projects, we recommend the use of a Guttman procedure (Guttman, 1970; Levy, 1976; Shye, 1978) for the construction of four types of evaluation instruments: questionnaires, interviews, structured self-reports of teachers and principals, and observations.

This procedure requires:

1. The formulation of mapping sentences that elaborate the definitional systems for the items to be constructed.

2. The formulation of hypotheses of correspondence between the definitional and the empirical specifications. Appendix I illustrates the theoretical elements that are inherently built into the procedure.

We as well recommend the use of a set of tightly controlled experiments designed to study the effects of properties that are inherently built into IT tools. This procedure requires

1. The formulation of a rationale for each of the IT tools being used (such as Drill & Practice, Database, Word-processor, Simulations and Generative Templates).

2. The specification of each of the usages of each of the studied IT tools (such as date organization, data representation, data exploration, hypotheses generation).
The ITEC Project: Background, Preliminary Period

The construction of a controlled intervention in which usages are manipulated and their effects being studied.

In the remainder of this paper we will describe some of the evaluation instruments that have been used and are being used in Project COMPTOWN in Israel. We believe that these instruments, having been systematically derived from a comprehensive design, can lead to a better understanding of the characteristics that are unique to an IT project.

Descriptive and Change Evaluation: Instruments and Procedures

Questionnaires

We find the questionnaire an appropriate procedure for the following purposes:

1. Description of the initial status and initial conditions that characterize a pre-project situation.
2. Description of the project's on-going and varying "implementation" and "change" contexts.

For these purposes questionnaires should be administered to two populations - teachers and students - at least twice (pre - post). In "Comptown" Project we use teachers' and students' questionnaires (see appendices) that have been designed to provide for classifiable and scalable information.

The "Teachers' Questionnaires" provide information about teachers' computer literacy, attitude to IT, conception of IT, preferences regarding the usage of IT in teaching, perception about students' ability to use IT in learning, "openness" to innovations in teaching and learning and self-image.

The "Students' Questionnaires" provide information about students' computer literacy, attitudes to IT, prior exposure to IT, preferences of IT usage, social interactions related to IT, motivation, self-image, and locus of control.

Item construction followed a Guttman procedure. Item selection followed standard item analysis procedures. The items displayed in these questionnaires were tested and analyzed with groups of students and teachers who represent the target populations. Items that elicited homogeneous responses and items that proved to be unclear were removed from the questionnaires. Items' scaled properties and item's internal consistencies have been examined with an \( \alpha (" \text{Alpha}) \) procedure (Cronbach 1951) as well as with a Guttman SSA procedure (Guttman, 1968; Lingoes, 1973).

Scales that were poorly represented were supplemented by additional items in the questionnaires; while scales that were overrepresented were revised, and tested with a smaller number of items.

Interviews

We think that the information provided by the questionnaires as well as by the observations (which will be discussed in the section that follows) has to be deepened and extended through supplemental semi-structured interviews with regard to the following: educational philosophy of the relevant environment, didactic models affecting IT usages, changes in teacher's role (as a planner, as an administrator of learning, and as an instructor), structure and content of the curriculum affected by IT, problems encountered by the teacher and the students.

Interviews should be done by senior researchers to complement their existing information.

Change and Innovation Evaluation: Instruments and Procedures

Observations

According to Winkler et. al. (1985) the concept of "pedagogical sound microcomputer use" has important implications for how studies of classroom microcomputer use might be conducted. Because this concept focuses on preactive, interactive and evaluative processes, naturalistic and field-based research should prove informative (ibid, 291-292).

Consequently, evaluation of change and evaluation in an IT project should depend heavily on observational procedures that are contentbound. These observations, relying on various IT contexts and on a wide range of IT related behaviours, can contribute to the understanding of IT impact on teaching styles, learning styles, classroom's interactive typologies, technical and academic mastery of computers.

Our observational tools have been designed to capture qualitative and quantitative aspects of classroom (teachers and students) behaviour. We used "Open Observations" for the study of the qualitative aspects of classroom behaviour, and "Structured Observations" for the study of the quantitative aspects of classroom behaviour. The following sections of this working paper fully elaborate the constructions of our observation tools.
The Open Observations

Our Open Observations have been designed and used with classrooms and teachers recognized as typical representatives of a particular teaching style (such as student-oriented or content-oriented style which usually reflects a "school's climate").

The observations repeatedly conducted once a week in the same classes, followed "major events" in classes that have been using computers, and in those that have not. The description of these events allowed for systematic comparisons between classes and within the same classes with respect to:

(a) The different ways in which computers have been incorporated into the learning and teaching activities of class;
(b) The different ways in which computers have integrated into the various content areas (subject-matters);
(c) The different ways in which computers affected classrooms continuous and one-shot class activities;
(d) The different ways in which computers affected classroom disciplinary behaviour;
(e) The different ways in which computers affected classroom social organization of class;
(f) The different ways in which computers affected teaching and learning organization;
(g) The different ways in which computers affected students homework;

Structured Observations

Our structured observations followed Davis, Vinner, Finkelstein and Regev attempts (Davis et. al. 1986) to develop structured observations that provide valid quantitative characterizations of "Processes" (such as computer-student interactions) and "Activities" (such as the student's exchange of information in a computerized drill and practice context). We used these examples for the construction of two observation tools which fit into particular IT contexts.

The first tool - Computer-Operation-Observation (COO) - focuses on the individual student who operates the computer and is identified by a number attached to his name, as well as by his school and class symbol.

The COO encompasses two typologies. The first typology accounts for the technical and academic computer-skills of the individual student operating a computer in his/her regular classroom (but not in a computer-lab). This typology builds upon the quantitative specification of:

(1) The student's technical activities pertaining to simple computerized operations (such as turning on/off, loading diskettes, loading a programme/file, keyboard operation, overcoming technical operational problems, using screen editor and moving on the screen);
(2) The student's academic activities pertaining to relatively more advanced computerized operations (such as writing, practicing, processing information, calculating, playing, etc.). The second typology relates to the interactive behaviour of the student working with the computer in his/her regular classroom.

This typology builds upon five quantitative domain facets (i.e. independent variables) that specify:

(1) The courseware being used,
(2) The partners of the interactive activity,
(3) The mode of the interactive activity,
(4) The goal of the interactive activity,
(5) The context of the interactive activity.

It assumed that these domain facets directly affect students' interactive behaviours which are further specified with two range facets (i.e. dependent variables). The first range facet specifies the intensity of the behaviours elicited, while the second range facet characterized and classifies each of the behaviours elicited.
The specifications used with this typology are summarized with a mapping-sentence that reads as follows:

**A Mappinm Sentence for the Characterization of a Student's Interactive Behaviour**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>a₁ verbal</td>
<td>b₁ goal oriented interactional</td>
<td>c₁ learning</td>
<td>d₁ drill and practice courseware</td>
<td>e₁ himself, is</td>
</tr>
<tr>
<td>a₂ non verbal</td>
<td>b₂ affective behaviour that</td>
<td>c₂ non learning context, and that is elicited</td>
<td>d₂ tutorial</td>
<td>e₂ a computer characterized as</td>
</tr>
<tr>
<td></td>
<td>fits a classroom's</td>
<td>c₃ mixed</td>
<td>d₃ game</td>
<td>e₃ a teaching</td>
</tr>
<tr>
<td>(X) who, operates a</td>
<td>d₄ programming</td>
<td>(X) who, operates a</td>
<td>d₅ &quot;open tool&quot;</td>
<td>e₄ a student</td>
</tr>
<tr>
<td></td>
<td>and who shares this behaviour with</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**R₁** a behaviour that intensively | **R₁** a behaviour that mildly communicates | **R₁** a behaviour that communicates | **R₁** a behaviour that communicates |

- a disregarding
- a dominant
- an instructional
- an imitating
- a help requiring
- a passive
- a positively reinforcing
- a negatively reinforcing
- a wondering
- a physical contact

Interactional inclination.

It is important to note that the "computer operating" observation is an "activity" and not a "process" oriented observation. It asks, and has been designed to answer two questions:

1. Do computer-use patterns vary with groups of users?
2. Are computer-use patterns sensitive to accumulative processes and to additional experiences with IT contexts. In other words, can distinction be drawn between the use - patterns that are demonstrated by first and second year users?

However, the "Computer Operating" observation can be easily used as a "process" observation. This option is granted by the inclusion of domain facets that are partially ordered and that provide information that is most relevant to the efficiency of the learning process.
Here we refer to three facets that are partially ordered with regard to an efficient learning process:

- Facet B - the goal facet;
- Facet D - the courseware facet;
- Facet E - partnership facet.

Each of these facets suggests a learning-efficiency hypothesis:

- Facet B suggests that interactive goal-oriented behaviour is relatively more efficient, while affective interactive behaviour is relatively less efficient.
- Facet D suggests that interactive behaviour associated with either "open tool" courseware, or with programming courseware is relatively more efficient, while interactive behaviour associated with drill and practice courseware or tutorial courseware has limited learning efficiency.
- Facet E suggests that a student-student interaction may prove to be more efficient than student-teacher or student-computer interactions.

Because the "computer-operating" observations cannot validate the above-mentioned process-hypotheses, we suggest the use of semi-structured supplementary observation that focuses on the following topics:

1. Mode of Teaching/Learning: frontal, group, individualized, mixed.
2. Integration of computers in the lesson: extent and timing.
3. Curricular-content of computer-use: integrated in the on-going content or differentiated from it (in subject, timing, other).
4. Level of teaching (according to Bloom's Taxonomy (1956) and the integration of computers into the appropriate level.
5. Detailed description of learning style of specific students (for a period of 10 min. randomly assigned). Observation and interview with specific student observed.
6. The integration by the student of the work done with the computer (using computer output, writing results in notebook, a test by the teacher, using specific worksheets, none).
7. Aids for working with computers (worksheets, textbooks, reference books, other students, teacher, blackboard, posters, the computer).

This observation should be further supplemented by an interview with the student observed and his/her teacher. The aim of the interview with the student is to learn about the interviewee's awareness (metacognition) of his/her activities. The purpose of the interview with the teacher is to evaluate the relative validity of the student's answers.

We suggest that this "supplementary observation" also be applied with the "classroom interactive observation", our second quantitative observational instrument.

**Classroom Interactions Observation**

Our second structural observation is the "Classroom Interactions Observation". It compares classrooms with and without computers in respect to:

a. Students' generated interactions;
b. Teachers' generated interactions.
Student's Generated Interactions

Our specification of student's generated interactions are summarized in a mapping sentence for the observations of the student's generated activities which reads as follows:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>a&lt;sub&gt;1&lt;/sub&gt; verbal</td>
<td>b&lt;sub&gt;1&lt;/sub&gt; goal oriented</td>
<td>c&lt;sub&gt;1&lt;/sub&gt; student with a computer and a student without a computer</td>
<td>d&lt;sub&gt;1&lt;/sub&gt; learning</td>
<td>r&lt;sub&gt;1&lt;/sub&gt; cooperative</td>
</tr>
<tr>
<td>a&lt;sub&gt;2&lt;/sub&gt; non verbal</td>
<td>b&lt;sub&gt;2&lt;/sub&gt; affective</td>
<td>c&lt;sub&gt;2&lt;/sub&gt; student with a computer and a student with a computer</td>
<td>d&lt;sub&gt;2&lt;/sub&gt; non-learning activity</td>
<td>r&lt;sub&gt;2&lt;/sub&gt; non-cooperative</td>
</tr>
</tbody>
</table>

and carried on by a:

- c<sub>3</sub> student without a computer and a student without a computer
- c<sub>4</sub> student with a computer and a teacher
- c<sub>5</sub> student without a computer and a teacher

and that bears a part in the classroom's

- d<sub>3</sub> undefined

is an interaction that yields a

- r<sub>3</sub> disturbing
- r<sub>4</sub> physically characterized

behaviour, that is

- entirely articulated
- partially

From these specifications, student's generated activities (such as: answering questions, correcting mistakes, exchanging information, watching another student, arguing with another student, ignoring classroom activities) can be analysed with respect to the following questions:

1. Do IT contexts intensify the student’s verbal activities or do they intensify his/her non-verbal activities?
2. Are the activities intensified, goal-oriented or are they affective?
3. Do IT contexts encourage particular interactive frameworks?
4. Do IT contexts encourage interactive activities that contribute to classroom learning activities, or do IT contexts generate activities that are dissociated from the classroom’s learning activities?
5. Do IT contexts stimulate cooperative behaviours, or do they elicit behaviours that are non-cooperative or disturbing?
Teachers Generated Interactions

Our specifications of the teacher’s generated interactions are summarized in a mapping sentence for the observation of the teacher’s generated activities. It reads as follows:

A Mapping Sentence for the Observation of the Teacher’s Generated Interactive Activities

- **A**
  - verbal
  - non verbal

- **B**
  - goal oriented
  - affective

- **C**
  - technical
  - subject matter
  - educational
  - current affairs
  - undefined

- **D**
  - class that studies with computers
  - class that studies without computers
  - class that studies with computers in a lab
  - class that divides into two groups:
    - one that studies with computers in a lab
    - one that studies without computers

1. **R**
   - fosters a teaching style that builds upon
   - does not foster

2. **R**
   - the students involvement
   - the teacher’s authority
   - the teacher ignoring students
   - undefined contexts

From these specifications, teacher’s generated activities can be analyzed with regard to the following questions:

1. **(1)** Do IT contexts intensify the teacher’s verbal activities or do they intensify his/her non-verbal activities?
2. **(2)** Are the activities intensified, goal-oriented or are they affective?
3. **(3)** Do IT contexts generate instructional events that are qualitatively different from non-IT generated events?
4. **(4)** Do IT contexts foster teaching styles that are different from non-IT fostered teaching styles?

**Validity**

Validity tests of our instruments are inherently built into their underlying faceted definitions. In these definitions the domain facets elaborate hypotheses, (i.e. predictions) that can be examined empirically with measures that vary along their corresponding range facets.

We are constantly validating the instruments presented in this working paper. Our first validity information is presented in our 1986/87 Activity Report. It shows that our observation tools are sensitive to teaching styles and to classroom activities as well as to the level and modes of computer use.
At the present stage we are less informed with regard to our instruments' "process" validity.

We hope that the data now being collected and processed will provide further information with regard to "learning styles" and learning processes fostered in IT contexts.

Reliability

Since our observations have always been conducted by two independent observers, we have been able to correlate the outcomes of these observations. These correlations ranged from .86 for the first Computer-Operating Observation (COO) to .82 for the second observation tool (Classroom Interactive Observation - CIO). Since our observers were trained students of psychology and education, these high reliability scores are not surprising.

Innovation Evaluation: Instruments and Procedures

Analytical and Quasi-Analytical Studies

We assume that descriptive IT data systematically designed and analysed, generate two types of questions that cannot be answered unless experimentally studied.

The first type addresses the conditions that underlie effective usage of IT. Following Becker's study (Becker, 1988), we agree that IT usages by school, classroom, or even by student, should be intensively studied in randomly designed experiments. In these experiments, comparison treatments should randomly be assigned to experimental and control groups that have been randomly selected. These experiments can provide answers to the following:

1. Are particular IT usages effective across schools, classrooms or students?
2. Are particular IT usages effective with some schools, classrooms and students, and ineffective with others?

However, these experiments do not provide an answer to a second set of questions, cognitive in its nature:

1. Is there a single way in which an IT usage can be effective, or are there many ways in which an IT usage can be effective?
2. Do IT usages stimulate learning processes that are different from those stimulated in a "normal" classroom setting?
3. Are IT stimulated processes qualitatively different from processes stimulated in a normal classroom setting, or are they incremental in their nature?

These questions which focus on the particular properties of each of the IT tools, build upon the tool's rationale as its frame of reference and try to manipulate its usages in a tightly controlled design.

The design that we propose schematically represented in Figure 1 should consist of an experimental group and a control group that are characterized with identical I.Q. and achievement scores, and that study an identical curricular subject-matter.

The experimental group, acquainted with the technique and the rationale of an IT tool (such as Database) and its usages (such as data organization, representation and reduction, and hypotheses generation) should be instructed to employ the tool appropriately (i.e. according to the tool's rationale).

The control group should experience a regular teaching/learning setting.

Post-tests should consist of:

1. I.Q. tests used in the pre-treatment stage.
2. Content-oriented achievement tests.
3. Methodological rationale-oriented tests (e.g. data organization or hypotheses generation).

In our study we have been using this design with Database, Word-processor, and Simulation. The following description of the Database study may illustrate the concepts and questions that guide our experimental studies.

We assume that a computerized database, appropriately used as a tool in a subject-matter learning situation should stimulate inquiry and should yield two types of learning outcomes:

1. Knowledge of the content studied.
2. Knowledge of methodology of information processing and information construction in the domain studied.
1.3.11 Evaluation of Behaviour

Our controlled experimental intervention conducted with four 6th grade classes, of which two are "treatment" classes and two - "control" classes is administered in six distinct stages:

(a) **A preparatory stage** (6-10 hours): Teaching the "treatment" teachers a specific database.

(b) **A pre-testing stage**: Administering I.Q. test to both treatment and control classes.

(c) **A preliminary intervention stage** (two weeks): Teaching students rationale and techniques of a prepared database; training students in data organization and in strategies of hypotheses generation. The outcomes of this learning stage are tested with a paper & pencil "Database Skills Test" designed and prepared by our evaluation team.

(d) **A second intervention stage** (one month): Teaching students to construct a database that is associated and extends an on-going curricular activity. This stage which is expected to demonstrate the application of the rationale and skills acquired in the preliminary stage (c) is monitored by classroom observations.

(e) **A third intervention stage** (one month): Training students to apply database individually or in small groups learning situations. This stage is monitored by classroom observations and intensive students' interviews that test the students' awareness and understanding of information handling.

(f) **A fourth intervention stage** (one month): Teaching an identical curricular topic in both "treatment" and "control" groups. This stage monitored by classroom observations will be followed by:

   1. I.Q. test used in the pre-intervention stage;
   2. Content-oriented achievement test;
   3. Test of data organization and hypotheses generation;
   4. A systematic analyses of classroom interactions and teaching strategies and styles.

Concluding Remarks and Comments

The table in Appendix II summarizes the evaluation means and methods used in Project Comptown in Israel, from five perspectives:

1. Source of Information.
2. Type of Information.
3. Level of Information.
4. Content of Information.
5. Target Population.

This table emphasizes the use of multiple information sources which we consider a great advantage for an evaluation study that is subjected to "uncontrolled" field conditions. Although we suggest that IT usages can be studied with controlled designs we think that most classroom's behaviours can not be studied through controlled interventions. Consequently we highly recommend the use of multiple information sources that can be cross-validated.

Winkler et. al. (1985) suggest the concept of "pedagogical soundness of classroom microcomputer use" (Winkler et. al., 1985). According to this concept a "pedagogically sound" use of computers in a classroom "results from the appropriate integration of microcomputer-based learning activities with teachers' instructional goals and with the on-going curriculum, which changes and improves on the bases of feedback that indicates whether desired outcomes are achieved" (ibid, 288). Pedagogical sound use of computers in classrooms is characterized by teachers' decision to integrate microcomputers into their on-going instruction. This decision may be in five educational domains; goals sought for students, curricula coordinated by microcomputers, learning activities surrounding microcomputer use, and methods for obtaining feedback regarding microcomputer-based instruction (ibid, ibid).

Winkler et. al. based their arguments on a study of "successful" teachers' patterns of microcomputer-based mathematics and science instruction (Shavelson et. al., 1984).

Following this approach this paper tried to provide some guidelines for a sound evaluation of an IT intervention in education.
An Illustrative Example of the Guttman's Procedure

A mapping sentence for the construction of "computer operating" items, that are included in both our teachers' and our students' questionnaires, reads as follows:

A "Computer Operating" item, is an item that is characterized by a domain that asks about

******************************************************************************
| A              | B               |
| a₁ autonomous  | b₁ mechanic     |
| a₂ non autonomous | b₂ mixed       |
| b₃ academic     | computer operating |

...event, and by a range that is ordered from very frequent to rare occurrence of the event
******************************************************************************

In this mapping sentence the definitional system for the construction of "computer operating" items consists of two domain facets and one range facet.

The domain facets are:

A: the autonomy facet.
B: the computer operating context facet.

The range facet is R - expressing the frequency of the event. It is important to note that the elements of the facets are ordered. This implies that:

(1) The items constructed with the specifications of the domain facets are scaled;
(2) The responses predicted with the scaled domain facets can equally be scaled with the range facet.

Types of Information, its Sources, Level, Content and Populations

<table>
<thead>
<tr>
<th>SOURCE OF INFORMATION</th>
<th>TYPE OF INFORMATION</th>
<th>LEVEL</th>
<th>CONTENT</th>
<th>POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q INT SR OB</td>
<td>-background information</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>+ + +</td>
<td>-level of computer-literacy</td>
<td>+</td>
<td>+</td>
<td>+ + +</td>
</tr>
<tr>
<td>+ + +</td>
<td>-attitudes toward IT in education</td>
<td>+</td>
<td>+</td>
<td>+ + +</td>
</tr>
<tr>
<td>+ + +</td>
<td>-IT exposure</td>
<td>+</td>
<td>+</td>
<td>+ + +</td>
</tr>
<tr>
<td>+ + +</td>
<td>-social preferences and interactions</td>
<td>+ +</td>
<td>+</td>
<td>+ + +</td>
</tr>
<tr>
<td>+ +</td>
<td>-educational philosophies</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>+ +</td>
<td>-IT and its educational use</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>+ + +</td>
<td>-teaching org. and style</td>
<td>+ +</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>+ +</td>
<td>-motivation for learning/teaching</td>
<td>+ +</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>+ +</td>
<td>-classroom\school setting and climate</td>
<td>+</td>
<td>+</td>
<td>+ + + +</td>
</tr>
<tr>
<td>+ + +</td>
<td>-learning style</td>
<td>+ +</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>+ +</td>
<td>-learning and cognitive attainment</td>
<td>+ +</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
source of information: Q - questionnaire, INT - interview, SR - self reporting, OB - observation
level: level of research and evaluation - D (descriptive), CA (computer-skills), SI (social interactions)
content: educational content - LO (learning outcomes), CA (computer-skills), SI (social interactions)
population: ST - students, ED - teachers and school administrators, OT - others (in particular - parents)

**Figure 1:**
An Experimentally Controlled Design
For Studying IT Usages Effects

<table>
<thead>
<tr>
<th>TREATMENT CLASS</th>
<th>CONTROL CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-TEST</td>
<td></td>
</tr>
<tr>
<td>POST-TEST</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teachers preparatory stage</th>
<th>I.Q tests to both groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing stage</td>
<td>Tools rationale test (paper &amp; pencil test)</td>
</tr>
<tr>
<td>Students preparatory stage (Intervention I)</td>
<td>Observations &amp; interviews</td>
</tr>
<tr>
<td>IT assisted teaching-learning situation. Simple applications of IT tools. (Intervention II)</td>
<td></td>
</tr>
<tr>
<td>IT assisted teaching-learning situation. Advanced applications of IT tools. (Intervention III)</td>
<td>Regular teaching-learning situation</td>
</tr>
<tr>
<td>(Intervention IV)</td>
<td>I.Q tests Content-oriented achievement test Data organization &amp; hypotheses</td>
</tr>
</tbody>
</table>
References

1.3.12. OBSERVATIONS AND PROTOCOLS ON CHILDREN AND CLASSROOM BEHAVIOURS

Questionnaire: Computer Literacy & Attitude for Teachers

Prof. Zimra Peled, Israel

We are interested in learning what you think about the computer and the various aspects relevant to teaching and using it in school. We will be most grateful to you for filling in this Questionnaire carefully. All information transmit will be treated as strictly confidential. Thank you for your cooperation; we sincerely hope that your work with the computer will be gratifying and fruitful.

************************************************************************************

Please fill in the following details:

1] 1

Town

2-3

Name of school in which you teach ________________________

4 - 7

Class ________________________

8 - 13

Date of filling in questionnaire __________

14

Male / Female ( encircle )

15 - 18

Number of questionnaire ________________________

( Please enter the last four numbers of your Identity Card)

10

Type of questionnaire

19-20

Part

21
The ITEC Project: Background, Preliminary Period

1. Do you have a computer at home? Yes / No

2. If you have a computer at home, for how long have you had it? ________________

3. Do you know how to work with a computer? (Not for teaching purposes)

Know very well 5 4 3 2 1 Do not know at all

If you do not know how to work with a computer, skip to question 5.

4. What do you do with the computer? (Mark with x)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>a little</th>
<th>Not too little &amp; not too much</th>
<th>Often</th>
<th>very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Computer games</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Program Basic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other language)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Word processing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Construct data-base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Other (itemize )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. How important is it for the students to be acquainted with the computer for its own sake?
1.3.12. Observations and Protocols on children

Prof. Zimra Peled, Israel

<table>
<thead>
<tr>
<th>Most important</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>at all</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Are there children in your class who know how to work with a computer? Yes / No
If so, how many? __________

7. In your opinion, which subject can be taught effectively with the aid of the computer and which cannot?

Effective  Not effective

a. __________  a. __________

b. __________  b. __________

c. __________  c. __________

d. __________  d. __________
8. Which of the students in the following successive groups will be helped more by studying with the aid of the computer?

(Indicate the description you consider the most apt with an x. If the two characteristics are equally pertinent, place the x in the central column.)

<table>
<thead>
<tr>
<th>Will be helped very much</th>
<th>Will be helped a little</th>
<th>Will both be helped equally</th>
<th>Will be helped a little</th>
<th>Will be helped a little</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Low motivation</td>
<td></td>
<td></td>
<td></td>
<td>High motivation</td>
</tr>
<tr>
<td>b. High achievement</td>
<td></td>
<td></td>
<td></td>
<td>Low achievement</td>
</tr>
<tr>
<td>c. Little curiosity</td>
<td></td>
<td></td>
<td></td>
<td>Great curiosity</td>
</tr>
<tr>
<td>d. Great self confidence</td>
<td></td>
<td></td>
<td></td>
<td>Lack of self-confidence</td>
</tr>
<tr>
<td>e. Grasps quickly</td>
<td></td>
<td></td>
<td></td>
<td>Grasps slowly</td>
</tr>
<tr>
<td>f. Not interested in studies</td>
<td></td>
<td></td>
<td></td>
<td>Much interested in studies</td>
</tr>
<tr>
<td>g. Seeks challenges</td>
<td></td>
<td></td>
<td></td>
<td>Indifferent to challenges</td>
</tr>
<tr>
<td>h. Unsociable</td>
<td></td>
<td></td>
<td></td>
<td>Sociable</td>
</tr>
<tr>
<td>i. Undisciplined</td>
<td></td>
<td></td>
<td></td>
<td>Disciplined</td>
</tr>
<tr>
<td>j. Concentrates well</td>
<td></td>
<td></td>
<td></td>
<td>Lacks ability to concentrate</td>
</tr>
<tr>
<td>k. Orderly</td>
<td></td>
<td></td>
<td></td>
<td>Disorderly</td>
</tr>
</tbody>
</table>

9. Below are a number of possible uses of the computer in your school. (Indicate on a scale of 1 - 5 the degree of importance you attribute to each use)
1.3.12. Observations and Protocols on children

Prof. Zimra Peled, Israel

<table>
<thead>
<tr>
<th>Great importance</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Altogether unimportant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office work</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accumulating &amp; storing data</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Games</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Library</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

10. There are various definitions of computer literacy. How do you define computer literacy? ______________

11. With the introductions of the computer into the classroom, what functions will be added to the teacher’s role? (mark with x).

<table>
<thead>
<tr>
<th>Very likely addition</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Very unlikely addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Training of teachers to work with computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. More initiative and creative</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Planning of computer-aided learning activities</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>d. Evaluation of courseware</td>
<td></td>
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</tr>
<tr>
<td>e. Acquisition of technical ability to deal with the computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Accumulating operational knowledge about the computer</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>g. Protecting the computers (against theft, damage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Support of children with difficulties</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
12. Below are a number of possibilities for the utilization of the computer in your class. (indicate the extent to which its use is important on a scale of 1 - not at all important - to 5 - very important)

<table>
<thead>
<tr>
<th>Very important</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Drill and practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Teaching of new material</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Educational games</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Simulation</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>e. Dealing with information</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Word processor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Graphics and music</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>h. Programming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Computerized demonstrations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Individual attention to weak students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k. Examinations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l. Follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m. Individual attention to good students</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

13. Do you think the introduction of the computer require additional effort on the part of the teacher? Yes / No

14. If so, how do you think the teacher should be compensated for the additional effort? __________
15. Do you think you will be more valuable if you know how to use the computer (indicate with an x)?

<table>
<thead>
<tr>
<th>My value will increase</th>
<th>My value will be unchanged</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN THE EYES OF:</td>
<td>5</td>
</tr>
<tr>
<td>the students</td>
<td></td>
</tr>
<tr>
<td>the teachers</td>
<td></td>
</tr>
<tr>
<td>the parents</td>
<td></td>
</tr>
<tr>
<td>the principal</td>
<td></td>
</tr>
</tbody>
</table>

16. From what class do you think it is desirable to begin to teach with the aid of the computer? ___________

Why? ____________________________________________
17. React to the following implications of the computer for the students and grade the extent to which you agree with each of them: (mark with an x)

<table>
<thead>
<tr>
<th>Very much agree</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Increases motivation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Increases achievement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Facilitates slow progress</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Develops thinking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Reduces the gap between the school and an advanced technological environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Advances teaching and learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Introduces a pleasurable element into studying</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Improves self-confidence and self-image</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Increases ability to concentrate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Reduces the disparity between the sexes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Entirely disagree
18. The knowledge that a computer is about to be introduced into your classroom causes you to feel (mark with an x):

<table>
<thead>
<tr>
<th></th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Joyful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Indifferent</td>
<td></td>
<td></td>
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<tr>
<td>c. Involvement</td>
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<tr>
<td>d. Angry</td>
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<tr>
<td>e. Doubtful</td>
<td></td>
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<tr>
<td>f. Challenged</td>
<td></td>
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<tr>
<td>g. Something else</td>
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</tbody>
</table>

19. The source of my knowledge about the use of computers in education (mark with an x):

<table>
<thead>
<tr>
<th></th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Not a source at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Personal knowledge</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>b. Conversations with friends</td>
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<tr>
<td>c. Professional literature</td>
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<tr>
<td>d. Lectures</td>
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<tr>
<td>e. Personal experience</td>
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<tr>
<td>f. Information from teachers who attended computer courses</td>
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<tr>
<td>g. From other teachers at the school</td>
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<tr>
<td>h. Other</td>
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</tbody>
</table>
The ITEC Project: Background, Preliminary Period

20. Please numerate three specific situations in which you can use the computer

1. 

2. 

3. 

21. Which Teachers' Aid do you think is most similar to the computer? 

22. Relate to the following implications of the computer for the students. Indicate the extent to which you agree with each of them (mark with an x).

<table>
<thead>
<tr>
<th>Implication</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Adversely affect social activities</td>
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<td></td>
</tr>
<tr>
<td>b. Adversely affect group activities</td>
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<tr>
<td>c. Competition among the children</td>
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<tr>
<td>d. Reduces time devoted to reading</td>
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<tr>
<td>e. Adversely affects contact with the teacher</td>
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<tr>
<td>f. Will increase polarization</td>
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<tr>
<td>g. Will reduce time for writing</td>
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<tr>
<td>h. Increases gap between the sexes</td>
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<tr>
<td>i. Reduces physical activity</td>
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<td>j. A frustrating experience for the student</td>
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<tr>
<td>k. Impairs self-confidence &amp; reduces motivations</td>
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<tr>
<td>l. Reduces human support of the study process</td>
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</tbody>
</table>
23. What type of teacher is likely to succeed best in teaching the computer?

24. What type of advantage is the computer likely to bring to the class teacher? (mark with an x)

<table>
<thead>
<tr>
<th>Maximum Advantage</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>No advantage at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Assistance in direct teaching</td>
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<td></td>
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<td></td>
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<tr>
<td>b. Making drill easier</td>
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<td></td>
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<tr>
<td>c. Dealing with deviant students</td>
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<tr>
<td>d. Occupying the students</td>
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<tr>
<td>e. Freeing time to work with individual students</td>
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<tr>
<td>f. Assistance in diagnosis and follow-up</td>
<td></td>
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<tr>
<td>g. Easing of technical tasks (demonstration, graphics)</td>
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<tr>
<td>h. Preparing lessons</td>
<td></td>
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</tbody>
</table>
25. With arrows, try to indicate the system of contract that will be created among the following elements after the introduction of the computer (mark --> for one-way contact mark nothing)

```plaintext
            Principal
          /          \
Students in class  Teachers in parallel classes
          \          /  
Conscientious students  Other teachers
          \          /  
Students with difficulties  Average students
```

26. Grade the following possible implications by the computer on the class teacher (mark x)

<table>
<thead>
<tr>
<th>Implication</th>
<th>Very likely to occur</th>
<th>Very unlikely to occur</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Competition over knowledge of computer between students and teacher that will damage the latter's standing in the classroom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Excessive reliance of the teacher on the computer as a teaching aid</td>
<td></td>
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</tr>
<tr>
<td>c. Competition among the students over knowledge of the computer.</td>
<td></td>
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</tr>
<tr>
<td>d. Difficulty in controlling the class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Exploiting the computer as a cover-up for inactivity on the part of the students</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
27. Are the following elements interested in your participating in extension courses (mark with an x)

<table>
<thead>
<tr>
<th></th>
<th>Greatly interested</th>
<th>Totally disinterested</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The school principal</td>
<td>5 4 3 2 1</td>
<td></td>
</tr>
<tr>
<td>b. Teachers who have taken computer extension courses</td>
<td>5 4 3 2 1</td>
<td></td>
</tr>
<tr>
<td>c. Other teachers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Family</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Friends</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

28. What criteria determine the success of your further study?

________________________________________________________________________

________________________________________________________________________

29. Have you received support with respect to participating in courses on the part of (mark with an x)

<table>
<thead>
<tr>
<th></th>
<th>Strong support</th>
<th>No support at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Directors of the course</td>
<td>5 4 3 2 1</td>
<td></td>
</tr>
<tr>
<td>b. School principal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Other teachers attending the courses</td>
<td>5 4 3 2 1</td>
<td></td>
</tr>
<tr>
<td>d. Members of your family</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Friends</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Teachers not attending the courses</td>
<td>5 4 3 2 1</td>
<td></td>
</tr>
</tbody>
</table>

30. What do you think will be the first use you will make of the computer in your class?

________________________________________________________________________
31. Does the introduction of the computer into the educational system in the framework of Comptown Project have an influence on various elements in the community? Yes/No

32. Please record the circles of influence of the Project on the elements of the community you live in: In the inner circle enter the unit/sphere that will be most influenced, and in the outer circle the unit/sphere that will be least influenced.

The unit/sphere that will be least influenced

The unit/sphere that will be influenced to a certain degree

The unit/sphere that will be most influenced

Thank you for your cooperation.
Observations and Protocols on Children and Classroom Behaviours
Questionnaire: Pertaining to Computer Literacy
Prof. Zimra Peled, Israel

This questionnaire deals with computer. We want to know your opinion with respect to the various questions asked. This is not an examination, and there are no right or wrong answers.
We want you to reply honestly and write exactly what you think. Your answers will be treated confidentially; they will not be read by anyone at school.
Thank you for your cooperation

Evaluation Team,
Comptown Project,

Please fill in the following details:

Town
Name of school
Class
Your number
Questionnaire number
Boy/girl (encircle)
The Street on which you live
Date

2. How many children including yourself, are there in your family?
a. How many boys
b. How many girls

3. Does your father use a computer at work?
   YES  NO

4. Does he work with a computer at home?
   YES  NO

5. Does your mother use a computer at work?
   YES  NO
6. Does she work with a computer at home?  
- YES  - NO

7. Do you have a television game at home?  
- YES  - NO

8. If you do, for how long have you had it?  
- 3 months  - Half a year  - A year  - More than a year

9. List the subject-matters you like most, in order of preference.  
   a. ____________________  
   b. ____________________  
   c. ____________________

10. List the subject-matters you like least (starting with the one you dislike most)  
    a. ____________________  
    b. ____________________  
    c. ____________________

11. Mark the answer that applies to you with an X:  

   I use the computer at home  
   | Never | A bit | Occasionally | A lot |

   I learned the computer at school  
   | No A bit | To some extent | Very much |

   I learned Basic  
   | Not at all | A bit | To some extent | Very much |

   I learned the computer as an extra-curricular activity  
   | Not at all | A bit | To some extent | Very much |

   I have played computer games  
   | Never | A bit | Fairly | Very often |

12. How many books do you read a week?  

13. How many days a week do you participate in extra-curricular activities?  

14. How many times a week do you go to your movement activities?  

15. To what do you devote more time during the week (after school hours) -
1.3.12. Observations and Protocols on children  
Prof. Zimra Peled, Israel

Write 1 alongside the activity to which you devote most time

Write 2 alongside the activity to which you devote slightly less time

Write 3 alongside the activity to which you devote the least time

- Watch television
- Use the computer at home or at friends' houses
- Prepare homework

14. How much do you enjoy doing the following:

<table>
<thead>
<tr>
<th>Extra-curricular activity</th>
<th>Not at all</th>
<th>A bit</th>
<th>Some-what</th>
<th>Very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going to Youth Movement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparing homework</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading books and newspapers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using the computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watching television</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. Which of the following two things do you prefer doing? (mark with an X)

- Play outside with friends (hide & seek, soccer, etc.)
- Play with friends in the house

16. If you know an adult who works with computers, write what he does?

17. What is a computer?

18. What can a computer do?

19. What places do you know of that use computers?
20. Who in your opinion is most responsible for what the computer does? (mark with an X)

☐ The person who designed the computer.

☐ The person who operates the computer.

☐ The computer itself.

21. The computer can do everything by itself

☐ Right.

☐ Wrong. Explain: ________________________________

22. What does the computer feel? ________________________________

23. One can do all sorts of things with the help of the computer. Mark with an X that which you would want most to learn and be able to do with the computer (mark only one item).

☐ Graphics and drawings

☐ Write programmes

☐ Play various games

☐ Learn subjects that are taught at school

☐ Write stories and letters

☐ Devise problems and riddles

☐ Compete with others or with the computer

24. If you think the sentence as written is generally correct, even if you are aware of certain exceptions, place an X next to "agree". If you think the sentence as written is basically incorrect, place an X next to "disagree".

70
Children who know how to use a computer, know how to repair bicycles.
- Agree
- Disagree

Children who know how to use a computer, know how to write books.
- Agree
- Disagree

Children who know how to use a computer do not like arithmetic.
- Agree
- Disagree

Children who know how to use a computer like to draw
- Agree
- Disagree

Children who know how to use a computer like to take things apart and put them back together again.
- Agree
- Disagree

Children who know how to use a computer are good students.
- Agree
- Disagree

Children who know how to work with a computer do not know how to play a musical instrument.
- Agree
- Disagree

Children who know how to work with a computer know how to invent all sorts of things.
- Agree
- Disagree

Children who know how to work with a computer less frequently play with friends.
- Agree
- Disagree

The computer knows what it is doing when it gives us results.
- Agree
- Disagree

25. How many times a week do you engage in sports? (swimming, basketball, etc.)

26. How many times a week do you take music lessons?
QUESTIONNAIRE FOR THE STUDENT

Instructions for Filling in the Questionnaire

In this questionnaire we are asking you to describe yourselves to us and tell us how you think and feel about a variety of things. This is not a test. There are no wrong or right answers. Because children are very different from one another, each of you will answer in accordance with what you yourself think or feel.

First let us see how the questions are to be answered. The following is a sample question, marked with the letter "a".

Very Quite
right right

a. [ ] [ ] There are children who prefer to play outside in their free time but Other children would rather watch television

Follow me as I read the question aloud. Question "a" talks about two kinds of children. First of all we want each one of you to decide if you are more like the children on the left side who prefer to play outside, or more like those on the right side who prefer to watch television. Do not mark anything yet. First you have to decide what kind of child resembles you most, and then look at the two squares on that side.

Now, after having decided which child resembles you most, we ask each of you to decide if it is quite right in your case or very right. If it is only quite right, place an X in the square beneath the words "quite right"; if it is very right in your case, place an X in the square beneath the words "very right".

For each question you may mark only one square. Sometimes it will be on one side of the page, and sometimes on the other, but only one square is to be marked for each sentence.

Now, please answer question "a".

Let us try another example, marked "b"

Very Quite
right right

b. [ ] [ ] There are children who never worry about anything but Other children sometimes worry about several things

I shall read question "b" aloud and you follow me. Question "b" refers to two types of children. First of all we are asking each of you to decide if he is more like the children on the left side who never worry about anything, or more like those on the right side who sometimes worry about several things. After you have chosen which child most resembles you, look at both of the squares on his side and decide whether it is quite right or very right that he resembles you.

After deciding, place an X in the appropriate square.

Remember, you can mark only one square for each sentence.

Now, please answer question "b".

Good. The two sentences we have read were only meant for practice. You can now answer the questions in order for each sentence, mark one square that is most appropriate and most correct for you. If you have any questions, raise your hand and one of us will come to help you.
### 1.3.12. Observations and Protocols on children

**Prof. Zimra Peled, Israel**

<table>
<thead>
<tr>
<th></th>
<th>VERY</th>
<th>QUITE</th>
<th>RIGHT</th>
<th></th>
<th>RIGHT</th>
<th></th>
<th>RIGHT</th>
<th></th>
<th>RIGHT</th>
<th></th>
<th>RIGHT</th>
<th></th>
<th>RIGHT</th>
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<th>RIGHT</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fits</td>
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<tr>
<td>Work with a computer makes some children feel rather uncomfortable.</td>
<td>Some children feel quite comfortable when working with a computer.</td>
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<td>2.</td>
<td>Fits</td>
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<td>There are children in whom the computer rouses curiosity.</td>
<td>There are some children who are not very much interested in computers.</td>
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<td>3.</td>
<td>Fits</td>
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<td>There are some children who will be quite happy to learn from a computer.</td>
<td>There are some children who are not very anxious to study computers.</td>
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<td>Fits</td>
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<tr>
<td>There are children who like friends who busy themselves with the computer.</td>
<td>There are children who do not particularly like others who already busy with computers.</td>
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<td>5.</td>
<td>Fits</td>
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<tr>
<td>Some children feel they do not manage very well at the computer.</td>
<td>Some children manage fairly well at the computer.</td>
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<td>6.</td>
<td>Fits</td>
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<td>Some children think it is not appropriate for girls to study computers.</td>
<td>Some children think it is quite appropriate for girls to study computers.</td>
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<td>7.</td>
<td>Fits</td>
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<td>but</td>
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<tr>
<td>Some children think every child must know to use a computer.</td>
<td>Some children think that only some should learn the computer.</td>
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<tr>
<td>There are children who believe the computer knows everything about them.</td>
<td>There are children who believe the computer knows only what it is told.</td>
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<td>Some children prefer to work with the computer alone.</td>
<td>Some children prefer to work with the computer together with friends.</td>
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<td>Some children prefer to play with friends rather than with the computer</td>
<td>Some children prefer to play with the computer rather than with friends.</td>
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The ITEC Project: Background, Preliminary Period

11. There are children who are quite attracted by a conversation about computers. but There are children who are quite repelled by a conversation about computers.

12. Some children think that one who knows how to work with a computer is successful. but Some children think that one who is good at sports is successful.

13. There are children who think the computer is complicated. but There are children who think the computer is simple.

14. Some children think it is harder for girls to learn with the computer. but Some children think it is harder for boys to learn with the computers.

15. Some children think that only those who like to take things apart and put them together again will succeed in working with the computer. but Some children think that only those who like to read and solve cross-word puzzles will succeed in working with the computer.

Many thanks for your cooperation!!!
1.4. Project Evolution, 1988-1989

1989 was a busy year for the ITEC Project, as much had to occur in order to meet the ambitious plans of the May 1988 meeting. The papers which were to stimulate the development of the project (see Section 1.3) came in at varying dates, before and after the September 1988 deadline. Getting these bundled and disseminated for researcher consideration and comment thus did not occur until October 1988. The meeting of the Task Force, planned for November 1988, could not take place until January 1989. Various persons who had been initially involved in the project appeared not to be able to commit themselves to it; other persons were continually being identified who would like to become involved. Thus it was not until January 1989 that the next steps could be taken in formalizing ITEC and its procedures. In this section, we describe the outcomes of an "Advisory Committee" meeting in Bulgaria, 1989; the official public launch of the project; the next project meeting, in May 1989, in Bulgaria; the finalization of the national teams; the development of the instrumentation and procedures for the project; and its execution launch, in November 1989.

1.4.1. First Refinement of Theoretical Framework and Project Design, January 1989

A second ITEC meeting for a working group of five ITEC researchers (plus a representative from UNESCO) was held in Sofia, Bulgaria, 5-8 January 1989. During the meeting, the theoretical framework for the study was further delineated, and based on the analysis that had gone on during the previous six months, a revision of the time planning and methodology of the Project was worked out. The new version of the Project planning resulting from this meeting is given as ITEC Document 5 (see Appendix A).

The major refinements (and changes) in the Project's planning related to:

- A delay in its time line, with observations planned to begin in January 1991, instead of January 1990.
- Classes in participating countries were to be chosen on the basis of finding classes with relatively little experience of school computer use, half of them to be assigned to a computer intervention, the other half to a different type of media intervention.

Much discussion occurred with respect to the management of such a design; what about the teachers, for example? Over a three-year period (as planned for ITEC), students would normally move through three teachers. It was felt at this meeting that some sort of teacher training or support for each cohort of teachers would have to be provided, or else the difference in teacher preparation and motivation would be so strong in the various countries that no real comparison of the effects of computer use on metacognitive development could be carried out.

The meeting ended with the clear awareness that trying to carry out a quasi-experimental design, given the complexity of situational differences among the different countries, schools, classes, and teachers eventually to be involved in the study was perhaps going to be unmanageable. Yet, how else to proceed? The excitement being generated by the project since its May 1988 birth, and the commitment of many persons already to the idea of a "good" scientific study meant we must continue to look for a valid way to compare student cognitive development, relative to computer use experiences, in different countries and classrooms.

The meeting in January in Bulgaria also struggled with a way to articulate and visualize the theoretical framework of the study. By the end of the meeting, a conceptualization was found that was felt to be as simple as possible (for manageability purposes--everything we would add would have to be measured and categorized and synthesized in what was now more than 15 countries) and yet would still be scientifically useful. Figure 1.1 shows the model of the theoretical framework of the ITEC Project that was developed in January 1989 and has continued to be used throughout all of Phase 1.
Figure 1.1: ITEC General Model for the impact of school computer use on children's cognitive skills development.

1.4.2. Project Announcement, March 1989

After communication and dialogue with project researchers about the developments of the January 1989 meeting in Bulgaria, a first public invitation to participate in the Project (or for information about the Project) was circulated in March 1989. Researchers identified by the Project Co-Principals as potentially strong contributors to the Project were approached about participation in the project. Many of the researchers from the May 1988 Experts Meeting were formally invited to participate; but in addition, a number of other names were added, for scientific and geographic balance.

1.4.3. First Project Presentation, UNESCO International Congress, April 1989

On invitation from UNESCO, a paper describing the current theoretical framework, methodology, and planning for the ITEC Project was prepared for the UNESCO International Congress, "Education and Informatics: Strengthening International Cooperation", Paris, 19 April 1989. The paper was given at the Congress, subsequently appeared in the Proceedings of the Congress, and also appears as ITEC Document 7 in the Project Archives. The paper follows. It is interesting to compare it with the May 1988 Summary Report and Recommendations (Section 1.2.2); the research questions in the April 1989 document show the evolution of the project since May 1988 and the new "Plan of the Study" reflects the January 1989 Bulgaria meeting decisions.

The ITEC Project

AN INTERNATIONAL LONGITUDINAL STUDY OF THE IMPACT OF INFORMATION TECHNOLOGY IN EDUCATION ON CHILDREN'S COGNITIVE DEVELOPMENT

Introduction

With the support of UNESCO and the Lyudmila Zhivkova International Foundation a study investigating the effects of information technology in education (ITE) on various aspects of child development has begun. The major objective of the study is to investigate the impact of computer use in schools on the development of children's higher-order cognitive processes.

Background of the Study

Information technology, primarily involving the application of computers in the educational setting, is capable of having a profound effect on the developing child. The study of this effect -- what mediates it and how it may be channelled to the best advantage of the child -- is of major interest to researchers and educational decision makers throughout the world.

However, despite this extensive interest in the use of computers in education, it remains difficult to draw conclusions from the experiences which are occurring (Anderson, 1987; Becker, 1987; Bozeman & House, 1988). Partly this is because the field of information technology is continually changing in its characteristics; partly it is because "the effect" of computer use cannot be expressed simply but instead must be considered in the context of a complicated network of variables which conjointly influence it (Collis, 1988).

The lack of research synthesis is also a reflection of the incomparable aspects of the many studies which have already taken place (Becker, 1987; Clark, 1983; 1985). For example, culture as an important influence on computer impact is not considered in the majority of studies, and "computer use" and "computer impact" are interpreted in a wide variety of ways. Also, there are many problems which are frequently mentioned as limiting the scientific value of research in this area. These include:

1. Inadequate length and intensity of treatment.
2. Inappropriate choice of dependent variables or of instrumentation to measure the dependent variables.
3. Confounding of the novelty effect of working with new media and the Hawthorne effect of participating in a study.
4. Inadequate consideration of variables critically influencing the impact of computer use, particularly: the teacher effect, the effect of instructional decisions relating to the integration of the computer use in the larger educational setting, and considerations relating to the social organization of computer use.

Despite the apparent problems in conducting credible research in the impact of computer use in schools on children, there is consensus that such research still must continue to be done, but must be done in a way that recognises and tries to limit the impact of the problems that accompany research in this area. The ITEC Project is being planned in this spirit. It is a large-scale, multinational project designed to make a contribution to the methodology of research in relation to computers and children as well as to a better understanding of important outcomes of child-computer interaction, particularly cognitive development.

Conceptual Framework and Research Focuses of the Study

Conceptual framework

The conceptual framework of the study with respect to the development of higher-order cognitive functioning in the child is derived from the theoretical work of the Soviet psychologist, Vygotsky. Vygotsky emphasizes the concept of the human mind's systematic structure. His work provides a rationale for the expectation that computer use can effect higher-order cognitive functioning (Tikhomirov, 1989).

Research Questions

The major conceptual premise of the study is: that any eventual change in a child's higher-level cognitive functioning related to computer use in school is a function of certain background variables, including culture, type and frequency of computer use, the social organization and activities surrounding this computer use, and the instructional meaningfulness of this use. Following from this premise, the specific research questions are:
1. Will certain higher-level cognitive skills increase more rapidly for children in situations where (certain types of) computer use is integrated into the learning environment over a period of time than for children in comparable situations but without computer use?

2. Will the extent of acquisition of higher-order cognitive skills be higher in computer-integrated settings that emphasize open, tool-type software, certain types of simulations, or programming than it will be in comparable settings that emphasize drill and routine practice?

3. To what extent is the cognitive impact of the use of computers mediated by cultural variables, as well as by other demographic and situational variables?

4. Will particular types of social organization of computer use, such as cooperative division of work while solving a problem, be related to the heightened emergence of higher-order cognitive skills?

5. Will higher-order cognitive gain be more pronounced and be manifested more quickly for less advantaged children compared to more advantaged children?

6. Can we identify, from a longitudinal perspective as well as a cross-cultural one, differences in the profiles of cognitive and metacognition skills between computer-using and non-using children?

It is clear that these are ambitious and serious questions. However, they are powerful and important questions which should be considered as a group rather than in a more fragmented fashion.

Plan of the Study

Just as it is clear that the research focus of the ITEC Project is ambitious, it is also clear that the problems cited earlier as being typically associated with research in this area can easily become magnified in a large-scale, cross-national study. The plan of the study includes various features whose aim is better scientific control relative to these problems.

1. To investigate cultural impact, a number of countries will be involved in the study. It is planned that at least four classes of children will be involved from each of the countries. Discussions are in progress with researchers from Austria, Brazil, Bulgaria, China, the Federal Republic of Germany, France, Hungary, Israel, Japan, Mexico, The Netherlands, Sweden, UK, USA, USSR, and Zimbabwe with regard to their involvement in the project.

2. To allow adequate time for higher-level cognitive functioning to be affected and to look for patterns of variation in cognitive growth over cultures and computer-use settings, the study will span three years. The children involved in the study will be at the Grade 4 (approximately nine to ten years old) level in 1991, the first year of the full-scale operation of the study. This age group was chosen in order to have a cohort of subjects that is young enough to still be involved in a single undifferentiated school setting over the time of the project but is old enough to read end engage in a variety of computer activities during the project, particularly in activities more likely to involve higher-level thinking processes.

3. Classes in each country with relatively little experience of school computer use will be selected. Half the classes will be randomly assigned to the computer intervention, while the others to a different type of media intervention. This is to offer control for the Hawthorne effect.

4. In order to let the study proceed as naturally as possible, suggestions and some support for the computer and media interventions will be given, but local adaptations will be respected. Careful attention will be given to documenting these local variations in a systematic way using commonly defined categories of variables and procedures for information collection.

5. Teachers who are involved with the various classes of children as they move through Grades 4, 5, and 6 will receive in-service training relative to computer use or other media use. Again, suggestions and some support will be given for the teacher training, but interpretation and delivery will be organized locally.

6. Testing of children's higher-level cognitive functioning will take place prior to the interventions and again at the end of each of the three years of the study. A small subgroup of children will be observed more closely throughout the study in order to build the comparative cognitive profiles for the last of the research questions. Again, common instrumentation (after translation and necessary alterations to reflect cultural differences) will be used to facilitate the synthesis of results. Selection and validation of appropriate measures of higher-level cognitive functioning is a particularly challenging aspect of the study.
7. Because the social aspects of computer use are hypothesized as being critical to its impact on higher-level cognitive functioning, classroom observations of social interactions of students will occur. In addition, data will be kept on type and frequency of computer (or media) use, and on the instructional relevance of such use. Common data collection procedures again will be used in all countries. Arrangements have been made to share some of the instrumentation being used in another current international comparative study (Wolf, Plomp, & Pelgrum, 1986) to strengthen the subsequent synthesis of results.

Implications of the Study

The unique characteristics of the study, including its cooperation between researchers from a diverse range of countries, support its potential value. The study can help us understand better about significant variables in the child-computer interaction process by allowing us to examine these variables in various cultural settings. The study also has the potential to contribute to our better understanding of cognitive development separate from computer-related considerations. Finally, the study can make a major contribution from the perspective of how to design and manage cross-cultural comparative research.

Project Coordination

The Co-Principal Investigators for the ITEC Project are Dr. Assen Jablensky, President of the Academy of Medicine in Bulgaria and Dr. Betty Collis, University of Twente, The Netherlands. An international steering committee of scientists has been formed to oversee the study. Among the members of the steering committee are Elad Peled, Israel; Vitaly Rubtsov, USSR; and Alastair Mundy-Kastle, UK. Three scientific planning meetings, involving researchers from 16 countries, have been held. A series of 11 conceptual papers (ITEC Publications Series No. 2) has been produced as a result of these meetings. Regular meetings of the Steering Committee will be held, some of which will be attended by national project leaders. At least one meeting attended by all Project participants, including classroom teachers, is planned. In addition, a publication series relative to both the methodology and the findings of the Project has been established. This series will also include resource materials for teachers and a Project newsletter.

References


Participants. The third ITEC Project Planning meeting was held, in Sofia, Bulgaria, 19-23 May 1989, in conjunction with the Third International Conference "Children in the Information Age". Fifteen researchers at this meeting made further refinements and decisions about Project planning, variables and research questions, time line and responsibilities, and expectations for National Leaders. These participants were:

- A. Jablensky, Bulgaria
- B. Collis, The Netherlands
- E. Peled, Israel
- Z. Peled, Israel
- A. Mundy-Castle, UK
- J. Oliveira, Brazil
- P. Resta, USA
- Zhang, Hou-can, China
- B. Lindahl, Sweden
- J. Moonen, The Netherlands
- V. Tsoneva, Bulgaria
- P. Dimitrov, Bulgaria
- L. Lazarova, Bulgaria
- D. Wilson, Zimbabwe
- P. Greenfield, USA

Notes of this meeting and a new Project Description resulting from the meeting appear as ITEC Document 8 (see Appendix A). Major project decisions were made at this meeting. The highlights of project evolution are:

Research Questions and Variables. The research question was finalized, as were the variables to be measured. The refinement of the research question was:

- In the context of various combinations of background variables, under what combinations of:
  - characteristics of computer use,
  - social interaction surrounding computer use, and
  - instructional integration of computer use is a positive impact on children's higher-order cognitive functioning more likely to occur? How do these sets of conditions vary in different cultures?

This question relates directly to the visualized theoretical framework for the study, adopted at the January 1989 meeting (see Figure 1.1). The variables to be studied to deal with this general question are to include:

Background Variables:
- Socio-economic level
- Categorization of ability level of child

Characteristics of Computer Use:
- Type of computer applications
- Frequency of computer use
- Number and physical arrangement of available computers

Social Interaction Surrounding Computer Use:
- Teacher/student interaction
- Student/student interaction

Instructional Integration of Computer Use:
- Integration relative to larger instructional framework

Culture:
- May be school, community, or country

Higher-Level Cognitive Functioning:
- Various indicators of problem-solving skill

80
1.4 Project Evolution

B. CoUis

In addition, "preliminary research questions" were also adopted:

1. In the context of children using computers, what are indicators of presumed higher-order cognitive functioning?
2. Do these indicators of presumed higher-order cognitive functioning vary in different computer-use settings (including different cultures)?
3. Once we agree on these indicators, how can we reliably assess their presence in a cross-cultural study?

Two-Phase Design Approach. A major decision made at the May 1989 meeting was to change the planned design of the study from a three-year interventionist approach, to a two-Phase approach. The first phase was to be both a pilot and exploratory study. The pilot aspect involves the testing and refining of the use of the common observation and coding systems in different countries. More substantially, a major test of the first phase will be to look more closely at the nature of the "dependent variable" of the study—what do we mean by "higher-order cognitive functioning" and do conceptions of manifestations of this type of functioning vary in different cultures?

Thus Phase 2 would retain many of the originally decided-upon aspects of ITEC design, including preliminary teacher training, some intervention-type of study of common instructional strategies involving computer use, and cross-culturally validated observation and coding schemes.

Videotaping. Another major decision made by the project group during the May 1989 meeting in Bulgaria related to how best to capture situational differences in the different classrooms. There will be complexities involved, because of the nature of what is to be observed and coded but also because of the many researchers who will be involved, many of them who will use relatively inexperienced junior researchers for classroom observation and coding. The use of videotape in each of the observed settings provides opportunities for the researchers to exchange and scrutinize the situational variables, even in far-off contexts (essential for ITEC, with its 17 countries). In particular it was decided to use videotape in Phase 1 to try to help the researchers better clarify common indicators of higher-order cognitive functioning.

Action Points. A new timeline and action point list had to be made, after this expansion and change of methodological and design aspects of the study. A September 1989 meeting was planned, and various tasks were assigned to the researchers, to be done prior to the meeting.

1. Write a review based on the literature, leading to a justification of the need for the Project, of the model (Figure 1.1), of the underlying basic research questions of the Project, and of the issues to anticipate in the design and execution of the project.
2. Firm up strategies for observing, coding, and describing the settings of the classroom using ethnographic procedures; also strategies for assessing and coding the fundamental variable relating to "background".

Strategies. We also called for a critical examination of the control-group or "no computer use" aspect of our original plans. It seems to us that the limited comparative aspects that occur when different intact school classes are used in a study and the many confounding variables that will inevitably obscure any statement we will be able to make about the "impact of the computer" may so severely constrain the value of having control groups that they will not be worth the cost. However, we decided to postpone this decision until more experience from Phase 1 has been accumulated and we had a firmer sense of the financial resources available to the Project.

Another consequence of the two-phase decision was that this precluded the idea of following a cohort of children over a three-year period. However, the teacher-training and support aspects involved with three different sets of teachers, the inevitable diffusion of children over such a long period, (as well as the virtual impossibility of maintaining a control group situation) were likely to make this original approach very difficult on an international level. The two-phase approach had other distinct logistic advantages. We could conduct Phase 1 work using classrooms where computer use is already established. Thus we could postpone the problem of finding equipment, supplies, and training teachers until the Project had more maturity and firmly established resources.

Revised Phase 1 Purposes. Thus the purposes of ITEC Phase 1 as stated after the May 1989 planning meeting were:

1. To address the preliminary research questions (1.4.4.3), in particular by studying closely school settings where a teacher was already "doing good things" with computer use during instruction with 8- and 9-year old children
2. By "backward mapping" from these closely examined settings, to search for models of good practice or trends in situational variables that seem to be robust enough to appear in different cultural settings

3. To use the same backward mapping approach to see if observable indicators of "metacognitive development" (our basic dependent variable) can be seen across cultures and settings and thus can be instrumentalized for use in a subsequent Phase 2.

Phase 1 was now set to be completed in summer of 1991 and would serve as a critical source of input for the subsequent Phase 2 of the study (Phase 2 would include aspects of the original study design model such as some interventionist aspect with some pre-post test type of measurement of cognitive effect of the intervention).

1.4.5. Final Preparations, 1989

Establishment of National Research Teams. Formal letters of invitation were sent to potential National Leaders (ITEC Document 9, Appendix A) and intensive communication organizing national participation took place during the period, June 1989-October 1989.

Also, a new version of the Project Planning Document was prepared (See ITEC Document 10, Appendix A) and circulated for comments. A "Steering Committee" (six persons) and a "Methodological Advisor" were appointed, and national teams and Chief Collaborating Investigators were established (in November 1989, participation was confirmed for Bulgaria, Canada, China, Costa Rica, Hungary, Israel, Japan, Mexico, Netherlands, New Zealand, Portugal, Romania, Sweden, USA, USSR, and Zimbabwe). Names and addresses of researchers involved in ITEC Phase 1 are given in full in Appendix C along with those of participating teachers and school principals. Following are only the names and countries of the ITEC Phase 1 researchers' team at the start of Phase 1 execution:

Co-Chief Investigators:
Assen Jablensky, Bulgaria
Betty Collis, The Netherlands

Steering Committee:
Jablensky and Collis
Joao Oliveira, Brazil
Elad Peled, Israel
Alastair Mundy-Castle, UK
Vitaly Rubtsov, Russia

Methodological Adviser:
Z. Peled, Israel

Chief Collaborating Investigators, National-Level:
Martin Valcke, Belgium
Violeta Tsoneva, Bulgaria
Lloyd Ollila, Canada
Hou-can Zhang, China
Clotilde Fonseca de Pachero, Costa Rica
Mihaly Csako, Hungary
Gad Alexander, Israel
Takashi Sakamoto, Japan
Marco Murray-Lasso, Mexico
Jef Moonen, The Netherlands
Kwok-Wing Lai, New Zealand
Altamiro Machado, Portugal
Ion Diamandi, Romania
Vitaly Rubtsov, Russia
Bengt Bengtsson, Sweden
Robert Lewis, UK
David Wilson, Zimbabwe
Paul Resta, US

For some of these investigators, participation was contingent upon obtaining national funding or other aspects of local support.
Final Planning Meeting, November 1989

The next ITEC Planning Meeting was held in Bulgaria, 23-26 November 1989. Out of this meeting came the specific observation and interview instruments for Phase 1, the requirements for videotaping, and other requirements for the national teams. Final timelines for Phase 1 data collection and analysis were also established (see ITEC Document 11). Materials were sent to all national teams, 30 November 1989. Because these form the final procedural and theoretical documents of Phase 1 of ITEC we discuss them in more detail in the next section.

TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Item</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Student Consent Form</td>
<td>84</td>
</tr>
<tr>
<td>Notes on Component 1</td>
<td>85 - 86</td>
</tr>
<tr>
<td>(School/Class/Teacher Selection)</td>
<td></td>
</tr>
<tr>
<td>Form A, Sample Description</td>
<td>87 - 89</td>
</tr>
<tr>
<td>Notes on Component 2</td>
<td>90</td>
</tr>
<tr>
<td>(Descriptions of Settings)</td>
<td></td>
</tr>
<tr>
<td>Form B, School Description</td>
<td>91 - 95</td>
</tr>
<tr>
<td>Form C, Principal Interview</td>
<td>96</td>
</tr>
<tr>
<td>Form D, Student Information</td>
<td>97 - 100</td>
</tr>
<tr>
<td>Form E, Teacher Interview</td>
<td>101 - 104</td>
</tr>
<tr>
<td>Form F, Videotape Summary</td>
<td>105</td>
</tr>
<tr>
<td>Notes on Component 3</td>
<td>106 - 108</td>
</tr>
<tr>
<td>(Computer Use and Higher Order Thinking)</td>
<td></td>
</tr>
<tr>
<td>Form G, Computer Use Description</td>
<td>109 - 111</td>
</tr>
<tr>
<td>Form H, Videotape Summary</td>
<td>112 - 113</td>
</tr>
<tr>
<td>Form I, Teacher Comments</td>
<td>114 - 115</td>
</tr>
<tr>
<td>Form J, Researcher Comment</td>
<td>116</td>
</tr>
<tr>
<td>Notes on Summary Report</td>
<td>117</td>
</tr>
</tbody>
</table>
The ITEC Project: Background, Preliminary Period

Documents for ITEC Phase 1: Procedure and Instrumentation

Model, Parental Consent Form (for systems requiring parent consent)

(Note: We supply the following document as a model of a consent form that might be useful to you if "informed consent" for participation in research projects is required in your institution or your country. National requirements will vary widely on this aspect; the ITEC Project will assume you have secured the necessary consent in your country.)

ITEC Project International Study - Parental Consent Form

I understand that the (name of school) will participate in the "ITEC Project," an international study of the impact of computers in education on children's thinking skills. This study has the support of Unesco, (the national institution involved in the Project), and other organizations in 18 countries.

I understand that the purpose of the study is to help educators better understand the ways that computers may be used to improve the critical thinking and problem-solving skills of students in different countries. I also understand that (name of teacher)'s class has been selected to participate in this important study.

As part of the study, I understand that: (a) my child's classroom will be observed and videotaped during instruction; (b) the videotapes and observer's comments will be reviewed by researchers at the (name of national leader's institution) as well as by an international research team to help identify factors that may be associated with children's cognitive development when using computers; and (c) no child in the classroom will be identified by name during the observation of the videotaped material and other documents of the study.

Finally, I understand that the videotapes, along with those produced in other countries, may be used for both research and teacher training processes.

******************************************************************************

1 ___________ (Name of parent) do / do not (circle one) consent to
my child, ___________ (Name of child) being observed and videotaped

as part of the ITEC Project study.

Date: ________________ Signature: __________________________

******************************************************************************
Notes on Component 1: Selection of a Class for Phase 1 Observation

On this sheet we:

1. Review the research questions of the Project;
2. Discuss criteria for the site and student selection for Phase 1 (Cycle 1);
3. Describe your procedure for dealing with Form A (General Sample Description, due 31 January 1990).

1. Review of ITEC General Research Questions and Specific Phase 1 Research Questions

1.1. The ITEC General Research Question:
Given various combinations of background conditions, particularly culture, under what conditions of:
- characteristics of computer use,
- social interaction surrounding and/or during computer use,
- and instructional integration of computer use,
is a positive impact on children's higher-level cognitive functioning more likely to occur? Which aspects of these conditions can be generalized to different cultures?

1.2. Preliminary Research Questions for Phase 1:
As you know, we have deliberately abstained from endorsing any particular theoretical definition for the construct of "higher-level cognitive functioning" because in Phase 1 we are instead focusing on comparing the implicit and explicit definitions that educators in different cultural settings may have. Therefore our preliminary research questions for Phase 1 reflect this aspect of the study and also reflect our need to validate our descriptive and observational processes in a variety of cultural settings. The preliminary questions are:

1.2.1. In the context of children using computers in an instructional setting, what are observable indicators of presumed higher-order cognitive functioning?

1.2.2. Do these indicators vary in different computer-use settings (including different cultures)?

1.2.3. If we agree on these indicators, how can we reliably assess their presence in a cross-cultural study?

1.2.4. What are characteristics of instructional strategies that are associated with computer use and the observed indicators of presumed higher-order cognitive functioning?

Based on our investigation of these research questions during Phase 1, we hope to be able to:

- Generate a hypothesis based on our general research question for comparative testing in Phase 2 of the study;
- Refine our methodology relative to the special needs of a multinational study;
- More sharply define our set of independent (contextual) variables, and
- Develop consensus about an operationalized definition of our outcome variable, "higher-level cognitive functioning".

2. Site and Student Selection, (Cycle 1 of) Phase 1 (January - June 1990)

2.1 Each national research should select a class for (the first cycle of) Phase 1 with the following characteristics:

2.1.1. The children in the class are approximately 9 and 10 years old

2.1.1.1. There can be some variation in the age range; the more important issue is that the children involved are generally within the same general developmental age range

2.1.1.2. As a general principle we prefer a heterogeneous, "regular" class rather than a class with specialized characteristics (such as all needing remedial help, a "gifted" class, or all with physical handicaps). However, if a "special" class is the best which is available, then this is acceptable but must be well documented.
2.1.2. In order to avoid the situation that the teacher and students are preoccupied with purely mechanical problems, the teacher (and many of the children in the class) should have some experience with computers used in an instructional setting.

2.1.3. The class and teacher have access to one or more computers for activities integrating computer use and instruction during the Phase 1 period.

2.1.3.1. The instructional integration can be with any subject—either traditional subjects such as mathematics, or "computer literacy" activities. The important criterion is that the teacher feels that some kind of valuable, "higher-level thinking" or problem solving is occurring for at least some of the students in the context of the computer-related instructional activity.

2.1.3.2. The definition of "class" may also be a problem. As an example, it is possible that in some situations groups of children come together from different naturally occurring classes for work with computers. The important aspects to consider are the presence of social interaction and teacher-monitored instructional integration surrounding the computer use. To work with our model we need situations where the teacher is trying to integrate computer use into regular instruction involving at least a portion of a class, and where the teacher remains present, available for interaction, while the student-computer use is going on.

2.1.4. The teacher (and school administration) are willing to cooperate with the schedule of classroom observations, videotaping, and interviewing specified in this document for Phase 1.

3. Procedure for the Chief Collaborative Researcher

3.1. By 31 January 1990, please send a copy of Form A, "General Sample Description" to each of A. Jablensky and B. Collis. If we need more information or foresee a problem with generalizing observations from your sample we will indicate this to you. (Your FAX numbers are critical for this). If your sample appears to fit the guidelines of Phase 1, we will also send you immediate confirmation of this. We will also send a letter to the school principal and the teacher, thanking them for agreeing to participate in the ITEC Project. (Let us know if a letter from us to some other person or institution in your country is helpful to you.)

4. Points to Consider

4.1. An important issue you may need to address is the nature of the "reward" to these participating teachers and schools. The International Project promises that the teachers and the schools will be mentioned by name in future publications of the Project, that a certificate (in English and Bulgarian) will be given to the schools and teachers after Phase 1, and that the school will receive a compiled summary videotape of Phase 1 activities. We urge you to investigate local incentives for Project participation.

4.2. An updated short summary of the Project (2-to-3 pages) will soon be sent to you if this is helpful to you in your approach to schools and teachers. The Project Planning Document (dated 20 August) which was sent to you earlier is being revised; if you require the most up-to-date version, please let us know.
FORM A: General Sample Description, Phase 1 ITEC

Instructions: Please send a copy of the following form to both A. Jablensky and B. Collis before 31 January 1990 regarding the children and teacher you propose to involve in Phase 1 of the ITEC Project in your country.

Your Name: ________________________________
Country: ________________________________
Your FAX number: __________________________
Date: ________________________________

School Information:
Name of school: ________________________________
Complete mailing address of school:
Name of principal: ________________________________

Student Information
Number of students in proposed class: _______
Are the children in this class generally 9 and 10 years of age?

  ____ Yes  ____ No
If no, what age range are they? __________
Does the class have exceptional characteristics of some nature, compared to an "average" classroom in your region?

  ____ Yes
  ____ No
If yes, please describe briefly:
Have at least some of the children had experience with computer use for instructional purposes in the school setting?

- No
- Yes, but only a few
- Yes, but less than half
- Yes, half or more

If at least some of the children have had computer experience, can you make any special comments to make about the nature of their past experiences? (i.e., either relating to type of experience, such as, "all Logo", "all word processing"—or to frequency, such as "every week," "once or twice", etc.)

Teacher Information

Name of teacher in proposed class: ____________________________

Approximate years of teaching experience __________

Has the teacher had some training and/or other experience with computer use for instructional purposes in the school setting?

- No
- Yes, but very limited
- Yes, more than a limited amount

If yes, please describe briefly the training and other experience the teacher has had with respect to computer use for instructional purposes:
Computer Use:

Are there any special reasons why this class and teacher have access to a computer for instructional purposes (i.e., part of a special project, school has special funding or commitment to computer use, etc.)

_____ Yes     _____ No

If yes, please explain briefly:

Thank you very much. Please return, prior to 31 January 1990, one copy to A. Jablensky and one copy to B. Collis. Please FAX the form if it is not likely to be received in the regular mail by 31 January. We will send you confirmation of your sample as soon as possible, unless further discussion or clarification is necessary.
Notes on Component 2: Planning for a General Description of the Setting

As you know, one of the tasks of Phase 1 of ITEC is to develop observation procedures that can be used in a multinational project in order to better anticipate the eventual synthesis of experiences in different countries. In order to collect similar categories of descriptive information on the schools, classes, and teachers participating in Phase 1 of ITEC, we ask you please to submit five forms and a videotape to us by 31 March 1990. These forms are:

1. Form B, "General Description of the School"
2. Form C, "Interview with the School Principal"
3. Form D, "Student Information"
4. Form E, "Interview with the Teacher"
5. Form F, "Summary of the Videotape"

Instructions for these forms are given on the forms themselves.

In addition, we would like you to submit a short videotape segment, no more than 15 minutes, showing general observations about the school, and the class and teacher who will participate in Phase 1. Structure your tape generally around the following plan:

- First 5 minutes:  
  A general overview of the school, its location, and aspects of its "culture" as well as that of the surrounding neighbourhood. Try also to include an overview of the extent to which technology is used in the school

- Second 5 minutes:  
  An uninterrupted sequence showing the teacher and class who will be involved in ITEC as they participate in an "ordinary", non-computer use classroom activity. Position the videocamera in a location in the room so that as broad a view of the class, teacher, and classroom environment as possible is obtained.

- Last 5 minutes:  
  An edited sequence of the class and teacher which will be involved in the ITEC Project, containing footage that shows examples, in a non-computer use situation, of:

    - "typical" classroom instructional and working arrangements with regard to students working in groups or individually
    - "typical" examples of student-student interaction in instructional situations
    - "typical" examples of teacher-student interaction in instructional situations

Form F is used to give us a brief written summary of the contents of the videotape. Please return copies of all the forms to both A. Jablensky and B. Collis no later than 31 March 1990. Send your videotape to A. Jablensky. Processing of the videotapes will be done in Bulgaria.
FORM B: General Description of the Setting of the School

Country: ____________________________ Date: ____________________________

To the Researcher:

Please answer the following concerning the school involved in your country for Phase 1 of ITEC:

Country: ____________________________
Date: ____________________________

1. Overall Description of School

1.1. Approximate number of Students ______

1.2. Number of Teachers ______

1.3. General Description (choose one in each category):

1.3.1. State ______
Private ______

1.3.2. Day students only ______
Boarding ______

1.3.3. Regular* ______
School with special orientation ______
(Please describe below)

1.4. Brief description of school organization:

Number of grades: ______

Typical entry and exit age: ______

Any unusual aspects of school organization? ______ If yes, please describe:
1.5. Which of the following best describes the degree of autonomy of the school with respect to curriculum and instructional decisions?
- Centralized educational system, little autonomy for the school
- Autonomy in some respects
- Predominantly autonomous

1.6. Give a brief description of the location and population of the school relative to the "social geography" of the country:

1.7. Give a brief general description of students in the school:

1.7.1. Ethnicity

1.7.2. Entry criteria for students:
- All students in the neighbourhood
- Other (please describe below)

1.8. A typical elementary school is often organized around an organizational model of an intact group of students working predominantly with one teacher in a self-contained classroom. Please comment if your school differs from this "typical" pattern:
1.9. How would you characterize the educational background of parents of students in the school, on average, compared to other schools in your country?

- Very low
- Low
- Medium
- High
- Very high

(Do you wish to add any comment or explanation about your response? If yes, do so below: )

1.10. What is your sense of the experience of the school within approximately the last three years with respect to each of the following sorts of instructional change?

1.10.1. Mandated instructional change:
- Considerable experience
- Some experience
- Little or no special experience

1.10.2. Locally generated forms of instructional change:
- Considerable experience
- Some experience
- Little or no special experience

(Add a comment here if you wish to describe this further: )
2. General Description of the School’s Experience with Computers

2.1. As an estimate, about what percent of students have computers at home?

- [ ] None
- [ ] Less than 10%
- [ ] Between 10-30%
- [ ] Between 30-60%
- [ ] More than 60%
- [ ] Can not estimate

2.2. As an estimate, about what percent of teachers have computers at home?

- [ ] None
- [ ] Less than 10%
- [ ] Between 10-30%
- [ ] Between 30-60%
- [ ] More than 60%
- [ ] Can not estimate

2.3. In which type of rooms are the school computers usually located?

- **FIXED Location (e.g. located in a certain place for at least a semester)**
  - In classrooms
  - In special rooms for computers (e.g. laboratories)
  - In other instructional rooms (e.g. science and reading labs, learning centres)
  - In libraries (but used by teachers and students)
  - In departmental rooms and offices (but used by teachers and students)
  - In school offices (but used by teachers and students)

- **NO FIXED Location (e.g. moved from room to room)**

- **OTHER Location (please specify)**
2.4. How many teachers would you estimate make some use of computers for instructional purposes?

- [ ] Less than 10%
- [ ] Between 10-30%
- [ ] Between 30-50%
- [ ] More than 50%

2.5. How similar is the school to the "average" school in your country with respect to computer resources?

- [ ] Probably in the bottom quarter
- [ ] Probably near the average
- [ ] Probably in the top quarter
FORM C: Summary of Interview with the School Principal

Country: ________________________________  Date: ____________________

Please summarize the principal's opinion with respect to the following questions:

1. What does the principal think is happening of importance in his or her school because of the presence of computers?

2. What are the principal's principle concerns with respect to:
   - Computer hardware and software?
   - People-related issues associated with computer use?
   - The impact of computers on the school organization?

3. What age and type of students does the principal think will most benefit from using the computers in his or her school?

4. How would the principal describe the most typical patterns of student-teacher interaction in his or her school?

5. How would the principal describe the most typical patterns of student-student interaction in his or her school?
1.5 Final Version of Instrumentation

FORM D: Student Information

1. Student Anonymity

It is important that students' names are not associated with the information that will be circulated for this project. Work with the teacher to assign each child a code number. The ITEC Project only wants to receive children's code numbers, not their names.

2. General background information on the students in the class selected for the ITEC Project will come from two sources:
   - The teacher's responses to five questions about each child
   - The student's responses to ten questions relating to his or her feelings about solving problems or learning new skills

3. The student questionnaire will have to be translated and duplicated, one for each child in the ITEC class. If the children are unfamiliar with responding to an opinion questionnaire, emphasize to them that there is no "right" or "wrong" answer to any question, but only the student's best answer about how he or she feels. You may wish to read the questions to the students. The questionnaire has been extensively validated in one of the countries in our study; we are interested in its validity in other cultures.

4. You may also wish to translate and make multiple copies of the teacher's questions. However, we recommend you simply ask the teacher's opinions about each student and code the responses yourself.

5. We wish you to submit to ITEC, not all the individual student and teacher opinion sheets, but instead only a one-page summary. This is the matrix that appears on the page 19 in this document.
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Family Socio-economic level:</td>
<td>Above average, Average, Below</td>
</tr>
<tr>
<td></td>
<td>average, Cannot say</td>
</tr>
<tr>
<td>2. School Achievement Level:</td>
<td>Above average, Average, Below</td>
</tr>
<tr>
<td></td>
<td>average</td>
</tr>
<tr>
<td>3. Apparent experience with Computers:</td>
<td>Variety of experience, Some,</td>
</tr>
<tr>
<td></td>
<td>Little or none</td>
</tr>
<tr>
<td>4. Apparent Interest in Computers:</td>
<td>Very interested, Some interest,</td>
</tr>
<tr>
<td></td>
<td>Little or none</td>
</tr>
<tr>
<td>5. Work Habits:</td>
<td>Prefers to work independently,</td>
</tr>
<tr>
<td></td>
<td>Prefers to work with others,</td>
</tr>
<tr>
<td></td>
<td>No particular preference</td>
</tr>
</tbody>
</table>
### FORM D: Children's Questionnaire

(To be translated into language appropriate for the children in your setting)

**Child's Code Number** (Teacher substitutes this for the child's name)

#### WHEN SOLVING PROBLEMS OR LEARNING NEW SKILLS...

<table>
<thead>
<tr>
<th>Question</th>
<th>Very often</th>
<th>Sometimes</th>
<th>Usually not</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you get upset if you see that you have made an error?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. When given a problem, do you try to plan ahead how to go about solving it?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. When trying to solve a problem, do you feel irritated if someone reveals the answer?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. How often do you try to invent new tasks or problems yourself?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. How often do you offer help to your friends if you know how to solve a problem and they don't?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Do you prefer being given instructions or finding your own way of solving a problem?</td>
<td>Prefer Instructions</td>
<td>Can't say</td>
<td>Prefer own way</td>
</tr>
<tr>
<td>7. When trying to solve a problem, how often do you experiment with different ways of doing it, if one method doesn't work?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. How often do you ask for the teacher's assistance if you find a problem to be difficult?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Do you have your own &quot;tricks&quot; for solving problems, &quot;tricks&quot; that you have discovered yourself?</td>
<td>Quite a few</td>
<td>Some</td>
<td>Not really</td>
</tr>
<tr>
<td>10. Do you easily give up if the task turns out to be too hard to solve at once?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FORM D: Summary Matrix, General Student Information

(Please submit only this summary matrix to ITEC)

Place children's code numbers on the rows of the matrix.

For each child, fill in the columns of the matrix as follows:

- Column 1 M or F for gender
- Column 2 Age in years
- Columns 3-7 Underlined letters from teacher response sheet (i.e., If the teacher circled "Little or none" for Item 4, Apparent Interest in Computers, put LN in Column 6 of the matrix)
- Columns 8-17 First letter of student's circled response

<table>
<thead>
<tr>
<th>Child Number</th>
<th>Columns 1</th>
<th>Columns 2</th>
<th>Columns 3</th>
<th>Columns 4</th>
<th>Columns 5</th>
<th>Columns 6</th>
<th>Columns 7</th>
<th>Columns 8</th>
<th>Columns 9</th>
<th>Columns 10</th>
<th>Columns 11</th>
<th>Columns 12</th>
<th>Columns 13</th>
<th>Columns 14</th>
<th>Columns 15</th>
<th>Columns 16</th>
<th>Columns 17</th>
</tr>
</thead>
</table>

(Photocopy the matrix if more rows are needed)
**FORM E: Summary of Interview with the Teacher**

Country: ___________________________ Date: ________________

1. **Information about the Teacher**

   1.1. How many years (including this year) has the teacher used computers in some way for teaching?

   ___________________________

   1.2. **Does the teacher have access to a computer for use at home?**

   Yes ☐ ☐ ☐ ☐ No ☐ ☐ ☐ ☐

   1.3. About how many hours per week does the teacher use a computer?

   0-5 hours ☐ ☐ ☐ ☐
   6-10 hours ☐ ☐ ☐ ☐
   11-15 hours ☐ ☐ ☐ ☐
   More than 15 hours ☐ ☐ ☐ ☐

   1.4. About which of the following computer-related topics did the teacher study during teacher and/or in-service training? Please check all that apply.

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Little brief</th>
<th>More extensive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   - How to use a word processor
   - How to use a data base
   - How to use a spreadsheet
   - Programming topics
   - Social issues related to computers in society
   - Pedagogical applications of drill/practice/tutorial programs
   - Pedagogical applications of simulations
   - Strategies for evaluating educational software
   - Integration of software in existing lessons*
   - Organization of computer use during lessons**

   (*) This refers to the relation of software to curriculum and content
   (**) This refers to the methodology of organizing time, equipment, and students in the classroom

   1.5. **Does the teacher have a computer conveniently available for lesson preparation or other activities?**

   _____ Yes _____ No

   1.6. From whom can the teacher get support in case he or she encounters problems in using computers?

<table>
<thead>
<tr>
<th>School administration</th>
<th>Other teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer co-ordinator for the school</td>
<td>Other non-teaching staff in the school</td>
</tr>
<tr>
<td>Students</td>
<td>Other educational agencies outside the school</td>
</tr>
<tr>
<td>Computer and/or software companies</td>
<td>Other (please specify)</td>
</tr>
</tbody>
</table>

   No support available at all
2. The Teacher's Use of Computers with the Class Involved in the ITEC Observations

2.1. On most occasions when a computer is used for lessons in this class, where do students use these computers?

<table>
<thead>
<tr>
<th></th>
<th>In the classroom where their class normally meets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In a computer laboratory</td>
</tr>
<tr>
<td></td>
<td>In another place</td>
</tr>
</tbody>
</table>

2.2. Who usually supervises the students when they use computers?

<table>
<thead>
<tr>
<th></th>
<th>The classroom teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The teacher and another person</td>
</tr>
<tr>
<td></td>
<td>Another teacher in the school</td>
</tr>
<tr>
<td></td>
<td>A technical aide</td>
</tr>
<tr>
<td></td>
<td>A student</td>
</tr>
<tr>
<td></td>
<td>Other (please specify)</td>
</tr>
</tbody>
</table>

2.3. On average, how many students in this class share one computer to work with at the same time?

102
2.4. With this class, how often has the teacher used the following approaches to using computers in his or her lessons?

<table>
<thead>
<tr>
<th>Approach</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never weeks</td>
</tr>
<tr>
<td>Drill: Students do practical exercises on the computer</td>
<td>_____</td>
</tr>
<tr>
<td>Instruction by computer: the software provides the actual instruction</td>
<td>_____</td>
</tr>
<tr>
<td>Explanation/demonstration; the teacher explains and/or demonstrates an idea or skills</td>
<td>_____</td>
</tr>
<tr>
<td>Testing: students take tests by using computer software</td>
<td>_____</td>
</tr>
<tr>
<td>Enrichment: fast learners get additional instruction/exercises on the computer</td>
<td>_____</td>
</tr>
<tr>
<td>Remedy: slow learners get additional instruction/exercises on the computer</td>
<td>_____</td>
</tr>
<tr>
<td>Let students explore concepts on their own</td>
<td>_____</td>
</tr>
<tr>
<td>Other (please specify):</td>
<td>_____</td>
</tr>
</tbody>
</table>

2.5. How many hours do students in this class spend, on the average per month, at the computer?

2.6. What type of computer activities does the teacher feel have been most successful with his or her students?
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- No, because there is benefit for everyone
- Cannot say
- Yes

If yes, what types of students, and why?

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? ______ If yes, in what ways?

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
# FORM F: Summary of Descriptive Videotape

Country: ___________________________  Date: ___________________________

On this form **briefly highlight** for us the contents of your 15-minute descriptive videotape of the school, teacher, and class participating in the ITEC Project in your country. Begin your videotape with its counter at 0.

<table>
<thead>
<tr>
<th>Time Interval (Example: From 1:00 to 2:00)</th>
<th>Counter Begins</th>
<th>Counter Ends</th>
<th>Brief Description of Contents (Example: Shots of student-student interaction during group work in various classes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Notes on Component 3: Observations of Computer-Use Situations

We ask you to organize three classroom observation and videotaping sessions involving computer use, beginning as soon as you are able and concluding no later than 30 June 1990. For each of the sessions, the teacher will be asked to organize a classroom lesson involving computer use that he or she predicts is likely to generate some "higher-level thinking" or problem solving activity among at least some of the children. The lessons should fit naturally in the class' regular instructional activity, not be "staged events" for the videotaping.

The teachers may need some guidance as to what is meant by "higher-level thinking" or "problem solving". Give suggestions and examples such as:

- Stop and think about what to do next, about alternative approaches, and about the consequences of alternative approaches
- Make a plan, evaluate the plan
- Consider what others might do and why
- Simplify the problem, relate it to past experiences

You might find it helpful to give counter-examples: for example, "lower-level" thinking involves following routine procedures, or the rote learning of facts, or waiting for the teacher or someone else to solve a problem, or giving up immediately.

Although this kind of clarification is acceptable, it is important that you do not impose a specific theoretical construct on the teachers' opinions, in that a purpose of Phase 1 is to elicit the teachers' notions of "higher-level thinking" or problem solving.

Data from each session will include:

1. A description of the computer use situation (Form G)
2. A 10- to 15-minute videotape of the computer-use situation, including:
   2.1. Some coverage of the teacher introducing the computer usage
   2.2. Some coverage of the whole class while the computer activity is occurring
   2.3. Some coverage of student-student interaction associated with the computer use
   2.4. Some coverage of teacher-student interaction associated with the computer use
   2.5. Students displaying what the teacher feels are examples of higher-level thinking or problem solving, and
   2.6. If possible, brief exchanges between the teacher and selected students from Category 2.5, where the teacher asks the child to comment on his or her approach to solving a problem
3. An outline (Form H) accompanying the videotape where the different time periods on the tape are described in terms of the above six categories
4. A summary of an interview with the teacher after the observed computer activity (Form I).

You may, if you wish, have one or more practice sessions in order to familiarize the children and teacher to the process of being videotaped. The three sessions for ITEC are to be done by the end of June 1990. Thus the following forms will have to be duplicated for each of the three sessions. All the forms for Session 1 should be sent to both A. Jablensky and B. Collis no later than May 5. The first videotape should accompany the set of the forms sent to A. Jablensky, for initial processing before the Steering Committee meets in Bulgaria later in May. (Note that regular airmail to Bulgaria tends to take at least two weeks to arrive).

The timing between the 1st, 2nd, and 3rd observation sessions is at your discretion.
1. How many computers were available? ______

2. What type of software was used? ______________________

3. How many children had contact with the computer(s)? ______

4. Describe briefly the ways in which the computers were used:

5. How familiar were the students with this type of computer activity? ______________________

6. What is your assessment of how effectively the computer use was integrated with some larger body of instruction?
   - Little or no integration
   - Supplementary drill, but the lesson could have gone on the same way without the computer use
   - Enrichment or remedial activities, but no real impact on the general instructional activity
   - Integrated for demonstration within the lesson
   - Was an important part of the lesson

7. What is your assessment of the overall frequency of student involvement with the computer activity?
   - Fewer than a third of the class had involvement
   - One- to two-thirds had involvement
   - More than two-thirds had involvement

8. What is your estimate of how long a child who did have involvement with the computer was engaged in this involvement? ______ minutes

9. How were the students organized for their involvement with the computer?
   - Used the computer individually
   - Used the computer with one other student
   - Used the computer with a group of two or more students
   - Observed the teacher use the computer

10. Describe the student-student interaction associated with the computer work:
11. Describe the teacher-student interaction associated with the computer work:

12. Which comment best summarizes your impression of how interested the children were in the computer activity?

   - The students did not seem very interested
   - Only a few of the students seemed interested
   - Most of the students showed some interest
   - Most of the students showed strong interest

   Observation: 1st 2nd 3rd

13. Which comment best summarizes your overall perceived competency of the teacher?

   - Below average competency
   - Average competency
   - Above average competency but not outstanding
   - Outstanding

   of this form, any other comments you would like to add in summary of your description of the observed lesson.
FORM G: Description of the Computer Use Setting During the Observed Lesson
(Researcher's Opinions)

Country: ___________________________ Date: __________

Observation _______ 1st _______ 2nd _______ 3rd _______

(Note: "lesson" is defined as one continuous time period during which computer use is integrated into some instructional framework).

1. Instructional Overview of the Lesson

1.1. According to the teacher, what were the instructional objectives of the lesson?

1.2. Describe the overall instructional activity of the lesson (not just the computer portion):

1.3. Describe the way in which computer use was integrated within the lesson:

2. Details of Computer-Use Activity: Hardware and Software

2.1. How many computers were available? _______

2.2. Was a printer available? _______

2.3. Were there any special characteristics of the computer equipment? _______

   If yes, describe:

2.4. Where were the computer(s) located?

   _______ In the children's regular classroom
   _______ In a computer room outside the children's regular classroom
   _______ In the library or a general-purpose room in the school
   _______ Other (please describe): _______________________

   Describe the arrangement of the computer(s) (i.e., location relative to the rest of the room,
   number of chairs around the computer(s), etc.):

2.5. Give your opinion of the ergonomics of the computer-use environment relative to vision,
   seating, general comfort of computer use, etc.

2.6. Describe the software that was used:
2.7. How familiar were the students with this type of computer activity?
   - Apparently quite familiar
   - Some familiarity
   - Apparently not familiar

2.8. Did the children appear to have any difficulties using the computers and/or software? (This question does not relate to the content of the software but to the mechanics of using the computer and software).
   - Generally no difficulties
   - Some difficulties
   - Considerable difficulties

If some or considerable, please describe:

2.9. In your opinion, how closely did the software that was used relate to the overall instructional objectives of the lesson?
   - Close relationship
   - Some relationship
   - Little relationship

2.10. In your opinion, what contribution did the computer activity make to the attainment of the instructional objectives of the lesson?
   - The computer activity made a strong contribution
   - The computer activity made some contribution
   - The computer activity did not appear to contribute much to the attainment of the instructional objectives of the lesson

(If you would like to add some clarifying comments about your opinions in Items 2.9 and 2.10, please do so below:)

3. Details of the Computer-Use Activity: Child Interaction-Related

3.1. What is your assessment of the overall frequency of student involvement with the computer activity?
   - Fewer than a third of the class had involvement
   - One- to two-thirds had involvement
   - More than two-thirds had involvement

3.2. What is your estimate of the average time a child who did have involvement with the computer was engaged in this involvement?
   - minutes

3.3. How were the students organized for their involvement with the computer?
   - Used the computer individually
   - Used the computer with one other student
   - Used the computer with a group of two or more other students
   - Observed the teacher use the computer
   - Other (please describe):
3.4. Describe the student-student interaction associated with the computer work:

3.5. Describe the teacher-student interaction associated with the computer work:

3.6. Which comment best summarizes your impression of how interested the children were in the computer activity?

[ ] The students did not seem very interested
[ ] Only a few of the students seemed interested
[ ] Most of the students showed some interest
[ ] Most of the students showed strong interest

Please indicate on the back of this form any other comments you would like to add in summary of your description of the observed lesson.
FORM H: Reference Sheet for Videotape of Computer-Use Observation

<table>
<thead>
<tr>
<th>Country:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>1st</td>
</tr>
</tbody>
</table>

Instructions to the researcher:

Please submit a videotaped summary of the observed computer-use lesson. As noted earlier, the videotape should be between 10 and 15 minutes long and include:

1. Some coverage of the teacher introducing the computer use
2. Some coverage of the whole class while the computer use is occurring
3. Some coverage of student-student interaction associated with the computer use
4. Some coverage of teacher-student interaction associated with the computer use
5. Students displaying what the teacher and/or researcher feel are examples of "higher level thinking" or problem solving
6. If possible, brief discussions between the teachers and selected students from Category 5 (above), where the teacher asks the children to comment on the work they are doing (what they are thinking about, what they are planning, what different approaches they have used while solving their problem, etc.)

On this summary sheet, we ask you to indicate for each (approximately) one-minute segment of the video which of the above categories predominate.

Summarize very briefly in English what is being said in each of these segments if this will be helpful to us in the analysis of the tape. Only supply translations if comments made by the children or if exchanges between the teacher and the children will be useful to our analysis of children's higher level thinking (such as in Category 6 above).

The summary sheet appears on the next page (p. 33). Use copies of it if you need more than one page to summarize the videotape. Set the counter to zero at the beginning of the tape.
Reference Sheet for Videotape of Computer-Use Observation

<table>
<thead>
<tr>
<th>Country: ___________________________</th>
<th>Date: ____________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>1st</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Segment Number</th>
<th>Counter</th>
<th>Predominate Categories (1 to 6)</th>
<th>Brief Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FORM I: Summary of Interview with Teacher Concerning His or Her Perception of "Higher Level Thinking" Displayed by the Students in Connection with Computer Use

Country: ________________________________ Date: ________________

Observation ______ 1st ______ 2nd ______ 3rd

This is a central aspect of this research. Discuss with the teacher what he or she felt happened of value during the computer use activity, and in particular what she or he feels are examples of children's behaviour associated with the computer use that demonstrate "higher level thinking" or problem solving.

Look at the videotape with the teacher and see if these behaviours can be noted on it. When they can, note the time elapsed on the videotape and supply that to us. Summarize this discussion here and add your own perceptions relative to the appearance of behaviours that may be operationalizing higher level thinking and problem solving as stimulated by the computer activity, the social interaction, and the lesson integration surrounding that activity.

1. Does the teacher feel that at least some of the children were displaying behaviours that could be examples of higher-level thinking or problem solving?
   ______ Yes ______ No ______ Uncertain

2. If yes, give the code numbers (from FORM D) of the children displaying these behaviours:
   Code Numbers:
   __________________________________________
   __________________________________________
   __________________________________________

3. Summarize the teacher's reasons for his or her answer to Question 1:
4. If the teacher based his or her opinion in Question 3 on the results of some sort of test or written activity of the students, describe the procedure carefully:

5. Do you as a researcher/observer have generally the same opinions as the teacher with respect to the appearance of behaviours that may indicate higher-order thinking or problem solving?
   
   _____ Generally agree
   _____ Some substantial differences or additional insights.

   If you chose the second category, please elaborate.
FORM J: Researcher's Comment Sheet

Country: ________________________________ Date: ____________________

Observation 1st 2nd 3rd

Use this sheet to communicate your comments, observations, evaluative feedback, etc., to us after each of the observation sessions. You may wish to comment on the methodology (the instrumentation, the procedures, the videotaping), the theoretical framework of the study and how it might be modified through the experiences that are emerging in Phase 1, the contextual variables specified for the study, or the problem of trying to "see" and operationalize higher level cognitive activity.

Your comments on this sheet may be informally stated, and as short or as lengthy as you feel is useful.
Summary Report, National Level

A scientific report for Phase 1 of the study will be prepared during the latter half of 1990. The Co-Principle Investigators and others from the Project will write chapters describing the overall Project but we would also like each of the Chief Collaborating Researchers to include a short chapter with the following specifications:

1. Title: Summary Report of ITEC Participation, Phase 1-(Name of the specific country)

2. Author: The Chief Collaborating Researcher and/or other researchers from the specific country

3. Length: No more than 10 double-spaced typed pages

4. Organization:
   - Motivation for joining the project-Description of the community, school, teacher, and class (in narrative form; we will include a summary of your Forms B-F in tables or appendices in another section of the scientific report)
   - Description of the computer-use lessons (again, in narrative form as we will include a summary of your Forms G-I elsewhere)
   - A summary of your observations with respect to observed behaviours assumed to be associated with higher level cognitive activity
   - Your suggestion, based on your observations, for a response to ITEC's general research question:
     Under what conditions of
     - characteristics of computer use
     - social interaction surrounding and during computer use, and
     - instructional integration of computer use is a positive impact on children's higher level cognitive functioning more likely to occur?
     - An overall reflection on Phase 1, from your perspective
     - Your recommendations for Phase 2 of ITEC

5. This contribution to the Phase 1 scientific report does not prevent you from writing a lengthier report of your activities for publication elsewhere. We require only that you fully acknowledge the ITEC Project and reference the Phase 1 scientific report. Later we will develop a standard procedure for this.

6. We ask that this short summary chapter be in the possession of both A. Jablensky and B. Collis no later than 15 October 1990.
1.5.2. FINAL PHASE 1 PROJECT DOCUMENT

While the previous 42-page bundle formed the instrumentation-procedural structure of ITEC Phase 1, it was still necessary to rewrite a project document addressing the revised theoretical framework of the study and its research questions and showing how the planned methodology relate to the overall project vision and goals. This was done, in a document circulated in March 1990. This document reflected feedback from the researchers on an earlier concept version, which had been circulated in September 1989 (ITEC Document 10, see Appendix A). The March 1990 Project Document follows (and remains the definitive ITEC document).

Revised Project Document: Phase 1, ITEC Project

1. Overview of this Document

1.1. Purpose

This document has two purposes. It contains the current draft of the literature review for the ITEC study and it also contains a discussion of the specific planning for Phase 1 of the study.

1.2. Structure of the Document

The document consists of the following sections:

- Section 2: Theoretical framework of the study
- Section 3: Methodological issues pertinent to the study
- Section 4: Overview of methodology for the study
- Section 5: Specific planning for Phase 1
- Section 6: References

2. Theoretical Framework of the ITEC Project

2.1. Background of the study

Information technology, primarily involving the application of computers in the educational setting, is perceived by educators and the public in countries throughout the world as capable of having a significant effect on the developing child. The study of this effect—what mediates it and how it may be channelled to the best advantage of the child—is a topic of major interest to researchers and educational decision makers. In recognition of this interest, UNESCO and the Bulgarian Committee for Science and Education established a collaboration in 1985 with the purpose of stimulating various international initiatives with respect to information technology, education, and children.

The idea of stimulating an international research study on the effect of computers in the educational setting emerged from this collaboration. In December 1987 a first international scientific discussion was held to explore the direction of such a study. Preliminary papers were commissioned and a decision was made to include the study of the effect of information technology on children's metacognitive development as a focus of the research.

Subsequent to this, the Bulgarian National Neuro Science and Behaviour Research Programme has become a co-sponsor of the research, and three more international scientific planning meetings have been held, involving researchers from 19 countries. The project, which acquired the name "ITEC," Information Technology in Education and Children), is now in the first of its two phases.

2.2. Conceptual Starting Point for the Study

The conceptual starting point for the study is derived from the theoretical work of the Soviet psychologist, Vygotsky. Vygotsky emphasizes the important role that social interaction plays in cognitive development (Vygotsky, 1966, 1978; Wertsch, 1985). A key element of this transactional, or socially mediated approach to cognitive development and learning is that cognitive development occurs in the context of "everyday" problem-solving interactions (Saxe, Gearhart, & Guberman, 1984). "Learning in context" is seen as the motive force for cognitive development and thus the analysis of thinking and learning cannot be separated from the analysis of the social organization in which learning transactions occur (Levine, 1989; Schoenfeld, 1989). Vygotskian theory, therefore, gives the ITEC Project its rationale for the expectation that computer use in the social context of the school setting can effect the child's higher-order cognitive functioning. Vygotskian theory also underscores the necessity of studying the complex of variables
pertaining to teacher and student interaction with regard to computer use in any consideration of the eventual
effect of such use.

2.3. Multidimensional Aspects of Computer Impact on Children's Cognitive Development

Vygotsky's theories are not the only source of support for a multidimensional approach to the study of
the impact of computers in education on children's cognitive development. The extensive research that has
already been conducted on aspects of the impact of computers in education substantiates the conclusion that
such impact cannot be considered in isolation: it is inextricably embedded in and varies with a large number
of other variables (Clark, 1985; Collis, 1988a; Eraut & Hoyles, 1988; Hawkins & Sheingold, 1986; Pea &
Sheingold, 1986; Salomon & Gardner, 1986; Schoenfeld, 1989; Sutton, 1987). Technological innovations are
"interpreted and shaped by the knowledge, experience, and setting of those teachers and students who
encounter them" (Hawkins & Sheingold, p. 43) and "serve as 'mirrors of the minds and cultures' in which
they live" (Pea & Sheingold, p. 10).

Many clusters of factors have been identified as critical in mediating the impact of computer use on
children's learning. Elaborations of clusters can be found in Collis, 1988a; Collis, Walker, and Grant, 1987;
Cox, Rhodes, and Hall, 1988; Eraut and Hoyles, 1988; Gayeski, 1989; McManus and Cannings, 1988; and
Watt and Watt, 1988, among others. From this research base, the following clusters of factors emerge as
critical:

- Background variables relating to student, teacher, school, and cultural characteristics
- Characteristics of the computer use itself, such as type of computer application, software design
  characteristics, and frequency of computer use
- Characteristics of the social interaction surrounding computer use, and
- The instructional integration and instructional "meaningfulness" of the computer use.

Each of these clusters has been the subject of considerable research activity. Among the conclusions of
this activity is that a number of specific variables within these clusters of variables have been identified as
being particularly important. A key selection of these specific variables can be described and briefly defended
as follows:

2.3.1. Background variables involving the child, the teacher, the school and the cultural setting

The child:

Key Variables:
- Family socioeconomic and educational levels
- Child's ability level
- Child's prior experience and understandings
- Child's gender

Becker (1987a) and Collis, Kass, and Kieren (1988) have shown the relationship between family
educational and socioeconomic level and type and frequency of usage of school computers, with children from
lower socio-economic levels having less opportunity than children from higher socio-economic levels to use
computers or to use them in open-ended and creative ways. These studies, and others, show gender to be
strongly associated with response to and engagement with school computers. Research done at the
Educational Technology Center (1988) at Harvard University reinforces the findings of many that children's
prior conceptions or understandings about computer use and subject matter affect their response to such use
and therefore its impact. Hativa (1988), among others, has documented the differential impact of computer
use on children of different ability levels. She notes that, "there will always be children who benefit from
some particular type of computer work, while other students, with different aptitudes and styles of learning,
will face problems working in that particular mode" (p. 18).

The teacher:

Key Variables:
- Teacher's subject matter and pedagogical awareness
- Teacher's expertise with respect to computer use in the classroom
- Teacher's attitudes and self-confidence
- Teacher's preferred instructional style
- Level of support available to the teacher with respect to computer use

There is an abundance of evidence that the teacher is a critical variable in the impact of any educational
tool, including computers (see, for example, Begle, 1979, and Brophy, 1986). Levin, Leitner, and Meister
(1986) found "profound" differences in the impact of even a very structured computer-delivered drill and
practice system when this system was monitored by different teachers, although the system was designed to be
virtually teacher-independent. Researchers at the Educational Technology Center (1988) note the inevitable
The ITEC Project: Background, Preliminary Period

impact of the teacher's "intellectual agenda" on computer impact and "vehemently contradict the popular
notion that computer-based lessons can be self-implementing... teachers need a clear understanding of the
purposes of the computer materials, an image of how to manage teaching in a new way, and a detailed map of
the subject matter they have to teach" (p. 20) with or without computers. Berger (1986) documents the impact
of science teachers' misconceptions and "thin-conceptions" on their subsequent use of computers to augment
laboratory investigations. The teacher's level of interest in computer use critically affects his response to
training opportunities and also predicts his effectiveness in using computers with his students (Cox, Rhodes,
& Hall, 1988; Friend, 1985). Orivel (1988) notes, for example, that "the high death rate of within-school
media (computer) projects is often due to teacher rejection" (p. 46). The teacher's preferred instructional
style is also a critical variable affecting computer impact. Cuban (1985) and Wiske and his colleagues (1988)
note that teachers are unlikely to change their characteristic teaching practices when considering computer
use, and indeed, "most teachers report no change in teaching style (after starting to use a computer), instead,
most adapt computer use to their existing style" (Wiske, et. al, 1988). Finally, a number of researchers have
noted the importance of providing teachers with in-school computer-related support as well as time and
opportunity for computer familiarisation, software evaluation, and lesson preparation if effective computer use
is to occur in the classroom (McManus & Cannings, 1988; Watt & Watt, 1988).

The school:

Key Variables:
- Availability and location of computers in the school
- School "climate" relative to technology
- Support of the principal

There is increasing recognition that the location of computers in the school can be a critical factor in
determining access to them and subsequently their eventual impact on children (Cheever, et. al., 1986; ,
Martin & Preskill, 1987; McManus & Cannings, 1988). The tendency to cluster available computers in a
single location has practical advantages but may significantly limit access and instructional integration beyond
the few students and teachers for whom the cluster location is convenient (Cheever et al., 1986; Collis,
1988b).

Many researchers have noted the importance of the principal in developing an effective school climate
for computer use (Cox, Rhodes, & Hall, 1988; Martin & Preskill, 1987; McManus & Cannings, 1988).
Cuban (1985) also notes the impact that the school environment and its "culture of teaching" have on
subsequent computer usage and impact. He comments that "settings have plans for their inhabitants" which
"situationally constrain choice" for both teachers and students with respect to computer use. The role of the
principal in influencing school culture is therefore a variable pertinent to the impact of computers within that
setting.

The culture:

The influence of culture on computer use and on learning is inevitable and complex (Salomon &
Gardner, 1986). Yet, the available research on the impact of computers in education on children gives little or
no consideration to the impact of regional or national culture on this impact. Only a relatively few
international comparative studies are available, and most of these are limited in their scope and in the
interpretive focus given to culture. The current IEA International Study, "Computers in Education," (Plomp
& Pelgrum, 1987) is a major exception. However, the IEA study is primarily interested in comparing
children's levels of "computer literacy" on an international basis and makes virtually no attempt to examine
the impact of computer use on children's higher-level learning and thinking. Culture as a variable influencing
learning "deserves extensive further research" (Cocking & Mestre, 1988).

Computer-Specific Variables

Key Variables:
- Type of computer use
- Frequency of computer use
- Software design characteristics

"Type of computer use" can be described broadly as content-specific or open-ended, or can be
categorized more specifically, (such as, instructional games, problem-solving games, word processing,
science simulations, etc.). The impact of the teacher is relevant with any type of computer use, but
accelerates as the type of computer usage becomes more open-ended. In addition, any type of computer use
can have different impacts on different types of children (Hativa, 1988; Rowland & Stuessy, 1987; Russell,
1987). There is logical support, although not much empirical evidence, that open-ended types of computer use
(particularly programming) are more likely to be associated with gains in higher-order thinking and other
metacognitive activities than are more convergent drill-oriented or tutorial-oriented computer uses (Clements,
1986; Liao & Bright, 1989).
In addition, there have been many studies conducted on the impact of various aspects of software design on student learning. Most of these studies relate to drill-type or tutorial-type software. Gillingham (1988), for example, reviews 23 studies that relate to the impact of design features related to text position and display in tutorial software. Finding consensus in design studies, however, is difficult; design decisions that are effective for some users in some situations are not effective for other users in the same or different situations, and thus no conclusive statements can be comfortably made (Collis, 1989; Hativa, 1988).

Variables Relating to Social Interaction Surrounding Computer Use

Key Variables:
- Teacher/student interaction
- Student/student interaction

The relationship of teacher/student interaction to learning has been long established (see, for example, Evertson, Anderson, Anderson, & Brophy, 1980, and Hart, 1989). In these and other studies certain teacher/student interaction variables have been significantly related to learning: number of interactions, initiator of the interaction, interaction in a public or private setting, and teacher feedback. Both teacher/student and student/student interaction are important as means by which meanings are created. This is also central to the work of Vygotsky (1962), but "has a venerable history dating back to Hegel... it follows that pupils must frequently talk in order to develop their thinking" (Erut & Hoyles, 1988, p. 2). Bruner (1966) also stresses the role of verbal interaction in cognitive development and uses the concept of "group reciprocity" to describe the influence of learning that comes from the child's awareness of the goals and activities of his social group. Schoenfeld (1989) notes that children's social and cognitive concerns are merged, with "individual's goal structures mediating between their social, interpersonal concerns and their subject-matter learning, and entering into a community is considered part of the learning process, with consequences for individual cognition" (p. 73). Brown, Collins, and Duguid (1988) describe collaborative learning and collective problem solving as key components of "cognitive apprenticeship." The value of group work with regard to computer use for children has been endorsed frequently, (see, for example, Clements, 1987, Clements & Natasi, 1988, Herman, 1988, Schofield & Evans-Rhodes, 1989, and Valcke, 1989), beginning perhaps with Papert's call for "participatory learning" in his landmark book, "Mindstorms" (1980). Developing better understanding of how to organize collaborative learning with computers has been particularly endorsed as an important area of continued research (Lewis, 1988).

Variables Reflecting Instructional Integration of Computer Use

Key Variables:
- Curriculum and student relevance
- Lesson integration

Personnel at the Educational Technology Center at Harvard University (1988), among others, have noted the critical importance relative to eventual learning impact of how the teacher integrates computer use into a lesson or teaching unit. Carver and Klahr (1987) note that explicit teaching should accompany children's computer "explorations" in order for effective impact to occur. Cox, Rhodes, and Hall (1988), however, observe that teachers frequently have a "lack of knowledge of how or when to join in children's work with microcomputers" and thus children fail to learn or "discover" what they might with judicious teacher-lesson integration. The importance of lesson integration and instructional "meaningfulness" has been particularly noted with respect to Logo use and with simulation software (Collis, 1988b; Govier, 1988).

2.4. Theoretical Model for the ITEC Project

Given this theoretical and empirical background, the ITEC Project takes as its model the multidimensional system shown earlier in Figure 1.1.

It is assumed that the so-called "Background Variables" influence all the other variable clusters. There is also assumed to be a two-way interaction between instructional integration and computer-related characteristics; based on instructional needs, teachers will select different types of computer use, but also, given a particular computer application, teachers will develop different strategies to integrate it into relevant instruction. Instructional integration also is assumed to be influenced by the type and level of social interaction the teacher structures or allows to occur during the computer use.

This type of multifactorial system allows us to investigate, not THE impact of computer use on children's cognitive activity, but instead to investigate the different combinations of factors that are likely to be associated with increased metacognitive activity, particularly given different sets of values of key background variables. This is a direction seen by many as most productive for current research in the impact of computers in education... "it is time to stop asking whether computer use 'works,' as we would do better to ask, 'Under what conditions should we expect transfer of skills and to what other situations might they transfer?'" (Phi Delta Kappa, 1987; see also, Barkman, 1988, Collis, 1988a; Salomon & Gardner, 1986).
2.5. ITEC General Research Questions

In the context of the above considerations, the general research questions to be investigated by the ITEC Project are:

- Given various combinations of background conditions, particularly culture, under what conditions of:
- characteristics of computer use
- social interaction surrounding computer use, and
- instructional integration of computer use is a positive impact on children's higher-level cognitive functioning likely to occur? How do these sets of conditions vary in different cultures?

3. Methodological Issues Pertinent to the ITEC Project

3.1. General Criticisms of Existing Research Methodologies

In spite of all the research which has already accumulated, progress toward better understanding about how to improve the impact of computers in education remains limited (Becker, 1987b; Collis, 1989; Orivel, 1988). A number of researchers give at least part of the blame to this slow progress to research design flaws which mar much of the current computers-in-education research. Clark’s reanalysis of previous research analyses is particularly critical (1985a, 1985b). He concluded that teacher and instructional integration effects have been improperly overlooked in many of the studies and that "computer use" and "teacher" are treated as uniform conditions. Salomon and Gardner (1986) similarly point out that educational media research often assumes learning happens in a vacuum, that it affects children in a uniform way, and that outcomes are clearly defined—assumptions all of which are invalid and should not be continued in the context of computer impact. These criticisms are addressed by the multidimensional model developed for the ITEC study.

Roblyer, Castine, and King (1988) in their extensive review of computer-related research comment that "one is struck immediately by the wide variation in study focuses, procedures, materials, and findings. Seldom do any two studies focus on the same kind of topic using the same kind of target population, instructional materials, and achievement measures. The absence of commonality makes it difficult to generalize across findings. The lack of standardization of data reported from study to study also severely hampers summarizing across studies" (p. 69). These are similar conclusions to those of Clark, who also notes that "the independent variables in much of this (computer-related) research are seriously confounded" (1985a, p. 137) and there is "compelling evidence that much of the educational computing literature lacks construct validity" (p. 146). Thus validation and standardization of measurement procedures and variables must be central to the ITEC Study.

3.2. Problems Relating to Specification and Measurement of Computer Impact

A particular problem in current attempts to measure the impact of computers on children's higher-level cognitive functioning is the difficulty of measuring such functioning (Theodor, 1988). Part of this difficulty seems to be in defining what is actually meant by constructs such as cognitive-functioning gains, metacognitive growth, development of problem solving, and strengthening of critical thinking. Many definitions are available, but frequently these definitions are open to various interpretations. For example, "the term metacognition is generally used to refer to the awareness, monitoring, and regulating of one's cognitive processes" (Haller, Child, & Walberg, 1988) but other definitions for metacognition abound, such as: "higher-order control processing" (Sternberg, 1985), and "the management of one's processing resources" (Chipman, 1985). Haller, Child, and Walberg examined the literature relative to metacognitive skills involved in reading comprehension and found at least 25 different variables used in the studies, all supposedly exemplifying "metacognition." A recent analysis of Logo studies, all focusing on the impact of Logo on children's higher-order thinking, found a similar plethora of non-summative variables (Collis, 1989). Roblyer, Castine, and King, (1988), in their extensive review of computer-related research, note that "when cognitive skills were being studied, no two experimenters seemed to use the same instruments" (p. 120).

The problem is enhanced even more by theoretical disagreement over the generality of cognitive skills. In their review of the literature, Perkins and Salomon (1989) conclude the "thinking at its most effective depends on specific, context-bound skills and units of knowledge that have little application to other domains" (p. 19) and that "the case of generalizable, context-independent skills and strategies that can be trained in one context and transferred to other domains has proven to more a matter of wishful thinking than hard empirical evidence" (p. 19; also see Pressley, Snyder, & Cariglia-Bull, 1987). One outcome of this dependent-variable complexity is that measures chosen to assess higher-order gains accruing through computer experience are frequently criticized. Papert, for example, has said, "I don't care what anybody's tests of cognitive change say—I can see something happening that is more important than those tests" (Cox, 1987, p. 3). This feeling—that traditional tests are not adequate for the measurement of the novel outcomes likely to be associated with computer use leads to the usage of many researcher-developed tests in educational computing research, and also to the criticisms of lack of validation and standardization mentioned earlier. As Lewis (1988) states, "studies are required which focus on the evaluation of the understandings achieved from the uses of IT..."
researchers are to persuade others of the value of their work, it will be necessary to create and test evaluation schemas having wide currency in the research and educational community. Research will be supported which identifies tangible indicators of change based on established benchmarks." (p. 10). In this context, a major purpose of Phase 1 of the ITEC Study will be develop an internationally validated definition of "higher-order cognitive activity" in the context of computer use in the classroom. The definition must be operational, so measurement procedures can be standardized and their construct validity directly supported.

4. Overview of Methodology for the ITEC Study

As was described in the summary reports of the ITEC scientific planning meetings held in Sofia, May 1989, the general design of the ITEC study was agreed upon, and is based not only on the theoretical framework developed in Section 2 of this report but also on a careful anticipation of the methodological issues identified in Section 3. An overview of the ITEC design follows.

4.1. In order to control for developmental variation in the children involved in the study, the research is limited to those at the Grade 4 level (approximate ages nine to ten years old). This cohort was chosen in order to have a sample of children who are young enough to still be involved in a single undifferentiated school setting with one teacher but who are old enough and read well enough to participate in a variety of computer activities, particularly those which are more likely to involve higher-level thinking processes.

4.2. In order to investigate cultural impact, a number of countries are involved in the study. Nineteen countries are represented.

4.3. An important feature of the study is the standardization of critical variables, descriptive, procedures, observational procedures, coding procedures, and data synthesis strategies on a multinational basis.

4.4. The study consists of two phases. Phase 1 involves exploratory research, with close investigation of classrooms (generally one per participating country) with children in the nine- to ten-year-old age range where computer use is already well established in order to better clarify the dependent variable of the study: higher-order cognitive functioning. Also, Phase 1 well involve pilot testing of the standardized observation and coding procedures for the independent variable clusters identified in the ITEC model—background variables relating to the student, teacher, school and culture; characteristics of computer use; characteristics of the social interaction surrounding computer use; and instructional integration of computer use. These procedures as well as coding of the procedures are described in the November 1990 working document for Phase 1 (pages 8-24, pertaining to Forms B through F).

4.5. The exploratory aspect of Phase 1 relates to the following preliminary research questions:
- In the context of children using computers, what are observable indicators of presumed higher-order cognitive functioning?
- Do these indicators vary in different computer-use settings (including different cultures)?
- Once we agree on these indicators, how can we reliably assess their presence in a cross-cultural study?

4.6. To explore these questions, we are using standardized videotaping procedures in each of the sites, (see Peled, Peled & Alexander 1989; Schoenfeld, 1989; Valcke, 1989), followed by opportunities for the researchers to exchange, scrutinize, and discuss the tapes. We are also using a variety of observational and interview techniques (see the November Phase 1 working document, pages 25-36, Forms G - J).

4.7. Also, Phase 1 will serve as the experience base from which final planning for Phase 2 will proceed.

4.8. Phase 2 of the study, if funding is secured, will involve different Grade 4 classrooms, approximately four per participating country. These classrooms will be observed over an entire school year. Two classrooms will serve as "comparison" classrooms; each of the other two will have a reasonably similar hardware environment, and will receive a regular dissemination of teaching ideas for using computers in ways likely to involve higher-order cognitive functioning (based on the consensus of observations from Phase 1). Standardized guidelines for teacher training will be offered to each country. (The details of these aspects will be clarified in 1991, following our assessment of Phase 1 experiences.) Videotaping of children engaged in computer activities where higher-order cognitive functioning is presumed to be observable will again be used, as well as the battery of other observational procedures which were pilot tested and refined during Phase 1.

4.9. Although baseline conditions of standard conditions will occur in the classrooms involved in Phase 2, no further attempt will be made to constrain the teachers in how they choose to make use of the computers or of the instructional ideas with which they are provided. An important aspect of ITEC is to study naturally occurring differences in the sorts of situations that best influence the impact of computer use on children. Therefore, the ways that different systems respond to similar computer-related opportunities is a major interest of the study.
5. Specific Planning for Phase 1 (January 1990-December 1990)

Phase 1 consists of observation in the period January-June 1990. During this period national leaders will work with one classroom and teacher in their respective countries. Details of twenty classes involved in data collection in Phase 1 are summarized in the report "Phase 1-Initial Profile of Participants" (March 1990; see Chapter 2 of this Final Report).

5.1. Site and Student Selection (January-June 1990)

Each national leader has been asked to select a class for the January-June 1990 period with the following characteristics:

- the children are approximately nine and ten years old
- the class and teacher are already "regular" users of computers (they have experience with computers and have access to computers during the time of the study)
- the teacher is willing to cooperate with four or five observation periods, all of which will involve videotaping, during the period January-June, 1990; each of which will also involve some teacher interviewing

Comments:

A particular question has arisen: How representative should the Phase 1 classes be? What about a "special education" class? During the exploratory phase, and in some countries where computer access is limited, it may be that any class which has regular access to computers is unrepresentative in some way, either by socio-economic level or by special characteristics of the school or students. We are sampling "regular" classes as a principle but making use of atypical classes if this is what is best available within the specification of being experienced with and having access to computer use. For Phase 1, diversity is not a problem, as long as class and teacher characteristics are carefully documented.

In order to work with the ITEC Project model (figure 1), we need to be able to observe the level of classroom lesson integration and social interaction surrounding the computer use. Computer use which becomes self-monitored and is outside the classroom dynamic (such as children choosing to do some word processing in a school resource centre) does not allow us to work with our full model. Thus the Phase 1 videotaping and observing is limited to situations where the teacher is trying to integrate computer use into regular instruction involving at least a portion of a class, and where the teacher remains present, available for interaction, while the student-computer use is going on.

During Phase 1, the instruction can be in any subject—either traditional subjects, such as mathematics, or "computer literacy" activities. The important criterion is that the teacher feels that some kind of valuable, higher-level cognitive functioning is occurring for at least some of the students as a result of the computer activity.

5.2. Observation Activity: Phase 1 (January-June 1990)

Full descriptions and forms are given in the November Phase 1 working document. The activity relates to:

- General descriptive information
- Pilot testing of procedures for observing, videotaping, coding, and summarizing
- Characteristics of computer use
- Social interaction
- Instructional integration
- Procedures to document behaviours indicative of "higher-order cognitive functioning"

Comments:

During the period January-March 1990 demographic descriptive data are being collected for each of the participating classes and schools. Reflecting the critical variables identified in Section 2 but also the pragmatic realities of multi-site data collection activity, the following are being pilot-tested:

(a) A brief description of the school (Form B), including information about:
- size, age, location, number of teachers, general organizational characteristics (i.e., one teacher per class? one grader age level per class?, etc.)
- general socio-economic level of families with children in the school (above average within country, average within country, below average within country)?
- experience with computers?
- What computers are available? (kind, number, associated equipment)
1.5.2 Final Phase 1 Project Document

- Where are computers located?
- What software is available? (Describe by categories and approximate quantity within category)
- How have these physical resources been acquired? (through a special project, through regular school purchases, etc.)
- Would you characterize the impetus for computer use in the school as coming from the teachers (bottom-up) or coming from the administration or through a special project offered to the school (top-down)?
- How would you characterize overall school interest in computer use? (High, involving a number of enthusiastic teachers and administrators; moderate, involving some staff members and school support; low, involving only a few teachers with little sense of support)
- Any special comments to make about the physical resources in the school?
- To what extent would you say the principal is supportive of computer use in the school? (Highly supportive, Generally supportive, Neutral, Not perceived as supportive).

Some of these questions use items from the IEA study (Plomp & Pelgrum, 1987) to allow some synthesis of data between the IEA and ITEC research.

(b) A videotape segment (Form F) (no more than 15 minutes) showing "general observations" about each of the schools, including indices of the school's "culture" pertinent to computer use and the ITEC model, including the following:
- Is there a "typical" orientation with regard to students working in groups or individually?
- What are "typical" examples of student-student interaction in instructional settings?
- What are "typical" examples of teacher-student interaction in instructional settings?
- In what ways is technology used in the school? (Include "older" technologies, such as filmstrips, audiotapes, etc.)

If possible, some videotape coverage of general school usage of computers might also be helpful.

(c) A translated transcript of a short interview with the school principal (Form C), in which he or she is asked to respond to the following questions:
- Why are there computers in your school?
- What do you think will or is happening of importance in your school because of the use of computers? Do you have any evidence yet of a positive impact?

(d) The descriptive information supplied at the end of March should also include background information on the teachers and students who will be involved in the Phase 1 observations. For each child (Form D), the following information should be provided by the teacher:
- Gender, age
- Family socio-economic level (Above average for the country, Average for the country, Below average for the country)
- Ability level (Above average for children of his/her age in the teacher's experience; Average for children of his/her age in the teacher's experience; Below average for children of his/her age in the teacher's experience)
- Child's prior experience with computers (Variety of experience, Some but more limited experience, Little or no experience)
- Aspects of child's personality and learning styles relevant to computer use:
- Prefers to work independently/Prefers to work within structured situations/No particular preference. For each participating teacher, a face-to-face interview is being conducted (Form E) in order to get information such as the following:
- How long have you used a computer?
- What are some of the things you have done with a computer for instructional purposes?
- What type of computer activities do you feel have been most successful for your students?
- What types of training have you had with respect to using computers in education?
- How satisfied are you with the training you have had?
- Do you have a computer available for your own use or for lesson preparation?
- What kinds of support are available for you in the school with respect to your use of computers in instruction?
- How satisfied are you with the level of support you have for your computer activities?
- What do you feel are some of the major benefits that can come from using computers in instruction?
Are there any special experiences you or your students have had in the context of computer use that you don’t feel would have happened without the stimulus of the computer?

- Do you feel you have changed the way you teach or organize your lessons because of the computer? If yes, how?

These interviews are being done in the mother tongue. The national leader is preparing a short summary of the teacher’s responses, in English, for the Co-Principal Investigators by the end of March.

The 15-minute videotape segments will also be available, accompanied by a written commentary (Form F) identifying portions of the videotape and describing what each of those portions is communicating. In addition, the videotape should be made with the researcher commenting in English as the videotape is being taken.

5.2.2. Observations of Computer-Use Situations
(April-June 1990)

(a) Three classroom observation videotaping sessions should be scheduled for each of the participating classes. (In addition there may be familiarisation sessions, to acclimate children and teacher to the videotaping, but these will not be included in the submitted data). For each of the videotaping sessions, the teacher will be asked to organize a classroom lesson involving computer use that he or she predicts is likely to generate some "higher-level thinking or problem solving activity" among at least some of the children. It is important that each teacher be allowed to define the target behaviour him or herself, so that we can examine the variation between teachers and countries as to what is seen as a "higher-level" outcome. However, to give some clarification we suggest the following ideas (Taken from Theodor, 1988):

Positive examples of observable aspects of "higher-order thinking"
- Stop and think about what to do next, about alternate approaches, and about consequences of alternate approaches
- Make a plan
- Consider what others might do and why
- Cooperate with partners, engage in mutual compromise
- Ask for clarification, or for information about alternatives
- Simplify the problem, relate it to past experience

Negative examples:
- Give up
- Let others take over
- Look for teacher solutions or "magical" solutions
- Display aggressiveness or unrelated activity

It is also important that the lessons be reasonably natural to the class’ regular activity—not a "staged" event for the videotaping. (This is a reason to recommend a trial-run of the observation-videotaping procedures - the teacher and class might be more inclined to behave "artificially" the first time they are observed).

Each of the three observation periods per class should be brief. Data from each will include a videotape segment (no more than 15 minutes; desired length, 10 minutes) and a short written commentary (Form H).

(b) Each videotape segment should include:
- Some coverage of the teacher introducing the computer usage (this is primarily to relate to the "instructional integration" of the computer use)
- Some coverage of the whole class while the computer activity is occurring (this is to relate to the instructional-integration aspect as well as to patterns of social interaction accompanying computer use)
- Some coverage of individual students involved in the computer use who seem particularly involved in the activities
- Some coverage of teacher/student interaction accompanying computer use
- Some coverage of student/student interaction accompanying computer use

With each segment, researchers will submit a short written overview of the segment, (Form H) where the tape is annotated relative to time elapsed (this is easy to see on the video-recorders). For example, Times 0:12.5 to 1:36.9 = Teacher explains computer use and relates to learning goals; 5:27.1-7:12 = Examples of student/student interaction accompanying computer use. This is to help the Co-Principal Investigators and others in the synthesis of data and in the compilation of "master tapes".

(c) For each observational segment, researchers will include a short written description (Form G), addressing the following:

126
1.5.2 Final Phase 1 Project Document

- A brief description of the type of computer use and software involved in the activity and the time involved for the entire computer-related activity
- A comment as to how familiar the students are with that type of computer use and the particular software
- An assessment of how integrated the computer activity was with some larger body of instruction
- An appraisal of the overall level of student engagement with the computer activity
- A description of how the teacher organized the social aspects of the computer use—did he or she structure group work, for example? Did he or she make a point of interacting with the students as they worked? If so, was the interaction content-oriented or more related to technical aspects of using the computer?

(d) Conduct a brief interview with the teacher after each videotaped observation in which he or she is asked to describe what he or she felt to be of value for the students during the computer activity (Form I). In particular, were any behaviours noticed that the teacher feels represent "higher-order thinking or problem-solving"? Summarize the interview in English.

(e) After each of the observational periods, the national researcher will also add his or her own impressions, both of the extent to which children's higher-level cognition functioning was observed and also of the research methodology itself (Form J).

5.3. First Appraisal Period, Phase 1 (May-June 1990)

The Bulgarian co-sponsors of the Project are providing funding to bring a key group of the national leaders to an ITEC meeting in Bulgaria in May 1990. During the meeting the videotapes that have been received will be viewed and discussions will take place as to the adequacy of the descriptive and videotaping procedures. Trends in observable behaviours representing "higher-order thinking" will be of particular interest as will be the types of computer activities chosen by the teachers as likely to facilitate such behaviour. Recommendations will be made as to the finer coding of the observations, for example with respect to student/student and teacher/student interactions (see Clements and Natasi, 1988, for seven categories of social behaviours in the context of computer use as one example). Suggestions will also be made with respect to other aspects of the observations, descriptions, interviews, and summaries. Strategies for coding and summarizing data will be prepared, incorporating some of the methodologies for qualitative data organization suggested by Miles and Huberman (1984) and Schofield and Anderson (1987).

5.4. Phase 1 Summary: September-December 1990

A meeting of key members of the Project will hopefully be held in the autumn of 1990 in which all the submitted materials for Phase 1 will be viewed and discussed. Decisions will be made as to summary procedures for Phase 1 and preparations for Phase 2. National leaders have been asked to prepare reports in which they summarize and interpret their own experience in the Project. Guidelines for these papers appear on p. 37 of the November working document and will be further elaborated... be developed during the first cycle of Phase 1 and presented to the national leaders after the May 1990 project meeting.

By December 1990, it is planned that the following will be completed:
- A Phase 1 project report, describing project activities and outcomes. (Written by Collis and Jablensky)
- An Executive Summary of Phase 1 (Collis and Jablensky)
- A series of articles submitted to scholarly journals (coordinated by Collis and Jablensky, written by designated participants in the project)
- Conference presentation proposals summarizing Phase 1, (Collis and Jablensky and/or other members of the Steering Committee)
- Reports from each national researcher, summarizing national experiences in the ITEC project.
- An annotated videotape, featuring a compilation of the different national videotapes
- Plans for Phase 2 of the project, to be discussed with potential national leaders during early 1991.

5.5. Phase 1 Short Summary Document

It was also important to prepare a new overview of the project for widespread circulation. A document (dated 20 February 1990) served this purpose (see ITEC Document 13, Appendix A). This seven-page summary of the document in Section 1.5.2 was circulated widely.
6. References


1.5.2 Final Phase 1 Project Document


1.6. Summary and Reflections on ITEC, from Conception to Start of Phase 1 Execution

It was also important to prepare a new overview of the project for widespread circulation. A document (dated 20 February 1990) served this purpose (see ITEC Document 13, Appendix A). This seven-page summary of the document in Section 1.5.2 was circulated widely.

1.6. Summary and Reflections on ITEC, from Conception to Start of Phase 1 Execution

In the year and a half between ITEC Project birth (May 1988) and sending out of the operating instructions for Phase 1 execution (November 1989) much scientific and human activity took place. Compromises were made and some fundamental changes in the project evolved. However, core aspects of the study continued and were strengthened. In the following observations, I, as one of the Co-Chief Investigators of the ITEC Project, offer my reflections on the evolution of ITEC, from its conception to the start of Phase 1 execution. It would be convenient to be able to organize these reflections in discrete categories theoretical, methodological, practical but all these perspectives overlap in the actual development of the project. Thus the reflection is organized around a few key ideas that intersect all of the perspectives.

1.6.1. Compromise on Causality

The first key idea is that of reconciling scientific ambitions with practical constraints. Our ideas regarding having something like a quasi-experimental design so that we could examine change in cognitive processing in the presence of a computer-use intervention in natural classroom settings and make cross-cultural comparisons just could not work, for a number of practical reasons. If we were to begin with non-computer using classrooms and randomly assign them to treatment groups, we ran immediately into (at least) two fundamental problems. First, non-computer using classrooms in a country where computer use is already common and widespread may be different in many fundamental characteristics than are non-computer using classrooms in countries where access to computers in schools is highly limited. School, community, parental, student, teacher characteristics may vary significantly; how can the introduction of computer use be equated in such different settings? This is a fundamental problem for attempting to use causal, interventionist designs in cross-cultural research: there is no way, in honesty, that the researchers can control enough of the situational variation among schools, teachers, and students to be able to make meaningful comparisons between some outcome measures following a computer intervention. Most of the ITEC team recognized this from the start of our deliberations; however, there was a strong urge (and it remained through the project) to do some sort of pre- and posttesting; to have a design where we would be able to designate “results” at the end of the project. The farther we went in acknowledging social-system complexity, the farther we went from the hope of yielding “results”. A rich descriptive commentary is also valuable, but is it enough to stimulate long-range commitment and funding for a project?

Our second fundamental problem with the idea of a quasi-experiment design with control groups related to the natural history that was bound to occur over the timespan of the project with respect to naturally occurring groups of children in school. Not only could we not require that “treatment group” children stay with the same cluster of treatments over a three-year period, but certainly we could not ask that the control classes continue to have nothing to do with computers throughout the timeframe of the study, in order to maintain a causal-comparative situation. Our belief that computer use offers valuable cognitive benefits to children made it unethical for us to condone the deliberate isolation of the control-group children from computer use over the long period of the study. But once naturally occurring computer use begins to occur with the control-group children, our comparative basis again fades.

1.6.2. The Two-Phase Approach: Postponing the Difficulties

Our decision to divide the project into two phases was good, both practically and scientifically, but also frustrating in terms of the “results” aspects. What would we have in 1992, at the end of Phase 1? Perhaps, enough insight to settle on a cross-culturally valid measure for capturing change in metacognitive processing; perhaps, enough insight to develop interventionist computer-use materials to use in a quasi-experimental design approach in Phase 2; perhaps a streamlined procedure for cross-culturally valid context description; perhaps a procedure for statistically handling data related to our theoretical framework, visualized in Figure 1.1. But, if we have less than this, will we have a scientific contribution to justify three years’ involvement of researchers from around the world?

1.6.3. Practical Constraints Relating to Standardizing Interviewing and Observing

Another compromise point related to finding a balance between what we could request of researchers and what we would have liked to have known. We are aware, of course, that culture and family variables play an inextricable part in a child’s metacognitive development, but when we tried to operationalize a procedure to capture and handle information related to these critical “background” variables, we had

131
insurmountable difficulties, both conceptual and practical. How do you categorize, and compare (implicitly or explicitly) culture and family environment? We finally chose descriptors at such a global level as to be relatively meaningless in any scientifically interpretive sense, but politically and procedurally we could not find a way to do a more refined job. Some countries would not be able to participate with potentially "embarrassing" labels given to its participants, as one example of a practical constraint.

Thus throughout our preparations we constantly cut back and cut back, in order to collect "enough" from everyone, but to recognize the operational difficulties researchers in the different countries would have getting this level of adequate information and conveying it in a standardized manner to the overall project data collection. The final instruments, (30 November 1989, 37 pages) still were a heavy burden, one that some of the researchers subsequently could not manage, but represented a compromise far away from what was hoped in the May 1988 planning (see Appendix B for what was felt then to be "essential" variables).

1.6.4. International Logistics

We can offer a final observation relative to conducting an international study a central staff with funding and time to coordinate, contact, and accumulate the activities and outcomes of the many different component settings of the project is of critical importance. For ITEC, this did not well enough materialize. Setting the operational headquarters of a project in a country operating under severe constraints with respect to international communication and support facilities, meant that more and more the operational infrastructure for the project operated out of my office in The Netherlands, an office with no support for ITEC beyond that of my own volunteer initiative as a scientist. Thus management delays frequently occurred, exacerbated by the great variation in the speed with which national researchers sent in requested forms and information. Given the lack of central financial support for the Dutch office of the project or for a Bulgarian project-office setting that could function with highly-effective communication support, our decision to move to a more naturalistic Phase 1 observation-based design was really the only way we could manage. Thus, scientific and practical concerns converged and were reflected in methodological decisions.

1.6.5. Procedural, not Motivational Changes

We still believed strongly at the end of 1989 in the value of the project--our basic goals and vision confirmed at the May 1988 meeting remained intact and in fact, were sharpened through the various rounds of iterative refinement. The "contributions to research and practice" that we identified at the end of the 20 February short summary of the project for public distribution are very much reflections of what we, in a less articulate way perhaps, hoped to accomplish in May 1988. What evolved was our procedure, not our underlying motivation.
A CROSS-CULTURAL ANALYSIS OF THE SETTINGS IN ITEC PHASE 1 COMPUTER-USE ENVIRONMENTS

2.1. INTRODUCTION AND OVERVIEW OF THE SAMPLE AND PROCEDURES

In this chapter we look closely at our experiences with trying to describe the context of computer use in ITEC Phase 1. As observed in Chapter 1, our intentions with respect to context description went through many iterations (as can be seen by comparing the variables listed by the team members in May 1988, as given in Appendix B, with those implicit in the final observation instruments of Phase 1, as given in Section 1.3.1). In this section we review our procedures for selecting teachers, schools and students for Phase 1 (Section 2.1.1) and our observation strategies (Section 2.1.2). We conclude the introductory section with a condensed summary of the participants in Phase 1 (Section 2.1.3). In other sections of this chapter we discuss the schools, principals, students, teachers, and settings of the Phase 1 participants in more detail.

2.1.1. Review of procedures for selecting teachers, schools, and students for ITEC Phase 1

Teachers. It was decided for Phase 1 to seek out existing classrooms in participating countries in which the teacher was known to be doing "good, interesting things" on a regular basis in terms of computer use in his or her instructional setting. We made this choice in order to maximize the chance of finding measurable effects on higher-level cognitive functioning. This decision was also made in order to somewhat control the variables relating to teacher experience with computers, teacher attitude about computer use and about innovation in instruction, availability of computers and usable software, school and community support for computer use, and experience of the students involved with computer use in an instructional setting. The participating researchers - 19 at the beginning of Phase 1 in 1988/89 - made the selection of teachers based on their own local and national information sources. They obtained the consent of the teachers and the principals (and sometimes the parents of the children involved) concerning participation in the study. At the close of Phase 1 observations, Autumn 1990, 23 teachers were involved in the study: one each from Bulgaria, Canada, China, Hungary, Israel, The Netherlands, New Zealand, Sweden, U.S.A., Russia, and Zimbabwe; two each from Costa Rica, France, Japan and Romania; and three from Mexico.

Schools. Because of the Phase 1 procedure of looking for exemplary settings of computer use, it is not surprising that the schools involved in the initial sample have many exceptional characteristics, compared to other schools in their regions or countries. Seventeen of the schools were described as having some special characteristic, such as having aggressively pursued involvement in a computer-related project, ability to convince others to equip the school with special levels of computer equipment, a special relationship with a university research department, or a principal with a particular vision for the school with respect to technology.

Again, in line with our sampling strategy, we tried to control for these sorts of contextual variables by including only (or mainly) schools that share these exceptional characteristics. In order to include countries with limited experience with computers, it is unavoidable that any school actually having a reasonable level of computer equipment and a teacher making regular use of it with his or her students is also an exceptional school.

Students. While the ITEC teachers and schools have exceptional characteristics, the participating children do not. It was decided to limit the study to nine- and ten-year children, as this cohort is old enough to make use of a wide variety of computer applications, but is still likely to remain with the same teacher most or all of the day and is still likely to be in a heterogeneous classroom setting, characteristics that are not possible after the age of about 11 in many countries. Approximately 680 children are in the ITEC classes; only one class, containing less than 20 of these children, was exceptional in terms of the class being comprised of deaf children. All other classes are described by their teachers as unexceptional for their neighbourhoods.
2.1.2. Review of observation procedure, Phase 1

After much discussion at a series of international meetings (see Sections 1.4.1, 1.4.4, 1.4.5), it was decided that the observation procedure for Phase 1 would involve:

1. Preliminary interviews with participating teachers and principals.

2. Description of the overall atmosphere of the school, its community, and the participating children. This was done through structured observations, interviews, and through a systematic videotaping procedure. These observations had to include a wide variety of examples of the typical types of social interaction among students and teachers in the school, away from computer use as well as around it.

3. In-depth interviews with the teachers and principals, relating to their opinions about the impact of computer use on their students, themselves, and their schools.

4. Profiles of each participating student, completed by his or her teacher, including information on child’s experience with computer use, ability level, work habits, learning style preferences and many other salient variables.

5. A detailed description of the school’s, teacher’s and students’ experiences with computer use. Eight detailed observations forms (see Section 1.5.1, Forms A through H) were developed to structure these observations, interviews and videotape episodes.

6. In-depth observation of at least three separate, full-length classroom lessons involving computer use of the type that the teacher felt would be likely to stimulate what he or she felt to be valuable higher-level thinking skills. For each observation, structured videotaping was done of the overall classroom environment in which the computer use occurred; other aspects of the lesson before, during and after the computer use; and teacher-student and student-student interactions before, during and after the computer use.

7. Following each in-depth observation, a detailed interview with the classroom teacher, in which he or she discussed the behaviours perceived to indicate higher-level thinking in the children, the strategies he or she used for computer use; his or her own appraisal of the impact of the computer-use session; and his or her identification of specific children, visible on the videotape or not, who seemed to be benefiting particularly well from the computer-use activities.

8. Following this interview, a written analysis by the researcher as to the extent to which he or she agreed with the teacher’s appraisal of what occurred in the computer-use setting and with the teacher’s appraisal of possible higher-level cognitive functioning among the students.

Aspects 6, 7, and 8 of the above procedure are described in Chapter 3; in this chapter we focus on Aspects 1 through 5.

2.1.3 Form A: A Brief Look at the Participants

In order to get a first sense of who would be the participants, ITEC researchers were asked to provide very brief descriptions of the schools, classes, and teachers they were proposing for Phase 1 participation. Form A was used for this purpose. Following is a summary of this overview.
Summary as of June 6, 1990

23 Schools

All Phase I Schools

FORM A

General Sample Description, Phase 1 ITEC:

Instructions: Please send a copy of the following form to both A. Jablensky and B. Collis before 31 January 1990 regarding the children and teacher you propose to involve in Phase 1 of the ITEC Project in your country.

Your Name: Phase I - ITEC

Country: 17 countries

Your FAX number: __________________________

Date: June 6, 1990

School Information:

Name of school: 23 schools

Complete mailing address of school: See list of teachers' names and addresses. (Appendix C)

Name of principal: __________________________

Student Information

Mean is

Number of students in proposed class: close to 32; 10 with 30-39 students

Are the children in this class generally 9 and 10 years of age?

Generally, all yes ___ Yes ___ No

If no, what age range are they? ______

Does the class have exceptional characteristics of some nature, compared to an "average" classroom in your region?

_____ Yes

17 No

If yes, please describe briefly:

1 = class as a whole is exceptional
1 = class has no computer experience
3 = variations in age range
1 = some students from out of region
Have at least some of the children had experience with computer use for instructional purposes in the school setting?

- 2 No
- 4 Yes, but only a few
- 6 Yes, but less than half
- 17 Yes, half or more

If at least some of the children have had computer experience, can you make any special comments to make about the nature of their past experiences? (i.e., either relating to type of experience, such as, "all Logo", "all word processing"—or to frequency, such as "every week," "once or twice," etc.)

(****)

Teacher Information

Gender: males = 9 females = 14 (see names on teacher list)

Name of teacher in proposed class:

Approximate years of teaching experience: $x = 15.7$ yrs. ($s.d = 8.0$) mode = 25 yrs. range from 2 yrs to 30 yrs.

Has the teacher had some training and/or other experience with computer use for instructional purposes in the school setting?

- 4 No
- 8 Yes, but very limited
- 14 Yes, more than a limited amount

If yes, please describe briefly the training and other experience the teacher has had with respect to computer use for instructional purposes:


<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>11</td>
<td>14</td>
<td>16</td>
<td>10</td>
<td>16</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Some</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Didn't say</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

N.B. = Depends on open-ended responses, so "none" may not necessarily be "none"
Computer Use:

Are there any special reasons why this class and teacher have access to a computer for instructional purposes (i.e., part of a special project, school has special funding or commitment to computer use, etc.) ______Yes ______No

If yes, please explain briefly:

- Part of Special Project = 10
- Computer Company donated = 4
- Parents donated = 1
- University collaboration = 1
- Nothing social (or unknown) = 6

Thank you very much. Please return, prior to 31 January 1990, one copy to A. Jablensky and one copy to B. Collis. Please FAX the form if it is not likely to be received in the regular mail by 31 January. We will send you confirmation of your sample as soon as possible, unless further discussion or clarification is necessary.
2.2. A Closer Look at the Schools in ITEC Phase 1

In this section we give a summary of the researchers' comments on Form B ("General Description of the Setting of the School") by summarizing first one particular aspect of the schools in Phase 1 characteristics that distinguish them from "average" schools in their neighbourhoods (Section 2.2.1), then we present a full summary of the school descriptions directly on a copy of the form (Section 2.2.2), a different view of a summary of Form B in an analysis written by S. Stoyanov in Bulgaria (Section 2.2.3), and finally a closer flavour of the schools through four narrative descriptions in Section 2.2.4.

More information about the schools can also be found in the researchers' reflections in Section 4.7.

2.2.1. Special Circumstances in the School Relative to Computers

ITEC Phase 1 had decided not to seek out "average" schools, but instead exemplary situations relative to computer use and young children, in order to extrapolate as much as possible the characteristics which may correlate with this kind of computer use. But how different are the ITEC Phase 1 schools, relative to others in their communities? It appears that they are distinguished in some way, but not remarkably so. The researchers were asked to describe any special circumstances in the schools relative to computers - if the children are not "special", why have these classes developed such strong patterns of computer use? Is it mostly the teacher variable, or are other school-wide factors involved?

Along with having well-experienced teachers, 17 of the schools participating in ITEC also appear to have something exceptional about them in terms of computer use. Summarizing the researchers' comments, here are descriptions of the various kinds of exceptionality in the ITEC Phase 1 schools:

- There is a school policy that all students use computers
- The school is a "key school" of the city, receiving more money and equipment and having better teachers than other schools
- It is a private school with many donated computers
- The school has made a special commitment to computer use
- There is an IBM project in the school with 50 computers and a special teacher to alternate with the regular classroom teacher when the children go to the computer lab
- The school itself has no computers, but because of special arrangements with a nearby university, and a highly motivated teacher, the children go each week to the university to use a computer lab
- There is a special teacher to teach the children programming; the school is associated with a national institute for research in informatics
- The school is part of a government-sponsored exploratory project, investigating the effects of computers in schools
- The school is part of a group of experimental schools, with an emphasis on informatics throughout primary school and a gradual emphasis on computer use in mathematics
- School leaders initiated a special program involving computer use over a number of years and are observing it closely
- The school is participating in a full-scale national project investigating the potential of computers as a pedagogical tool and providing extensive in-service training to teachers
- The school is in a middle-class suburb, where parents funded the school computer equipment (few other schools have such equipment)
- The school is part of a large-scale project, involving massive teacher training and hardware acquisition, with three computers in each 3rd-6th grade classroom, a networked laboratory with 16 computers in each school
- The school is part of a 16-school project exploring the use of computers in the primary school
- The school is part of a research project in informatics and in curricular applications of computers
- The school is part of a nation-wide computers-in-education project
- The school is an "Apple Centre for Innovation" and a member of the Apple Global Educational Network, has a laboratory with 33 networked computers
It can be seen by this that we have tapped very special schools, at least with respect to computers in education. This is good for ITEC Phase 1, in that we can use these experiences as somewhat of a ceiling for our expectations given well supported conditions, what can happen with computers in education? The ceiling aspect involves a different way of thinking about these well supported conditions if certain outcomes do not emerge in these classes, given such a wealth of special support in their schools and given such well experienced teachers, is it reasonable to hope that those outcomes would emerge in "ordinary" situations?

Again, the rich experiences provided by the schools in Phase 1 of ITEC are good for our purposes in that they increase (even maximize) the chance that good things will happen with children and computer use. They also make for a certain comparability among the schools, which can help control some of the non-culture-bound variation among them. The well-known "Hawthorne Effect," for example, which occurs when subjects know they are in special circumstances, would probably be pertinent to most if not all of these school (only two were indicated as having nothing "special about them") and thus could, in effect, cancel itself out to a certain degree. The highly atypical nature of the participating schools must be kept in mind as we make generalizations from the study our generalizations must relate to what can happen in a well supported, even rich, environment relative to computers and teachers, not necessarily to what can be expected in an "ordinary" situation.

2.2.2. Form B Summary

Section 2.2.1 gave an overview of the exceptionality of the schools in ITEC Phase 1. In this section we gave a broader summary of the schools and their settings, including overviews of the ways the schools are organized, their sizes and local situations, and the ways that computers are organized and used in the schools.
To the Researcher:

Please answer the following concerning the school involved in your country for Phase 1 of ITEC:

Country: 17 Countries, 23 Schools
Date: June 6, 1990

1. Overall Description of School

\[ \bar{x} = 900 \]

1.1 Approximate number of Students

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 500</td>
<td>9</td>
</tr>
<tr>
<td>500-999</td>
<td>7</td>
</tr>
<tr>
<td>over 1000</td>
<td>7</td>
</tr>
<tr>
<td>less than 30</td>
<td>10</td>
</tr>
<tr>
<td>30-60</td>
<td>7</td>
</tr>
<tr>
<td>over 60</td>
<td>6</td>
</tr>
</tbody>
</table>

1.2 Number of Teachers \[ \bar{x} = 35 \]

1.3 General Description (choose one in each category):

1.3.1 State 21

Private 2

1.3.2 Day students only 21

Boarding 2

1.3.3 Regular 20

School with special orientation 3

- for deaf
- "magnet" school (2)

1.4 Brief description of school organization:

Number of grades: "Grades" defined differently in different countries.

Typical entry and exit age: most typical = 6 yrs

11-12 yrs

Any unusual aspects of school organization? yes Please describe: if yes.

11 = no
1.5 Which of the following best describes the degree of autonomy of the school with respect to curriculum and instructional decisions?

- Centralized educational system, little autonomy for the school 
- Autonomy in some respects 
- Predominately autonomous 

9 12 2

1.6 Give a brief description of the location and population of the school relative to the "social geography" of the country:
See descriptions on attached sheet.
Overall, in major cities; often "upper class".

1.7 Give a brief general description of students in the school:

1.7.1 Ethnicity
Native = 16
of country
other groupings = 7

1.7.2 Entry criteria for students:
All students in the neighbourhood = 17
Other (please describe below) = 6
All come from the neighbourhood

1.8 A typical elementary school is often organized around an organizational model of an intact group of students working predominately with one teacher in a self-contained classroom. Please comment if your school differs from this "typical" pattern:
See descriptions on attached sheet.
France (both schools) - 1/3 time for substitute or student teacher
Canada - some days organized around topics
USSR - Grouping options and programs
Hungary - Specialist from start
New Zealand - Some specialist teachers in 3rd + 4th (cross-group teaching and shared teaching).
US - (limited team teaching)
Romania - Specialist teachers from 5th form.
1.9 How would you characterize the educational background of parents of students in the school, on average, compared to other schools in your country?

Very low
Low
Medium
High
Very high

(Do you wish to add any comment or explanation about your response? If yes, do so below:)

Also see attached sheets.

See: Mexico (*3) - low, learning with their children.
Hungary - Only 30% of parents completed Grade 12.
France (both) - Managers, "immediate occupations", "upper intellectual occupying" different from France as a whole.
Bulgaria - Parents have mainly intellectual professions and have graduated from universities or colleges.

1.10 What is your sense of the experience of the school within approximately the last three years with respect to each of the following sorts of instructional change?

1.10.1. Mandated instructional change:

Considerable experience
Some experience
Little or no special experience

1.10.2. Locally generated forms of instructional change:

Considerable experience
Some experience
Little or no special experience
Didn't understand

(Add a comment here if you wish to describe this further:)

Also, see attached sheet.

China: more experienced teachers
Bulgaria: For a decade, the school is associated with the experimental curriculum of the Research Group of Education.
Mexico (Hernandez)
(Collegio): Organized curriculum change.
Hungary: Constrained by lack of resources from generating change.
Sweden: Young teachers, involved in other special projects.
Costa Rica: Principal has freedom, gives teachers some flexibility in methods.
Portugal:
Canada: Gives examples of different types of change.
US: Changed into a magnet school.
2. General Description of the School's Experience with Computers

2.1. As an estimate, about what percent of students have computers at home?

- 1. None
- 11. Less than 10%
- 3. Between 10-30%
- 7. Between 30-60%
- 1. More than 60%
- Can not estimate

2.2. As an estimate, about what percent of teachers have computers at home?

- 5. None
- 11. Less than 10%
- 3. Between 10-30%
- 2. Between 30-60%
- 2. More than 60%
- Can not estimate

2.3. In which type of rooms are the school computers usually located?

<table>
<thead>
<tr>
<th>Type of Rooms</th>
<th>Number of Computers</th>
</tr>
</thead>
<tbody>
<tr>
<td>In classrooms</td>
<td>2 (59)</td>
</tr>
<tr>
<td>In special rooms for computers (e.g. laboratories)</td>
<td>6 (182)</td>
</tr>
<tr>
<td>In other instructional rooms (e.g. science and reading labs, learning centres)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>In libraries (but used by teachers and students)</td>
<td>(3)</td>
</tr>
<tr>
<td>In departmental rooms and offices (but used by teachers and students)</td>
<td>(6)</td>
</tr>
<tr>
<td>In school offices (but used by teachers and students)</td>
<td>1 (14)</td>
</tr>
<tr>
<td>NO FIXED Location (e.g. moved from room to room)</td>
<td>(3) (26)</td>
</tr>
<tr>
<td>OTHER Location (please specify)</td>
<td>1 (3)</td>
</tr>
</tbody>
</table>

- medical
- principal
- borrow from other institutions

missing: 1 mexican school
2.4 How many teachers would you estimate make some use of computers for instructional purposes?

- 10 - Less than 10%
- 2 - Between 10-30%
- 2 - Between 30-50%
- 6 - More than 50%
- 3 - (all)

2.5 How similar is the school to the "average" school in your country with respect to computer resources?

- 2 - Probably in the bottom quarter
- 4 - Probably near the average
- 16 - Probably in the top quarter
- 1 - (only school like it in country)
1.6 Give a brief description of the location and population of the school relative to "social geography" of the country:

1. **Bulgaria**
The school is located in an area where live predominately intellectuals. The living conditions are comparatively comfortable.

2. **Canada**
Students in the school came from homes whose economic structure range from upper middle class to poverty level with the school mean being just the national mean. Marigold has a heterogeneous population. Students score right about the mean on all tests, both academic and socio-economic.

3. **China**
The school is located close to downtown Beijing. Most of the pupils living near by. It is an old school with a history of 82 years. Since it is one of the best elementary schools in the city, the school is allowed to give special tests for admission. Thus, some of the pupils are not come from neighborhood. The parents of the pupils have different kinds of jobs, in average, they are of a little higher intellectual level.

4. **Costa Rica**
South Suburbs of San José, Costa Rica’s capital city.

5. **Costa Rica**
Middle class. Maybe 15% are low class. They are from a village that was born some years ago as a number of marginal huts.

6. **France P. Bernard**
The school building is relatively new (less than ten years old) located in a new urben area in the Dijon suburb which used to be agricultural land and marshes thirty years ago; in this area there are factories (mechanical engineering, building and civil work firms and stearineries), offices and workshops of the national company of electricity, a lot of schools (grammar and high schools), a teacher training school, local administrative education offices and it’s also a residential area mainly with modest old houses and new condominiums.

7. **France Chevreul**
The school "Chevreul" is a very new construction (two years old) located at 200 meters from the school "Petit Bernard". We find again the same characteristics as in the Petit Bernard’s area: factories, workshops, offices, schools and others administrative premises or the modest houses and condominiums, but there is also on the other side of this school, a residential area with middle and upper class inhabitants.
8. 1.6 Hungary
One of the characteristic working class environments of Budapest. About 70%
of fathers are industrial workers/blue-collar, mostly physical jobs. The school
is located in a modern Urvan Settlement Area "lakótelep", with multi-storey
reinforced concrete buildings, considered to be one of the lowest status housing
alternatives. 90% Of the pupils come to the school from the Settlement Area,
about 10% from more distant places. Families who were lucky enough to
move over to better housing. Most parents work in 2 or 3-shift arrangements,
night shift workers are frequent.

9. 1.6 Israel
Arad is a development town in the south. The school is located in one of the
newer areas in Arad. Relative to the country, the population is middle class
and lowered middle class and may be regarded as an average one.

10. 1.6 Japan
Tokyo - industrial area.

11. 1.6 Mexico S.P. Hernandez # 1
The community is formed by families of middle and lower class; the parents
are in the majority workmen (blue collar), small merchants, underemployed
(menial chores), and some are farmers. Most have a low academic level who
settled in former farming land in the west end of the city.

12. 1.6 Mexico Deaf School # 2
We have groups integrated in almost every points in the Mexico city.

13. 1.6 Mexico V. Hermosa # 3
Located in the Northeastern part of the capital of Mexico. Student body
represents one of the highest social and economic levels in Mexico.

14. 1.6 Mexico Collegio Madrid # 4
The students population consist in middle-class and high middle-class. They
are situated in the south of Mexico city.

15. 1.6 The Netherlands
Outskirts of a "medium sized" city; one of the "better" upper-class
neighbourhoods in the city, most parents own a house.

16. 1.6 New Zealand
Suburb on the outskirts of Dunedin which is a city of between 90-100,000
people. Middle class area. Some State housing.

17. 1.6 Portugal
It is a rather settered village with about 1000 homes located in an industrial
area (textiles). However, after the work shift in the factories most workers
have their small farm (parti-time agriculture).
18. 1.6 Romania
- district in the center of the town.
- population with a medium social level or above.
- intellectuals in high percentage.

19. 1.6 Romania
School № 56 is placed in Bucharest, the capital of the country, in a district near the center of the town. Therefore most of the pupils come from families with moderate, or above average social economic level. About 60% of the pupils' parents are graduated (professions like engineering, economists, teachers etc.) and the others are clerks and workers.

20. 1.6 Sweden
The school is in a suburb to Gothenburg on the west coast of Sweden. The area has a typical, average population of workers and office employees. Both parents work. Most students live in modern apartments of houses. The area is very representative for Sweden.

21. 1.6 U.S.A.
Close to one of the largest shopping centers in the state. A large metropolitan area in middle-class neighbourhood.

22. 1.6 U.S.S.R.
The school is located in the center of Moscow. Children are mostly from middle-class families.

23. 1.6 Zimbabwe
Upper middle-class school in capital city.
A typical elementary school is often organized around an organizational model of an intact group of students working predominately with one teacher in a self-contained classroom. Please comment if your school differs from this "typical" pattern:

1. **Canada**
Marigold is organized around the typical pattern with the exception of involvement in the challenge program in grades 4 through 7, the developmental enrichment program, and the Apple Global Network. There is also a four-year primary program option for students in grades 1 to 3 who need a slower paced program.

2. **France P. Bernard**
First, there are two consequences deriving from the fact of being an Application School: A) Teaching time is divided into two parts: 2/3 for the main teacher and 1/3 for the substitute teacher; B) Sometimes a teacher trainee plays the role of the teacher with or without supervision; secondly, there are, during the school year, some special school days organized around different non-academic topics (manual activities, etc.).

3. **France Chevreul**
There are two consequences deriving from the fact of being an Application School: 1) Teaching time is divided into two parts: 2/3 for the main teacher and 1/3 for the substitute teacher; 2) Sometimes a teacher trainee plays the role of the teacher with or without supervision.

4. **Hungary**
The same traditional pattern is used in 1st to 4th grades. In the higher 5th to 8th grades, there is a 'Cabinet' system meaning that all subjects have specially equipped rooms and pupils move around from Cabinet to Cabinet according to their daily schedule. 1st to 2nd graders are taught by one class teacher. 3rd and 4th graders have 2 special teachers usually for Environmental studies and Russian in addition to the class teacher. From 5th grade on, each school subject is usually taught by a different teacher.

5. **New Zealand**
Largely operate in a single-cell (one teacher in self-contained classroom) but there is variable space available for cross group teaching which is used for approximately 1/3 of the time. (eg of this is the doorways between 2 classrooms which may be opened to have shared teaching).

6. **Romania No 17**
1st - 4th forms: one teacher/class
5th - 8th forms: one teacher/topics

Rest of the schools answered: no difference

148
7. 1.8 Sweden
   From grade one to grade six the students usually have their own "class teacher".

8. 1.8 U.S.A.
   Mostly intact groups with some limited team teaching.

9. 1.8 U.S.S.R
   There are different teachers and different classrooms for math and language lessons. So, the subject-oriented education is practiced from the early grades.
1.9 How would you characterize the educational background of parents of students in the school, on average, compared to other schools in your country?

1.9 **Costa Rica #2**  
Many children's parents are professional people, such as lawyers, teachers, nurses, etc. Many of the students have the opportunity of reading and living in a rich environment. However, even if this happens for a high percentage (approximately 60%), there are children from a low and a very low cultural level.

2. 1.9 **France Petit Bernard**  
The following table gives the breakdown of families occupational status for the Petit Bernard's school and the whole country*:

<table>
<thead>
<tr>
<th>Socio-economics definition</th>
<th>France</th>
<th>Petit Bernard</th>
</tr>
</thead>
<tbody>
<tr>
<td>- work inquirers</td>
<td>9,6</td>
<td>2,79</td>
</tr>
<tr>
<td>- job-less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- workers</td>
<td>25,66</td>
<td>31,28</td>
</tr>
<tr>
<td>- employees</td>
<td>24,66</td>
<td>23,46</td>
</tr>
<tr>
<td>- intermediate occupations</td>
<td>18,35</td>
<td>19,55</td>
</tr>
<tr>
<td>- managers and upper</td>
<td>9,6</td>
<td>15,64</td>
</tr>
<tr>
<td>intellectual occupations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- artisans and traders</td>
<td>7,3</td>
<td>6,7</td>
</tr>
<tr>
<td>- farmers</td>
<td>5,5</td>
<td>0,5</td>
</tr>
</tbody>
</table>


Madame Valnet, the school director as also indicated that more than a quarter of the pupils parents have been divorced which has some implications on school management.
3. 1.9 France Chevreul

The following table gives the breakdown of families occupational status for the Chevreul's school and the whole country:

<table>
<thead>
<tr>
<th>Socio-economics definition</th>
<th>France</th>
<th>Petit Bernard</th>
</tr>
</thead>
<tbody>
<tr>
<td>- work inquirers</td>
<td>9,6</td>
<td>2,35</td>
</tr>
<tr>
<td>- job-less</td>
<td>25,66</td>
<td>14,7</td>
</tr>
<tr>
<td>- workers</td>
<td>24,66</td>
<td>28,82</td>
</tr>
<tr>
<td>- employees</td>
<td>18,35</td>
<td>31,17</td>
</tr>
<tr>
<td>- intermediate occupations</td>
<td>9,6</td>
<td>12,35</td>
</tr>
<tr>
<td>- managers and upper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>intellectuel occupations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- artisants and traders</td>
<td>7,3</td>
<td>10,58</td>
</tr>
<tr>
<td>- farmers</td>
<td>5,5</td>
<td>0</td>
</tr>
</tbody>
</table>


4. 1.9 Hungary

In the absence of detailed information on nationwide distributions this might be an overstatement. The proportion of parents not having completed 8-year elementary school is probably under 1%. But only an approximate 20% of fathers and mothers completed secondary school, and relative to the whole parent population, less than 20% have any post secondary degree/university or, more frequently, tertiary college certificate.

5. 1.9 Mexican School for the hearing impaired

Most of the parents have not educational background. Either they comment they are studying with their sons because we demand their participation in classes with their presence being auxiliars of teachers.
1.10 What is your sense of the experience of the school within approximately the last three years with respect to each of the following sorts of instructional change?

1. **Canada**
   Mandated changes have been curriculum-based and include such things as the new provincial math program and implementation programs outlined by the year 2000 document. Locally generated changes consist of integrating technology into the whole school program, the Learning Guild, and the developmental enrichment program.

2. **China**
   The name of the school is Second Experimental Elementary School, the teachers are of a higher level. They are good in instructional experiments. It has a very good tradition in teaching and moral education.

3. **Costa Rica #1**
   The school is a public school that follows the instructions of the ministry of education. Nevertheless, the principal has a relative freedom to make decisions on different situations.

4. **Costa Rica #2**
   Even if the school follows the Ministry of Education's policies, they have relative freedom. For example, there is one teacher that has a different method for teaching and she uses group work. The principal has observed her classes and gave her the authorization to continue. But in general, the principal tries to follow the national guidelines from the Ministry of Public Education; she is strict in the execution of teachers' meetings.

5. **Hungary**
   Although there exists a document called "Three year Plan" (for 1988-1991) this is now entirely a local production of the school. Central directives influence school life much less since the 1985 Act of Education than before. Teachers can realize their own initiatives and they can frequently adapt methods and procedures to the individual child. There are, however, important constraints, no longer directly conditional on the behaviour of the central policy makers: the extreme scarcity in floorspace, apparatuses and other resources as compared to a great number of children. The school leaders feel those constraints brutally narrow their "room" for any larger-scale local change.

6. **Mexico**
   In this school we have generated methodological instruments to make it easier to control the planning, development and evaluation in each of these instances the use of the computer as an auxiliary for teaching.
7. 1.10 Mexico
Collegio Madrid #4
Areas to change in the last 3 years: social science, nature science, mathematics, english, reading workshop, teachers training.

8. 1.10 Portugal
- the school collaborates with the local authority in the making of the village?
- the school is involved in a project about water pollution
- there are parent meetings
- they run the canteen with no government help, although it's a state school
- the teacher we are dealing with has bought with her own money part of the furniture of the classroom. Can you imagine!!!!

9. 1.10 Sweden
Most teachers are young. The school has a number of other educational projects, for example: education for handicapped students, use of video, "the school of the future project".

10. 1.10 U.S.A.
Significant changes in reorganisation of traditional school into a magnet school.
2.2.3. An International Study of the Impact of Information Technology in Education on Children’s Cognitive Development: An Analysis of Form B

Sv. Stoyanov, Bulgaria

Subject of the analysis. Form "B" is a standard questionnaire, referred to as "School". The subject of this analysis was 19 sets of these materials, submitted/presented by 13 countries, participating in the first stage of ITEC. France, Costa Rica and Romania are represented by two schools, and Mexico with four schools. The information sent additionally by Dr. Collis was used for the school in the USA, as Form B had not arrived at the time of this analysis. Also, at the time of this analysis, there were no materials for Japan, The Netherlands and Zimbabwe (although such materials arrived subsequently). The analyzed materials were sent within the period February-May 1990.

Conceptional model. Some popular ideas of Vigotsky underlined in his cultural and historical theory of the psychical development are the main theoretical preconditions of the study. The main point of this theory can be expressed in general by the statement that "each high psychic function appears twice in the growth of the child: first as joint, social activity, i.e. as interpsychical function and secondly as individual activity, an inner way of thinking, i.e. as intrapsychical function" (Vigotsky, 1983). This formulation of Vigotsky is very close to the proposition of Piaget about interiorization. Piaget states that: "the appearance of the system of intellectual operations is a result of the "cooperation" transferred as inner plan and originating in the conditions of the social life" (Piaget, 1947).

The study itself is multifactor, with several independent variables and dependent variables. The internal and external validity of the study are backed up by the way of its planning. The conception of the study gives an opportunity to control the systematic mixing of the variables. The theme of the project ("An international study of the impact of information technology in education children’s cognitive development") shows that the ITEC problem concerns the influence of the social environment on the children's cognitive development. The main problem of the first stage of the study (project) can be formulated as follows "Comparative influence of the social environment on the children’s cognitive development". The social environment is represented by a sum of factors. For each country the system of factors is formed in different structure gestalts (Wertheimer, 1945). With regard to the main problems, this can be reformulated as "Cross-cultural effects resulting from the influence of the new information technologies on the higher cognitive functions". Any factor included in the scheme can independently influence the dependent variables, but more important is the influence caused by the interaction of the independent variables. It can be equal to zero, passing, and crossing (Gottsdanker, 1982).

Levels of the analysis

Level I

According to the requirements of the analysis of the study's first stage this level represents a simple description of the answers given by all countries to each question.

Level II

The second level's aim is to determine the place of each variable of the "Schools" questionnaire in the general theoretical scheme. Each country is marked by a specific structure of the variables, which are mainly distributed in the block "Background" and in the block "Characteristics of the computer application".

The questionnaire scheme of form "B" is shown in the second level. It includes two main variables, which are made operational in the following manner:

1. General description of the school:
   - number of teachers and the students;
   - type of the school - public, private, common, special;
   - with evening-classes, regular classes;
   - organization of the school - age of starting and finishing the school, centralized or self-governing organization, formal organization model of the teachers interaction with the students, experience obtained from participation in experimental studies;
   - demographic characteristics of the school - nationality of birth, place of residence of the students, educational qualification of the parents.
2. General description of the school's experience in the use of computers:
- percentage of students and teachers with personal computers at home;
- number and localization of the computers;
- percentage of the teachers, using computers in the educational process;
- computer availability.

Level III

The third level is formed by polar variables of the questionnaire, made operative with two opposite categories: small/large school, public/private school, common/special school, centralized/self-governing organization, regular/evening classes, typical/not typical model of formal interaction teacher-students, experience/lack of experience obtained from participation in experimental studies, use/no use of computers in the educational process, one and the same/different nationality, high/low educational qualification of the parents, many/few students with computers at home, large/small number of computers at school, varied distribution/localization in one place of the computers at school.

This analysis gives an opportunity to make a more precise distribution of the variables of the "School" questionnaire in the general scheme. For example the following is included in the main variable of the scheme "Background": large/small school, centralized/self-governing, regular/evening classes, one and the same/different nationality, high/low educational qualification of the parents. The variable "Computer characteristics" includes: many/few students with personal computers, many/few teachers with personal computers, large/small number of computers available at school, varied distribution/localized in one place at school, many/few teachers use computers in the process of education.

The adapted method proves that part of the information is valuable not only for the variables "Background" and "Computer characteristics" but also for the "Social interaction" variable: typical/not typical formal organization of the teacher-students interaction, common-special school, participation/no participation of the school in experimental studies.

The variables of Form "B" set up a specific combination for each country. They are formed as a structure in the general scheme, and not as separate elements. For example a large, centralized, special school, with not typical organization model of teacher-students interaction, with large number of computers, allocated in different places, mass use of computers in the process of education, etc.

Some specifications have to be made with the aim of presenting more precise information.

1. Nothing specific can be said about the educational qualifications of the parents and the equipment of the school with computers, as the comparison basis, the norm, is not uniform for all countries. For example the educational qualifications of the parents in Hungary and Sweden is determined as average. But in Hungary only 30% have finished 12 years study, and in Sweden the average educational level means 12 years general education and additional vocational training.

2. The number of the computers in the school is not important. The importance is if they are used in the process of education, i.e. to what extent they are efficient. The same refers to the variable "Percentage of teachers with personal computers". The interest of the teachers, their specific competence, can be of significance only if they are somehow included in the process of education.

3. The different materials include different interpretations of the variable "Centralization-self-governing". The self-governing referred to in the questionnaire for Bulgaria is determined only with regard to the budget provisions and financing. The self-governing of the two schools in Costa Rica is defined with an answer to questions 1.10.2 ("Local changes in education") and refers to free choice of the method (group activity and advance of the educational programmes). The self-governing included in the questionnaire for Hungary is interpreted as a possibility for the schools to construct their own educational plans and programmes and the teachers to realize their own ideas related to the methods and forms of teaching.

4. In some of the participating countries the computer is an element of the cultural sphere and the educational sphere as well. In other countries the computer is either an element of the cultural sphere or the educational sphere. And in third countries the computer is neither an element of the cultural sphere, nor of the educational sphere. The basis of this conclusion is the relation between the following variables: "Number of the students with personal computers" and "Application of computers at school". In this way three groups of countries are formed:

Group I - Canada, Israel, Sweden, France, Mexico ("Colegio Madrid", "Colegio Vista Hermosa"). In the schools from the above countries, computers find wide application and most of the students have personal computers.
Group II - Hungary, Bulgaria, Mexico ("Simitrio Ramirez Hernandez"), Costa Rica, China. For example in Hungary most of the students (30-60%) have personal computers, but the percentage of teachers using computers in the educational process is small, though some classes are working in accordance with the LOGO experimental programs. Not a single student of the "Simitrio Ramirez Hernandez" school (Mexico) has a personal computer, but more than 50% of the teachers use computers as training aids. In Bulgaria the percentage of students having personal computers is small and their application in the educational process is also small. But the school, in general, is working in accordance with experimental training plans and programs - LOGO. The two schools in Costa Rica and the school in China are included in a national program for education computerization.

Group III - Portugal, Romania, USSR.

Data processing is one of the many subjects (notwithstanding if they are selectable or obligatory) in the presented schools of the above countries, and computers are either not used or find small application as training aids.

5. The variable: "Computers used in education" has the following two meanings:
   a. Computers as subject of study, i.e. treating the problems of data processing as subject of education. From this point of view the program language can be Basic, Logo or some other. The questionnaire contains data about all countries.
   b. Computers as training aids, i.e. the place and the functions of the computers in the teaching strategies. Computers can be used as part of different dialogue training computer programs, as data-base, text editor, programs for statistical processing, educational games, etc. Also it has to be known that the different ways of using the computer as training aid correlate with the forms and methods of organization typical of the different countries - the classic educational system and its modern modifications, method of the projects in its classical form and the modern versions, etc.

6. Two groups of countries can be formed with regard to the variable "Experience obtained from participation in experiments - lack of experience obtained from participation in experiments":
   The first group includes the countries with schools, which have large experience obtained from participation in experiments - Canada, Sweden, France, New Zealand, Mexico, China, USSR, Bulgaria.
   The second group consists of schools, which have not participated (or have very small experience) in experiments - Portugal, Romania, Costa Rica, Hungary.

7. The characteristic feature of the special school is the permanent specific organization of teaching, which leads to the use of special forms and methods of education. Four schools are marked as special in the documentation - Canada, USA, Russia, Mexico (Escuela 17). The Mexican school is for deaf children and it is excluded from the analysis intentionally, because it is not possible to make a correct comparison.

   The technological school in Canada in an Apple Centre and its typical feature is the specific organization predetermined not only by the use of computers in education, but also by some general characteristics as for example the individual training of the students.

   The school in Moscow is specialized in the development of the original thinking of the students. The method of shaping at group settlement of problems is used. The school from the USA is determined as a "magnet". It works according to special educational program called "Computers and Communication". The sponsor of this school is IBM.

   The Bulgarian school can be included in the category of the special schools, notwithstanding the fact that in the documents it is not determined as special school. The school is working to a curriculum, syllabus and textbooks different from these used in the common Bulgarian schools. The integral method is leading in the presentation and composition of the subjects of study. Non-traditional methods of education are used. Data-processing is a special subject.

8. The typical model of formal relations between a teacher and the students is presented when a teacher is teaching the students of one class in a classroom for each subject or study. Any departure of this model is determined as not typical formal relation between a teacher and the students. In the USSR, there is one teacher in mathematics, another in the humanitarian subjects, and the third in arts. In Hungary the teaching in the 1-2nd classes is organized in the typical system, in the 3-4th classes there are two teachers, and starting from the 5th class to the 8th class there is a teacher in each subject. In Canada there are two "assistant" teachers in the classroom. In
Costa Rica two teachers are involved in the educational process when the training is carried out in a computer room - the titular teacher of the class and a computer specialist. “Double classrooms” are used in the New Zealand school.

Other comments on Form B. The non-formal, rich-in-content organization of the educational process is also of great importance. An account should be rendered in this sense to the influence of such variables as the typical doctrine of education of a country, the leading educational values, the typical styles of teaching and study, etc.

The classification of the countries in groups on the basis of the different variables gives us the opportunity to have a better view on the possibility of the appearance of some effects, which may influence the trustworthiness of the information. Such effects include:

1. The effect of novelty. In some countries the students have a small experience in the work with computers. The computer is an artefact for them.
2. The effect of transference (system). The special organization (formal or rich in content) in some schools can influence in some way the methods of using the computers in education.
3. The effect of getting accustomed. Some schools have large experience in the participation of experiments, which may lead to "getting accustomed to experiments".
4. Effect of representativeness. This effect is related to our right to refer the results from the respective school to the entire population of the country for the certain age. The schools from Canada, Russia, USA, Bulgaria have some kind of special organization. The two private schools from Mexico are elite. The school from China is experimental. The schools from New Zealand, Israel, Sweden and the public school from Mexico have wide experience in experiments. The two French schools are basic for the Dijon administrative region.
5. Effect of hidden influence. There is a possibility for the existence of variables, which are not typical or operational, but they can exercise a hidden influence on the final results. The rich-in-contents educational organization, mentioned above, is such a variable.

References

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4. Wertheimer, M. Productive thinking. N.Y., 1945
2.2.4. Narrative descriptions of four of the schools

In addition to the information on Forms A and B, a number of the researchers gave us more detailed information, sometimes in case study form, about their schools. Following are a sample of these sorts of reports, in the form of two descriptions from Costa Rica, one from the United States, and one from Sweden.

The Jorge Debravo School, Costa Rica

This school could be considered as an average Costa Rican public school. It is run by the Ministry of Public Education, which defines the education policies it implements. The school is located on the south-west part of San José, the capital city of Costa Rica. This region is undergoing intense growth due to the housing projects the Government has established in the area in the last twelve years. The community where the school is located could be characterised as "low medium class". The school has approximately 1200 students and 34 teachers. The building has 20 classrooms, a library, a computing laboratory and the principal's offices. The drop out rate in this school is rather low, which seems to indicate that both parents and children are happy with the school's overall situation and functioning.

The School Computers in Education Program

The computer laboratory that exists in the school is part of a National Program of Educational Computing that has been taking place since 1988, with the creation of the Omar Dengo Foundation and its support to the Ministry of Education. The school was chosen by both institutions to be part of the Program because of its student population (number of students), location (marginal-urban) and the interest of the community to provide the classroom, the air conditioning, the electrical wiring and the caretaker. The Jorge Debravo school was chosen by the Foundation for the ITEC Project because of its disposition to innovate and cooperate and also, because it is considered an average school within the program.

Parents have been involved in the set up of the computer lab and many of them collaborate in its maintenance. Teachers and parents seem to be satisfied with the computer lab activities.

Description of the computer lab

As in the case of all the 130 computer labs located in different areas of the country by the Omar Dengo Foundation's Program, the lab has nineteen IBM computers PS/2/25, a PS/2/50 as host server and a printer. The computers function individually and in a local network.

The Program uses Logo, which was chosen for the national program on account of its potential to develop critical thinking, problem solving and creativity. Teachers are provided with training and permanent support by the Omar Dengo Foundation. In most school situations, the Principal also gets training and administrative support to run the lab.

Teachers selected to participate in the program work part of the day as homeroom teachers in charge of a grade, and work over time as lab attendants. These teachers are trained in Logo through successive Logo courses (in modules). When the children attend the computer lab twice a week for 40 minutes, their homeroom teacher is with them along with the lab attendant. In case of the Jorge Debravo School, there are three teachers who work as lab attendants and who have been trained and get periodical support from national tutors of the program. One of these lab attendants - Mayela Herrera - is the teacher participating in ITEC. She is a fourth grade teacher.

In this school religion is taught as other subjects because the catholic religion is, by law, the official one. Nevertheless, some parents of many religious groups that have appeared, limit their children in some aspects. People are satisfied with the school. This can be seen in the low scholar desertion rate and in the parental willingness to collaborate.

School history

The conditions in which the school begun are interesting: they did not have a building, so they used the empty warehouses where the government used to store the building materials. Since the school was not built along with the housing project, the warehouses were burnt in order to force the Government to give them proper accommodations for the classrooms and school. The Ministry of Education finally built the school that had been requested. At present, that building houses a day and a night elementary school. The evening program involves adults, while the day program deals with small children.
It is interesting to describe some of the social changes taking place in this community at present. Even though the Catholic religion is the national religion, culturally and legally, many new religious groups and sects have been coming into the community. The input of these groups is influencing the way children think and behave. There seems to be a tension between parents and children. The parents recently converted to these sects and religious groups tend to want the children to refrain from participating in certain activities: school assemblies and Catholic religion classes.

The Panama School, Costa Rica

The Panama School is a Costa Rican public school. Because of its age (100 years) and the quality of its teachers it is considered as higher than the average Costa Rican public schools. As all public schools, it is run by the Ministry of Public Education, which defines the educational policies it implements. The school is located on the south-east part of San José, the capital city of Costa Rica. This region could be characterised as middle class. The parents of the children are professionals: teachers, lawyers, nurses, etc. Even though the social class is higher, few students and teachers have a computer at home: 2 teachers and 30 students. The school has approximately 1400 students, 43 teachers and 39 grades (from kindergarten to sixth grade).

Two or three years ago, some suburbs near the school were born as poor huts. Because of this, the population of the school has changed somehow and maybe 15% of the children belong to low and very low classes. The children’s parents seem to be very co-operative. They attend the parental meetings in great numbers and give money for the School’s projects. Children co-operate sometimes; for example, the parents built a park and the children give 1 colon (national coin, approximately 1 cent of one US$) per week for its maintenance.

The School’s Computers in Education Program

The Panama School, as the Jorge Debravo School, is part of the National Program of Instructional Computing. This program has been taking place since 1988, with the creation of the Omar Dengo Foundation and its support of the Ministry of Education.

The school was chosen by both institutions because of its student population, location (marginal-urban) and the interest of the community to provide the classroom, the air conditioning, the electrical wiring and the caretaker.

The parents seem very interested in the Program, that is why some of them have their children in the Panama School even though this school does not geographically correspond with the school where they should go. The Panama School was chosen by the Foundation for the ITEC project since it has different conditions from the Jorge Debravo School. The social and economical level is higher and the school is older (the Jorge Debravo is 12 years old and the Panama school is 100 years old).

The principal has observed the process. She still considers that the relationship between teacher and student is the basis for learning. She thinks that many of the homeroom teachers of the school are not motivated with the computing program and that could affect the children. She thinks the lab attendants should do special work with the homeroom teachers, since their feelings are an important factor in the learning process of the child. This work should also include the exploration of the homeroom teacher’s expectations, because sometimes they are excessive. She says the effects of computing have been remarkable in some cases (especially with one special education girl). That is the way to get the homeroom teachers to start to cooperate with the lab attendant.

Description of the computer lab

As in the case of all the 130 computer labs located in different areas of the country by the Omar Dengo Foundation’s Program, the lab has nineteen IBM computers PS/2/25, a PS/2/50 as host server and a printer. The computers function individually and in a local network.

The Program uses Logo, which was chosen for the national program on account of its potential to develop critical thinking, problem solving and creativity. Teachers are provided with training and permanent support by the Omar Dengo Foundation. In most school situations, the Principal also gets training and administrative support to run the lab. In this case, the Principal has not been trained yet.

Teachers selected to participate in the program, work part of the day as homeroom teachers in charge of a grade, and work overtime as lab attendants. These teachers are trained in Logo through successive Logo courses (in modules). When the children attend the computer lab twice a week for 40 minutes, their homeroom teacher is with them along with the lab attendent. In case of the Panama School, we will work with the homeroom teacher, since we want to have different conditions. The teacher - Victoria Vargas - does not have any experience with computers.
The Zuni Elementary Magnet School, U.S.A.

What is it?
The Zuni Elementary Magnet School is one of three magnet schools at the elementary level, offered by APS. Zuni welcomes families from the entire Albuquerque Public Schools District in addition to those residing in the Zuni attendance area. Zuni offers a quality basic education program, with emphasis on "Computers and Communications".

Basic Skills
The instructional program at Zuni is designed to provide children with the essential skills necessary for their future success. The staff works closely with parents to ensure that each student strives to reach his or her highest potential while at Zuni.

Computers
Zuni Elementary Magnet School is committed to providing students with an education that will benefit them in the 21st Century. Computers are a very essential part of that education. The very comprehensive computer program at Zuni Elementary Magnet School is designed to encourage the development of critical thinking skills, as well as confidence in the use of the computer as a tool. There is a computer in each classroom in addition to a networked computer lab used by all classes, from kindergarten through fifth.

Communications
At Zuni, communication skills are considered a vital part of our curriculum. This school-wide program provides children with opportunities to gain skills in listening, writing, speaking, creative dramatics and other areas of communication. The publication and display of children's work in particularly encouraged.

Before and After School Program
Camp-fire Program, before and after school care, is available in the Zuni cafeteria. The program is available only on weekdays and starts in the mornings from 7.00 - 9.00 am, and continues in the afternoon from 3.30 - 6.00 p.m. On Wednesdays, the afternoon program is from 1.30 - 6.00 p.m.

The Rannenbergens Centrumska, Sweden

The computer as a pedagogical tool at Rannenbergens Centrumskola
A full scale project with the computer as an integrated, pedagogical tool in the junior and intermediate stages of the compulsory school. The project is part of a three-year trial period initiated by a report from the Ministry of Education to the Government to use the computer as a tool in the everyday work of an ordinary school.

Background
In Sweden the use of computers has until recently been restricted to the secondary and upper secondary school level and mainly to the following educational fields.

Computer literacy. At secondary school students are entitled to a course in computer literacy integrated with other subjects and aimed at giving a general competence and illustrating the impact on society and on human beings of a computerized society.

Vocational training. In upper secondary school there are many different educational programs aiming at future professions or further studies at the university level. Their purpose is to reflect the use of computers in different occupations and to confer up-to-date skills through the use of modern technique.

Computer science to train future computer experts. Instruction is provided in upper secondary schools.

The use of computers as a purely pedagogical tool to enhance the quality of education and to augment the potenitalities of teaching is not yet officially approved of in Sweden. The Ministry of Education therefore defined a strategy and the Government approved of a three year trial period to test the computer as a pedagogical tool in the every day work of an ordinary school and to broaden the use of computers to all stages of our compulsory school system and especially to the lower age groups.
The project

This particular project is one of the few full-scale ones in junior and intermediate stages of the compulsory school in Sweden. It is sponsored and supported by The Local Education Authorities in Gothenburg, The Swedish Board of Education, The Ministry of Education, The Teacher's Training Institute within the University of Gothenburg and IBM. The project started in August 1989 and will run for three years. Up to now we have completed the planning of the project, the budgeting, the activity analysis, the choice of hardware and software, the in-service training and an evaluation of the teachers attitudes towards the computer as a pedagogical tool.

The school chosen (Rannenbergens Centrumskola in Gothenburg) is a typical, comprehensive elementary school with students from the age of seven to the age of thirteen.

Study objectives

Turning information technology into a tool for teachers and students with a view to streamlining and at the same time improving the quality of school instruction is the most important task in the project. Research will be done in the problems of pedagogics and methods in this field. We will investigate if the computer has a role to play as an educational aid in the school of the future and explicitly for the students and teachers at the elementary school level.

A guiding principle in the project is that the computer should only be used as a teaching aid when it is expected to expand the scope of teaching or to improve its quality.

The overlapping aim of the project is to integrate the computer as a pedagogical tool and to study its consequences on the organization of the school, the teacher's and the student's role, the effect on the contents in the present curriculum and the attitude to and definition of what kind of knowledge we are going to offer our student. Its starting-point is the regular activities in an ordinary elementary school. It should activate the ordinary teacher, not only the computer enthusiasts. The teachers, the students and the local school administration will take a decisive part in the formulation of the activities in the project. The new infrastructure demanded by the new technology may also prove to be valuable hidden pedagogical resource.

Some of the main study objectives are:
- to implement the computer as a pedagogical tool in the elementary school;
- to identify parts of the curriculum where the technology can substantially improve education;
- to investigate the demands on computers and computer environment for computer-assisted teaching;
- to let the teachers in the project school use the computer as a personal, administrative tool. A resource computer containing all software is therefore placed in the staff room;
- to use and evaluate different kinds of software for computer-assisted teaching;
- to produce and evaluate teaching aids in the form of user-friendly manuals, teacher's guides, student's guides, textbooks and exercise material;
- to test and evaluate different models for in-service training of the teachers;
- to find, test and evaluate a suitable organization, infrastructure, pedagogy and methodology for computer-assisted teaching in this age group;
- in collaboration with private publishers translate and adapt appropriate educational software from abroad to the Swedish elementary school and develop our own software;
- especially take into consideration and study the needs for handicapped students.

The present situation

As I mentioned earlier we have so far defined the guiding principles, financed the project, built the organization for the project, given the teachers an introductory training and installed hardware and software. One teacher has been trained to become the computer coordinator.

A number of project-groups have been formed in different subject-areas. The teachers involved has been specially trained in how to use the computer as an educational tool with due respect to the expected new demands on pedagogy and methodology. Each project group has analyzed the present curriculum and chosen essential and important parts of it, considered suitable for computer assisted teaching.
During the project all parties involved will continuously evaluate the effects of the computer as a pedagogical tool according to the given study objectives.

Effort is made to continuously inform interested parties in the community and the Swedish school system about the findings and results. It will give the authorities a basis for a decision whether to introduce computers in this new educational field or not and to support, and if the outcome is positive, subsidize the acquisition of computers, software, in-service training, further research and the building of a new infrastructure within the schools in Sweden.

**The effects**

The attitude towards the new technology has been analyzed in an evaluation of a number of interviews with the teachers, performed during the planning phase. The in-service training of the teachers according to a realistic and activity-oriented three days course has been very positive. Most of them regularly use the computer as a personal, administrative tool. The resource computer in the staff room to a great extent contributes to this. It is also encouraging to notice that the teachers also to a great extent use the open-ended, integrated software packages for purely educational purposes to help students collect, analyze and present data.

A first informal evaluation of the students' attitudes shows that they very easily learn to master and use the new technology. Practically everyone is using the computer lab and the open-ended software package Wisepak, Storyboard Plus and a number of lessonware, relatively short application programs that complements or occasionally replaces a school lesson. The computer lab is a busy, open resource in the middle of the school.

Some of the present activities are the computer in the writing process, keyboard training, the use of databases in geography, telecommunication, desktop publishing, the building of a database for the school library and the computer as a creative tool in music and art.

The project has already initiated an active, pedagogical debate and discussion among the teachers and the administration. That will probably generate many new, interesting aspects around the computer as a pedagogical tool, increase the commitment in questions concerning education, pedagogy and methodology and give students and teachers a new and more appropriate knowledge in their subjects and a useful computer competence for their future studies.
2.3. THE PRINCIPALS IN ITEC PHASE 1 SCHOOLS

The school leader is a central figure in the impact of what happens with computers in the school. In order to get better insight into the roles and opinions of the school principals and how these might have influenced the occurrence of exemplary computer use in the school with young children, each ITEC researcher conducted a structured interview with the principal in his or her ITEC-participating school. The results of these interviews were summarized using Form C. In the following sections (2.3.1 and 2.3.2) two sets of researchers present their analyses of the many pages of interview notes assembled by the researchers and summarized on the Form C sheets.

2.3.1. Summary of Principal's Response: A Perspective from Costa Rica

C. Fonseca and R. Murillo, Costa Rica

Introduction

I. Methodology of analysis

Considering that the sample was very small (24 schools from 17 countries), a qualitative analysis was conducted. An itemized list of responses was prepared. The number of principals referring to that item was accounted for and indicated in the discussion of the answers. The definition of the items included under each answer was done by reading and categorising them. Other comments that could be of interest were taken into consideration, even if they were not very clearly related to the question.

It may be noted that the addition of the responses is not equal to the number of schools in the sample. Each school provided a different number of responses and referred to different aspects within each answer. For this reason, the numbers indicated in brackets in the following analysis correspond to the number of schools that provided each specific reference.

II. The results

This is a synthesis of the qualitative and quantitative analysis of the responses to the five questions in Form C. The detail is in the appendix at the end of Section 2.3.1.

Question 1: Importance of the presence of computers within the school's activity

Principals tend to view the presence of computers in a positive way. They refer to positive effects on children's learning (12). Some of the effects mentioned are cognitive, for example: development of intelligence, generation of critical attitudes, formulation of ideas through word processing, development of research skills. The remedial value of the use of computers is also mentioned.

There are also positive effects produced within an affect context. Some of these are: establishment of new interpersonal relationships and group interaction, development of self-discipline, acceptance of criticism, and pride among students and parents. According to the principals, students tend to express their opinions more. Interestingly, a principal considers that computers generate cohesion among teachers.

Some of the answers revolve around what could be called a modernisation process within the educational scenario (5). Some of the traits of this modernisation are: the definition of the computer as the new tool for the next two decades; the opportunity students have to deal with the technological innovation, which is something they desire; exposure to computers provides new opportunities for children, especially black children. Other aspects cited are the efficiency brought about by the use of computers and the development of job-related skills.

Principals evaluate the computer as a good teacher aid. One even mentions its use in order to run learner profiles and even envisions having one station per classroom. Another believes computers help in the generation of a more professional administration.
A Cross-Cultural Analysis of the Settings in ITEC Phase 1 Computer-Use Environments

Question 2: Principals concerns with reference to hardware and software, people related issues and school organisation

a) Software and Hardware issues

Software Issues

The most cited response with reference to software issues is undoubtedly the concern for lack of appropriate software (9). Apparently, principals do not seem to be satisfied with the software used in their schools.

Among the reasons indicated to explain that dissatisfaction are: lack of software sequence, concerns for the quality of it, concerns for its friendliness, and for the lack of software for special populations ("lack of software for deaf children"). Still, principals do not point out the specific reasons why they consider the software is "not good". The quality of software issue is not clearly defined. Principals do not mention or describe the cognitive or pedagogical aspects they believe software should or should not have.

Hardware and Financial Issues

Two principals are concerned about technical problems in the handling of hardware, basically due to the novelty of the equipment and probably to the lack of adequate training and experience. The cost and availability of software and hardware seems to be another concern (5). Also related is the problem that the computers rapidly become obsolete (1), especially in terms of hardware speed, power, transmission and compatibility to other systems (1).

Two principals indicate that they cannot refer to issues concerned with hardware and software problems, probably due to the fact that highly centralised national projects provide them with ready-made solutions and that they do not have to participate in the selection and decision-making process about these components.

Pedagogical Issues

Only two principals show concerns for pedagogical aspects. One of them expresses interest in the encouragement of math-oriented students towards the production of software (1). Mentioned, but not sufficiently clear, is the concern about "ownership of knowledge" when one principal discusses issues relative to software.

b) People Related Issues Associated with Computer Use

Some principals complain about the teachers' negative attitudes towards computers (6). As one principle puts it, teachers have "a paranoid fear of computers". This fear has frequently been reported in the literature. Principals tend to explain this in terms of reluctance to change. As one principle refers, "even if they know the importance" of computers, they "lack enthusiasm". One principal points out that "teachers do not like computers because they think they do not have many resources to work with" which they consider essential and the investments made in purchase of computers is often so high that it detracts from funds allocated to other elements they consider more important. Here there seems to be a concern for cost-effectiveness.

Principals stress the role of the administration in "motivating and orientating teachers". Another central concern of principals (5) is relative to training and teacher involvement. It is evident that principals give great importance to the teacher's role in the functioning of computers in education programs. Interestingly, one principal reported that "the relationship between the teacher and the student is still the most important factor". Furthermore, one stresses the need to "adapt software to students, not students to software".

Evidently these are issues that should be taken into consideration in the development of teacher-training programs, since, as one principal says "we do not want programmers teaching computing, but teachers using computers". It is possible that the alluded teachers' "paranoid fear" might be explained through the general responsibility held against them with relation to the crisis in education.

It is worth mentioning that some principals (3) report that parents, students and communities in general are very interested in computers. They "work together to get help". With reference to the students, principals believe students "should have a general understanding of computers" because "tomorrow's man has to know to use the computers" (2). They believe that "computers are here to stay" and that they will be a part of everyday's life.

One principal worries about the "isolation of children". This statement seems to coincide with a common myth about the use of computers by children. The reasons behind this common fear should be further investigated. By contrast, another says "dialogue has been stimulated".

c) Impact of computers on school organisation

It is worth mentioning that all the responses under this question refer basically to administrative elements. Almost no reference is made to pedagogical aspects such as new contents being taught, new methodologies. Two principals talk about new meetings with teachers and lab attendants; these meeting probably include some pedagogical discussions, but principals do not stress that element, even though one
mentions computer integration to the curriculum. Methodologically, the traditional approach in which the teacher is in front of the class is still mentioned. The same principal is concerned about lack of effective integration of computers.

The impact reported is on school administration (7). Some of the aspects mentioned are: automation of administrative areas, management control, including keeping "record of the achievements of the students, making exams and getting grades".

Impact on scheduling is another concern (5). One principal worries about the "reduction of teaching time", by which he probably means teaching time devoted to regular subject matters. Principals express that computer lessons do not change school organisation. Five principals indicate that most computer activities are held after class.

Interestingly, one principal analyses the present traditional use of computer within the school and proposes a new implementation model and new focus for the introduction of computers in schools. The development of "learning guides in a learning centre, working in small multi-age groups using technology" is proposed to substitute the "teacher in front of a classroom" pattern. Reference to students' interaction with skilled mentors through telecommunications is mentioned, and emphasis is placed on competence and productivity.

Question 3: Students that benefit the most from the use of computers

More than half of the principals (14) believe all students of all ages benefit from the use of computers. Nevertheless, there is reference made to the relationship between the age of the student and the computer activities selected. One indicates that the benefits depend on "pedagogical practice".

Still, there are many different ages referred to as ideal for children's work with computers. One principal believes benefits can be derived from working with children "as early as four". However, one principal states that he does not suggest working with kindergarten children. Another one considers that benefits are attained with students of "all ages from 8". Five principals believe children in the higher levels (ages 10,11,12) benefit most. Interestingly, emphasis is placed on the benefit "for girls" by one principal and for "black girls" by another one.

Another important group of principals (5) considers that the greatest benefits are derived from good students and good achievers (5), especially those who are "good in math and physics" and "children who feel they can do things". By contrast, two principals favour work with "low achievers" and "children that lack discipline". Reference is made to the fact that some children benefit from computers and not from other more traditional methods.

Question 4: Typical student-teacher interaction

Most principals believe student-teacher interaction is good (13). The responses, however, are not specific enough; some positive but somewhat vague statements are made. Among these are: "good", "trustful and tolerant", "open and democratic", "great, students look [at] their teachers as their love and guide", "human companion", "positive and friendly".

There is no clear agreement with respect to the characteristics of students-teacher interaction. Six principals indicate that "the student is the central figure", that there is "fellowship and support", that there is "no big distance between teachers and students", and that "there is friendly communication". They affirm that "teachers are advisers" and that there is a shift from "question-answer interaction" to "mutual discussion".

By contrast, five other principals point out to a more traditional type of interaction. They refer to the "chalk and talk in traditional pedagogical approaches" where the teacher talks and the students listen.

Question 5: Student-Student interaction

Principals consider student-student interaction basically good. Within classes, in a curricular activity framework, principals report little interaction. In these situations interaction is suppressed and often considered not productive. Within class, student-student interaction is mostly referred to sports, projects, art and music and creative activities. Some typical school student-student interaction is exchanging notes and helping each other.

Within other contexts, principals consider interaction good with few problems (4); as one principal puts it, it is "generally good, with some episodes of aggressiveness". Others (4) just find the student-student interaction positive. There is a certain similarity here with how they describe teacher student interaction in question 4. In both cases this description is quite vague. One principal mentions negative aspects exclusively. This person stresses the crowded conditions of the school as an important factor to explain aggressiveness.

Two principals mention extracurricular activities and the informal leadership structure to explain the ways in which children make friends. Three principals point out that their school stimulate activities and policies to generate cooperative student-student interaction; one of them even mentions the stimulating of critical attitudes among students.
Curiously, only two principals mention the student-student interaction during the computer use and not in positive terms. One of them indicates that "computers engage more and more attention on the part of the student, which implies isolation from classmates". Another states that in the computing class children decide who does what and that "difficulties sometimes [arise] because some children want to do everything and they do not let the others do anything".

APPENDIX

Results, Form C.

Number of countries: 17
Number of schools: 24

Question 1:
1. What does the principal think is happening of importance in his or her school because of the presence of computers?
   - Different supposed positive effects (cognitive and affective) of the use of computers by children: 12 principals
     "They improve learning and self discipline", "there is development of intelligence", "children begin to appreciate their own work", "parents appreciate what children do", "children are more critical, they express their opinion, accept criticism better, find more solutions to a problem", "word processing helps writing and creating ideas, proof reading; data bases help to develop thinking skills, working in groups helps the children establish new interpersonal relationships. There is group interaction", "students ask more about what they do not understand in arithmetics", "there are better results in math-physics school graduates", "research skills are developed", "computers as a project have brought people together and have developed cohesion among the staff and pride among the students and parents", "computers help in individual work and have remedial function".
   - Motivation, interest, enthusiasm, happiness of parents and/or children: 9 principals
   - Modernization: 5 principals
   - Job-oriented training: 1 principal
     "Students need further training to be useful for work"
   - Efficiency: 1 principal
     "Computers can help us to come up to our objectives in less time"
   - New teacher aid: 1 principal
     "Magnificent teacher aid"
   - Administrative: 2 principals
     "Technology is being use to run learner profiles on each student. A computer learning station per class is envisioned", "More professional administration".

Question 2:
2. What are the principal's concerns with respect to:
   a) Computer hardware and software?
   b) People related issues associated with the computer use?
   c) The impact of computers on the school organization?
   a) Computer hardware and software
     - Lack of software or of appropriate software: 9 principals
       "lack of ready-made software", "instructional software for teaching (even games) for teaching", "We have to find a good software if we want to change what we have assigned by the Board of Education", "lack of software for deaf children", "software does not have a sequence", "there are not support programs for all areas", "software is not friendly enough", "appropriate software with New Zealand bias", "bad programs".
     - Financial and availability problems: 5 principals
2.3 The Principals in ITEC Phase 1 Schools

C. Fonseca & R. Murillo, Costa Rica

- Handling of software and hardware: 2 principals
- Does not know: 2 principals
- Computers are rapidly obsolete: 1 principal
- Specific application of software: 1 principal
- Certain students maths oriented should be encouraged of doing respective software: 1 principal
- Hardware: speed, power, transmission, compatibility of systems: 1 principal
- Software: ownership of knowledge: 1 principal

b) People-related issues associated with the computer use

- Negative attitude of adults toward computers: 6 principals
  "adults' paranoid fear of computers", "fear in front of changes", "Teachers do not like computers because they think they do not have many resources to work and because it is too expensive", "The administration tries to motivate and orientate teacher's resistance", "Some teachers have fear in front of a change", "lack of enthusiasm of some teachers, even if they know the importance", "involve teachers".
- Training and involvement of teachers: 5 principals
  "training and retraining", "encourage teachers", "select teachers, train teachers", "in-service training"
- Interest of people: 3 principals
  "people are happy and work together to get help", "parents' interest", "it is useful in team-work and cooperation"
- What students should learn: 3 principals
  "students to have a general understanding of computers", "for deeply interested students: help them in programming", "tomorrow's man has to know how to use the computers"
- Isolation of children: 1 principal
- Adapt software to students, not students to software: 1 principal
- The relationship between the teacher and the student is still the most important factor: 1 principal
- Dialogue has been stimulated: 1 principal
- Computers do not influence people's life: 1 principal

c) Impact of computers on school organization

- Administrative and educational administration aspects: 7 principals
  "paper work of the school", "auxiliary in school organization", "use computers to make exams and get grades", "administrative areas have been automated", "management control", "record all the achievements of the students into the computer", "school management", "administration", "paper work", "administrative tool"
- Schedules of classes: 5 principals
  "every group works two lessons (40 minutes each) per week guided by their own teacher and the lab attendant", "problem: reduction of time for 'teaching'", "time problems of the teachers", "schedules"
- Not much change: 5 principals
  "they support the lessons and do not change the school organization", "not much", "no impact because circles are held after class", "limited", "used in extracurricular student activities"
- A change of structure is necessary: 3 principals
  "It is necessary a new infrastructure", "curricular integration", "the most typical pattern: a teacher in front of a class of students, there is no effective integration of computers"
Canada proposes: "The most typical pattern of classroom organization in schools is still that of one teacher in front of a class of students. Effective integration of computers would necessitate a change in this pattern. Students would be a part of learning guilds in a learning centre, working in small multi-age groups using technology as an integral part of the centre. Teachers might plan and direct these guilds, but many skilled mentors would join from time to time, some through electronic telecommunications. Emphasis in the guild would be on competence and productivity. Young learners would be empowered to take part in the world immediately, rather than spending their educational years in isolation preparing to participate"

- New reunions: 2 principals
"planning of the use of the computer lab", "new reunions for computer integration to the curriculum", "sometimes the meetings with the teachers and the principal are held at the computing lab, where they work with Logo"
- The school and the community got organized to get help: 1 principal
- Computers have become a routine element: 1 principal

Question 3:
3. What age and type of students does the principal think will most benefit from using the computers in his or her school?
- All students, all ages: 14 principals
"but different age, different activities", "activities depend on the age", "as early as four", "depending on the pedagogical practice", "all ages from 8", "but especially girls"
- Good students and good achievers: 5 principals
"good in maths and physics", "better records on performance tests", "higher classes", "children more clever and fast", "children that feel they can do things"
- Higher classes (10, 11, 12 years old): 5 principals
- Children that have scholar problems: 2 principals
"low achievers", "children that benefit from computers and not from other methods", "children that lack discipline"
- Young children: 1 principal
- It depends on what you want: 1 principal
- Not in infants department: 1 principal
- Black girls: 1 principal

Question 4:
4. How would the principal describe the most typical patterns of student-teacher interaction in his or her school?
- Good: 13 principals
"good", "good, teacher get to know the student and his family in order to help him/her. The staff tries the children to feel comfortable", "trustful and tolerant", "teachers try to establish true communication", "teachers stimulate the children in constructing their own world", "open and democratic", "tolerant", "personalized", "teachers have patience for kids with problems, but they expect hard work from all: 'kids can go as far as they can’", "respect and admiration on the part of the students toward the teachers, affection", "great, students look teachers as their love and guide", "no rough wild students", "human companion", "positive and friendly"
- More horizontal than traditionally: 6 principals
"student is the central figure, the teachers are instructors", "fellowship and support", "no big distance between teachers and students", "friendly communication", "teachers are advisers", "from question-answer interaction to a mutual discussion"
- Traditional: 5 schools
"chalk and talk in traditional pedagogic approaches", "teacher talk, student listen", the student requests information", "regular classroom instruction", "ordinary class, teachers talk, explain, organize", "traditional form (students are not so active)"
Question 5:

5. How would the principal describe the most typical patterns of student-student interaction in his or her school?

- **Interactional curricular activities:** 6 principals
  - "In ordinary classes they can hardly interact", "interaction in small groups: the interaction has a social basis and tends to be suppressed in class as it is not productive", "some prefer working in groups, but generally alone", "sports, projects, creativities together as art, music", "cooperative and groups forms of learning: problem solving, completing of homeworks, practical work; mutual control (USSR)", examples of typical in-class interaction as: "interchanging notebooks, help each other, etc."

- **Good with few problems:** 4 principals
  - "Normal, they play traditional games; sometimes they fight", "generally good, some fights (generally from the parents)", "generally good with some episodes of aggressiveness", "positive interactions, low disciplinary problems, low aggression"

- **Good:** 4 principals (Mexico, Netherlands)
  - "Enthusiastic and participating", "very familiar (like a family) and participating", "fellowship and communication", "school is a place to learn, but nice things may happen as well; play gently, order (no problems to keep it)"

- **Interaction encouraged by the school policies:** 3 principals
  - "Collaboration and mutual help are reinforced by the institution", "being considered and critic with the others is encouraged", "cooperative tasks"

- **Interactional extracurricular activities:** 2 principals
  - "Mostly in extracurricular activities, children get friends", "unofficial leaders"

- **Interaction in computing activities:** 2 principals
  - "Computers engage more and more attention on the part of the student which implies isolation form classmates", "In the computing class they decide who does what; difficulties sometimes because some children want to do everything and they do not let the others do anything"

- **Aggressive:** 1 principal (Hungary)
  - "Small children tolerate each other, but older children are exposed to negative effects of peer culture. They behave arrogantly with peers and teachers. The school is not really competitive: achievements of others are detested and mocked. The school is overcrowded so there is much aggressiveness"
### Categorization of the Principal's Responses

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<th>Response categories</th>
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F* = Frequency
2.3.2. Summary of Principals' Responses: Canadian Perspective

By L. Ollila, L. Francis, P. Farragher and T. Riecken, Canada

Methodology

In the analysis of both Form C and Form E page 4, it was decided that the best method would be a combination of quantitative and qualitative analysis. In the quantitative form, the principals' and teachers' responses were noted, and when there was a repeat of the same comment it would be noted on the previous comment that there was a repetition. This led to a number of categories in which comments were repeated, while other categories only contained one response. The qualitative component refers to the interpretation of the actual comments made by those who were interviewed. Due to translation problems a fair degree of judgement had to be used in order to determine the meaning of some of the statements. It is important to note that the comments found in the tables are as close to the interviewees' original statements as possible. Once the comments were categorized they were placed into tables. The tables were then commented on for their general meaning as interpreted by the researcher. The comments were further broken into percentage response, as found in Appendix A and Appendix B of this section.

Question 1: What does the principal think is happening of importance in his or her school because of the presence of computers?

The majority of principals expressed that they felt that computers were improving in some form or another the general standard of the students, teachers, and the school. Other points raised by the individual principals reflected their beliefs that the computers enhanced their various perceptions of the purposes of a school, such as increased efficiency in learning and improvement in the classically conceived purposes of reading and writing such as spelling correctly. There were two dissenting principals; one commented that the lack of computer resources made the public feel inequality existed, while the other principal felt that in reality the computer was a tool for communication and should be treated as such. (See Table 1.)

Table 1

<table>
<thead>
<tr>
<th>Principals' Comments</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increases student enthusiasm</td>
<td>8</td>
</tr>
<tr>
<td>Parental enthusiasm</td>
<td>3</td>
</tr>
<tr>
<td>Increase teachers' interest</td>
<td>3</td>
</tr>
<tr>
<td>Increases students' interpersonal skills</td>
<td>3</td>
</tr>
<tr>
<td>Kept students on task</td>
<td>2</td>
</tr>
<tr>
<td>Students don't like working in pairs</td>
<td>2</td>
</tr>
<tr>
<td>Computers are generally an asset</td>
<td>1</td>
</tr>
<tr>
<td>Increases rate of work</td>
<td>1</td>
</tr>
<tr>
<td>Gives students a sense of superiority</td>
<td>1</td>
</tr>
<tr>
<td>Develops intelligence</td>
<td>1</td>
</tr>
<tr>
<td>School life happier for students</td>
<td>1</td>
</tr>
<tr>
<td>Students learn advantages and limitations of computers</td>
<td>1</td>
</tr>
<tr>
<td>Assists teachers in lessons</td>
<td>1</td>
</tr>
<tr>
<td>Increases efficiency</td>
<td>1</td>
</tr>
<tr>
<td>Improves editing</td>
<td>1</td>
</tr>
<tr>
<td>The computer is a good tool for developing communication skills</td>
<td>1</td>
</tr>
</tbody>
</table>
Question 2: What are the principals' concerns with respect to:

a. Computer hardware and software

Without question, the primary concern revolved around the availability and choice of good software. Many felt that there was not enough choice, nor flexibility, to account for students with special needs. Concern was expressed over an apparent lack of effective means of evaluation for software. The concerns related to hardware were primarily related to affordability, fear of equipment becoming obsolete, and technical limitations such as speed. In some of the less developed countries there also was a real concern over the physical security of the computers. (See Table 2.)

<table>
<thead>
<tr>
<th>Principals' comments</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortage/unavailability of good software</td>
<td>12</td>
</tr>
<tr>
<td>Hardware limitations</td>
<td>4</td>
</tr>
<tr>
<td>Not enough hardware</td>
<td>3</td>
</tr>
<tr>
<td>Affordability</td>
<td>3</td>
</tr>
<tr>
<td>No comment</td>
<td>2</td>
</tr>
<tr>
<td>Security of equipment</td>
<td>2</td>
</tr>
<tr>
<td>Integration into curriculum</td>
<td>1</td>
</tr>
<tr>
<td>Hardware rate of becoming obsolete</td>
<td>1</td>
</tr>
<tr>
<td>Handling of software and hardware</td>
<td>1</td>
</tr>
</tbody>
</table>

b. People-related issues with computer use

Also without a doubt, the single greatest concern expressed was related to the training and motivation of teachers, assistants, and other staff members. There appeared to be a general feeling that if the computers were to be effective, teacher resistance to the integration of the computer into the classroom would have to be overcome. The other major concern was the availability of trained personnel who could either handle or care for the equipment and software. There was one principal who felt the computer had no impact on the school, but this was primarily due to the previous existence of computers already at the school. (See Table 3.)

<table>
<thead>
<tr>
<th>Principals' comments</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher training</td>
<td>7</td>
</tr>
<tr>
<td>Teacher motivation</td>
<td>3</td>
</tr>
<tr>
<td>Teacher resistance</td>
<td>3</td>
</tr>
<tr>
<td>Teachers are enthusiastic</td>
<td>1</td>
</tr>
<tr>
<td>Lack of trained assistants</td>
<td>1</td>
</tr>
<tr>
<td>Need software for people not vice versa</td>
<td>1</td>
</tr>
<tr>
<td>People with knowledge of computers needed</td>
<td>1</td>
</tr>
<tr>
<td>Thought people are happy</td>
<td>1</td>
</tr>
<tr>
<td>Computer is just a tool</td>
<td>1</td>
</tr>
<tr>
<td>No impact</td>
<td>1</td>
</tr>
</tbody>
</table>
c. The impact of computers on the school organization

The majority of schools were using the computers in a laboratory environment in which classes rotated from their respective classrooms to the computer room. Also, most students had to work in pairs or groups of three. In the administrative category, the two main areas that computers have had an effect on in most of the schools were in management control, and scheduling. It may be important to note, however, that a few schools felt that the impact was limited. (See Table 4.)

Table 4  
Principals' Responses To Question 2c

<table>
<thead>
<tr>
<th>Principal's comments</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used in Laboratory method of instruction</td>
<td>9</td>
</tr>
<tr>
<td>Used for administrative purposes</td>
<td>5</td>
</tr>
<tr>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td>Limited impact</td>
<td>1</td>
</tr>
<tr>
<td>Individual use in the classroom</td>
<td>1</td>
</tr>
<tr>
<td>Improving secure facilities</td>
<td>1</td>
</tr>
<tr>
<td>Extracurricular</td>
<td>1</td>
</tr>
<tr>
<td>Resistance by many to change</td>
<td>1</td>
</tr>
</tbody>
</table>

Question 3: What age and types of students do the principals think will most benefit from using the computers in his or her school?

Some of the principals had a specific age group where they felt the computers had the most positive effect, but, those specifics were more related to the software and hardware made available and to whom than the actual potential of the computers. Fifteen of the principals felt that the computers could benefit all children at all ages. However, it should be noted that question number three is a leading question, and thus its validity should be called into question. (See Table 5.)

Table 5  
Principals' Responses To Question 3

<table>
<thead>
<tr>
<th>Principal's comments</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>All students of all ages</td>
<td>15</td>
</tr>
<tr>
<td>Low achieving students</td>
<td>2</td>
</tr>
<tr>
<td>Students good in math</td>
<td>1</td>
</tr>
<tr>
<td>High achieving students</td>
<td>1</td>
</tr>
<tr>
<td>Older students</td>
<td>1</td>
</tr>
<tr>
<td>Poorly disciplined teachers</td>
<td>1</td>
</tr>
<tr>
<td>Students aged 11 to 12</td>
<td>1</td>
</tr>
<tr>
<td>Self motivated students</td>
<td>1</td>
</tr>
<tr>
<td>Students who are tens years of age</td>
<td>1</td>
</tr>
<tr>
<td>Black girls who have limited technical exposure</td>
<td>1</td>
</tr>
<tr>
<td>Ages 7 to 15</td>
<td>1</td>
</tr>
</tbody>
</table>
Question 4: How would the principal describe the most typical patterns of student-teacher interaction in his or her school?

In this category, the majority of the answers were quite diverse, perhaps due to the unfocused nature of the question. While there were five principals who stated that most of the teaching that occurred was based on the teacher talking and the students listening, eleven principals simply stated that the interactions were 'positive' with often no clarifying comments of their meaning of 'positive.' (See Table 6.)

<table>
<thead>
<tr>
<th>Principals' comments</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive perception of teacher-student interaction</td>
<td>11</td>
</tr>
<tr>
<td>Traditional interaction of 'chalk and talk' at students</td>
<td>5</td>
</tr>
<tr>
<td>Student is central to interactions</td>
<td>5</td>
</tr>
<tr>
<td>Interactions are dependent upon individuals involved</td>
<td>2</td>
</tr>
<tr>
<td>Flat, cross interaction</td>
<td>1</td>
</tr>
</tbody>
</table>

Question 5: How would the principal describe the most typical patterns of student-student interaction in his or her school?

The answers in this category were even more ambiguous than the answers in category 4, again probably due to the open-endedness of the question. Most principals described the student-student interactions as normal, good or very good. As well, four answers were totally unrelated to the question. (See Table 7.)

<table>
<thead>
<tr>
<th>Principals' comments</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive perception of student-student interactions</td>
<td>15</td>
</tr>
<tr>
<td>Interaction is primarily during extracurricular activities</td>
<td>3</td>
</tr>
<tr>
<td>Computer tends to promote interactions</td>
<td>3</td>
</tr>
<tr>
<td>Computer tends to isolate students</td>
<td>2</td>
</tr>
<tr>
<td>Students are generally aggressive and arrogant</td>
<td>1</td>
</tr>
<tr>
<td>Students are generally cooperative</td>
<td>1</td>
</tr>
</tbody>
</table>

Question 7: Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

Perhaps the most interesting aspect of this question is the diversity of answers that it brought. Again though, the numbers of different responses were due to the question being open ended. Of the 16 teachers who said yes, there were 18 different types of students the teachers felt would particularly benefit from the computers. (See Table 8)
Table 8
Teacher Responses To Question 7

<table>
<thead>
<tr>
<th>Teacher Responses</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>16</td>
</tr>
<tr>
<td>Slow students would benefit</td>
<td>6</td>
</tr>
<tr>
<td>Self motivated students would most benefit</td>
<td>5</td>
</tr>
<tr>
<td>Students who work alone would most benefit</td>
<td>3</td>
</tr>
<tr>
<td>Confident students would most benefit</td>
<td>2</td>
</tr>
<tr>
<td>Single responses</td>
<td>14</td>
</tr>
<tr>
<td>No, as there is a benefit to be had by all students</td>
<td>4</td>
</tr>
<tr>
<td>Could not say</td>
<td>2</td>
</tr>
</tbody>
</table>

Question 8: What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

There were more answers to this question than there were teachers, as every teacher had varying degrees of success in different areas. This may be suggestive that success is more individually dependent than due to any particularly innate characteristic of the computer. (See Table 9)

Table 9
Teachers' Responses To Question 8

<table>
<thead>
<tr>
<th>Teachers’ Response</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>It would help independent work</td>
<td>7</td>
</tr>
<tr>
<td>It would help logical thinking</td>
<td>5</td>
</tr>
<tr>
<td>It would help cooperation between students</td>
<td>5</td>
</tr>
<tr>
<td>It would help promote classical concepts of teaching</td>
<td>4</td>
</tr>
<tr>
<td>It would help students learn computer skills</td>
<td>3</td>
</tr>
<tr>
<td>It would help problem solving</td>
<td>3</td>
</tr>
<tr>
<td>It would help student interest in learning</td>
<td>3</td>
</tr>
<tr>
<td>It would help in meeting individual needs</td>
<td>3</td>
</tr>
<tr>
<td>Categories with one response</td>
<td>18</td>
</tr>
</tbody>
</table>
Question 9: Does the teacher feel he or she has changed the way lessons are taught or organized because of computers?

Of the teachers who said yes, many felt that lessons became more student-centred, with more time for individualized instruction. On the negative side, some teachers felt that they were hampered by the limitations of the software made available, and that there is less room for improvisation. Equally important is that some teachers felt that the computers affected the classroom atmosphere, rather than their individual styles of teaching, that is, the computer was simply another tool that was integrated into their existing program. (See Table 10)

<table>
<thead>
<tr>
<th>Teachers' Response</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>13</td>
</tr>
<tr>
<td>No</td>
<td>9</td>
</tr>
</tbody>
</table>
Appendix A

Percentage Breakdown Of Responses In Tables 1 To 10

Question 1: Important effects

<table>
<thead>
<tr>
<th>Response Category</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increases student enthusiasm</td>
<td>23.4</td>
</tr>
<tr>
<td>Parental enthusiasm</td>
<td>8.8</td>
</tr>
<tr>
<td>Increase teachers' interest</td>
<td>8.8</td>
</tr>
<tr>
<td>Increases students' interpersonal skills</td>
<td>8.8</td>
</tr>
<tr>
<td>Kept students on task</td>
<td>5.8</td>
</tr>
<tr>
<td>Students don't like working in pairs</td>
<td>5.8</td>
</tr>
<tr>
<td>Computers are generally an asset</td>
<td>2.9</td>
</tr>
<tr>
<td>Increases rate of work</td>
<td>2.9</td>
</tr>
<tr>
<td>Gives students a sense of superiority</td>
<td>2.9</td>
</tr>
<tr>
<td>Develops intelligence</td>
<td>2.9</td>
</tr>
<tr>
<td>School life happier for students</td>
<td>2.9</td>
</tr>
<tr>
<td>Students learn advantages and limitations of computers</td>
<td>2.9</td>
</tr>
<tr>
<td>Assists teachers in lessons</td>
<td>2.9</td>
</tr>
<tr>
<td>Increases efficiency</td>
<td>2.9</td>
</tr>
<tr>
<td>Improves editing</td>
<td>2.9</td>
</tr>
<tr>
<td>The computer is a good tool for developing communication skills</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Question 2: Principals' Concerns

2a. Hardware and Software Issues.

<table>
<thead>
<tr>
<th>Category Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortage/unavailability of good software</td>
<td>41.1</td>
</tr>
<tr>
<td>Hardware limitations</td>
<td>13.8</td>
</tr>
<tr>
<td>Not enough hardware</td>
<td>10.3</td>
</tr>
<tr>
<td>Affordability</td>
<td>10.3</td>
</tr>
<tr>
<td>No comment</td>
<td>6.9</td>
</tr>
<tr>
<td>Security of equipment</td>
<td>6.9</td>
</tr>
<tr>
<td>Integration into curriculum</td>
<td>3.5</td>
</tr>
<tr>
<td>Hardware rate of becoming obsolete</td>
<td>3.5</td>
</tr>
<tr>
<td>Handling of software and hardware</td>
<td>3.5</td>
</tr>
</tbody>
</table>
2b. People-Related Issues

<table>
<thead>
<tr>
<th>Category Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher training</td>
<td>35</td>
</tr>
<tr>
<td>Teacher motivation</td>
<td>15</td>
</tr>
<tr>
<td>Teacher resistance</td>
<td>15</td>
</tr>
<tr>
<td>Teachers are enthusiastic</td>
<td>5</td>
</tr>
<tr>
<td>Lack of trained assistants</td>
<td>5</td>
</tr>
<tr>
<td>Need software for people not vice versa</td>
<td>5</td>
</tr>
<tr>
<td>People with knowledge of computers needed</td>
<td>5</td>
</tr>
<tr>
<td>Thought people are happy</td>
<td>5</td>
</tr>
<tr>
<td>Computer is just a tool</td>
<td>5</td>
</tr>
<tr>
<td>No impact</td>
<td>5</td>
</tr>
</tbody>
</table>

c. School-Impact Issues

<table>
<thead>
<tr>
<th>Category Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used in Laboratory method of instruction</td>
<td>42.9</td>
</tr>
<tr>
<td>Used for administrative purposes</td>
<td>23.8</td>
</tr>
<tr>
<td>None</td>
<td>9.5</td>
</tr>
<tr>
<td>Limited impact</td>
<td>4.8</td>
</tr>
<tr>
<td>Individual use in the classroom</td>
<td>4.8</td>
</tr>
<tr>
<td>Improving secure facilities</td>
<td>4.8</td>
</tr>
<tr>
<td>Extracurricular</td>
<td>4.8</td>
</tr>
<tr>
<td>Resistance by many to change</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Question 3: Students Who Benefit

<table>
<thead>
<tr>
<th>Principals’ comments:</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>All students of all ages</td>
<td>57.7</td>
</tr>
<tr>
<td>Low achieving students</td>
<td>7.7</td>
</tr>
<tr>
<td>Students good in math</td>
<td>3.8</td>
</tr>
<tr>
<td>High achieving students</td>
<td>3.8</td>
</tr>
<tr>
<td>Older students</td>
<td>3.8</td>
</tr>
<tr>
<td>Poorly disciplined teachers</td>
<td>3.8</td>
</tr>
<tr>
<td>Students aged 11 to 12</td>
<td>3.8</td>
</tr>
<tr>
<td>Self motivated students</td>
<td>3.8</td>
</tr>
<tr>
<td>Students who are tens years of age</td>
<td>3.8</td>
</tr>
<tr>
<td>Black girls who have limited technical exposure</td>
<td>3.8</td>
</tr>
<tr>
<td>Ages 7 to 15</td>
<td>3.8</td>
</tr>
</tbody>
</table>
Question 4: Teacher-student Interaction

<table>
<thead>
<tr>
<th>Category response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive perception of teacher-student interaction</td>
<td>45.8</td>
</tr>
<tr>
<td>Traditional interaction of 'chalk and talk' at students</td>
<td>20.8</td>
</tr>
<tr>
<td>Student is central to interactions</td>
<td>20.8</td>
</tr>
<tr>
<td>Interactions are dependent upon individuals involved</td>
<td>8.3</td>
</tr>
<tr>
<td>Flat, cross interaction</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Question 5: Student-student Interaction

<table>
<thead>
<tr>
<th>Category Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive perception of student-student interactions</td>
<td>60</td>
</tr>
<tr>
<td>Interaction is primarily during extracurricular activities</td>
<td>12</td>
</tr>
<tr>
<td>Computer tends to promote interactions</td>
<td>12</td>
</tr>
<tr>
<td>Computer tends to isolate students</td>
<td>8</td>
</tr>
<tr>
<td>Students are generally aggressive and arrogant</td>
<td>4</td>
</tr>
<tr>
<td>Students are generally cooperative</td>
<td>4</td>
</tr>
</tbody>
</table>
2.3.2.10 Appendix B

Percentage breakdown of Category response To Form E Page 4

Question 7: Students To Benefit

Category Response: %

Could not say 9.1
No, as there is a benefit to be had by all students 18.2
Yes 72.7

Those who said yes
Slow students would benefit 20.0
Self motivated students would most benefit 16.7
Students who work alone would most benefit 10.0
Confident students would most benefit 6.7
Single responses 46.7

Question 8: Student Advantages

Category Response: %

It would help independent work 13.7
It would help logical thinking 9.8
It would help cooperation between students 9.8
It would help promote classical concepts of teaching 7.8
It would help students learn computer skills 5.9
It would help problem solving 5.9
It would help student interest in learning 5.9
It would help in meeting individual needs 5.9
Categories with one response 35.3

Question 9: Changes In Lesson Plans

Category Response: %

Yes 59.1
No 40.1
2.4. The Students in ITEC Phase 1

In this section we summarize information about the children participating in ITEC Phase 1, including descriptive information (Section 2.4.1, 2.4.2, and 2.4.3) and information about their computer experience (Section 2.4.4). We conclude with a summary of Form D, in which teachers were asked to categorize the children's personal characteristics with respect to solving problems or learning new skills.

2.4.1. Number of Children in Participating Classes

The total number of children participating in Phase 1 as of March 1990 was 630, with an average of 31.5 per class. Class sizes range from 10 to 55, in the following size intervals:

<table>
<thead>
<tr>
<th>Size Interval</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 15</td>
<td>1</td>
</tr>
<tr>
<td>16 - 25</td>
<td>6</td>
</tr>
<tr>
<td>26 - 35</td>
<td>7</td>
</tr>
<tr>
<td>36 - 45</td>
<td>4</td>
</tr>
<tr>
<td>46 - 55</td>
<td>2</td>
</tr>
</tbody>
</table>

The population is thus reasonably normal, with one very large class and one very small class. The mean (31.5) is identical to the median (31.5) and also is in the modal category, so the variability in class size does not appear to be a serious problem in aggregating observations.

The very small class is one of the four from Mexico. It is a special education class, with hearing impaired children. For reasons to be discussed later, we think it is good to keep this class in the Phase 1 sample, even though its demographics are different from those of the other classes.

2.4.2. Age Range of Children

All but three of the classes are comprised of children in the targeted 9-10 year old age range. The three exceptions have average ages of 10-11 years, 11 years 7 months, and 11-12 years. The three exceptions are close enough developmentally to our targeted age range so that the children involved can probably be considered along with a 9-to-10 year old cohort; however, some care should be taken when aggregating observations to see if any perceptible differences occur with these three classes that might be related to their higher ages.

2.4.3. Are the Children "Exceptional"?

Only three researchers indicated their children to be "exceptional," one because the school is a special "key school" with "better than average teachers and equipment," another because the school is in a relatively high socio-economic area, and a third, because the class is hearing impaired. Neither of the first two reasons necessarily suggest the children in the ITEC classes are themselves exceptional, either physically or mentally. It seems reasonable therefore to use 19 of the classrooms as potentially generalizable to "average" children. Most of the researchers were quite explicit in describing their classes as "average" or "typical" in terms of the range of students' intellectual and physical characteristics.

The one special education class is exceptional. However, since there are three other "unexceptional" classes from Mexico and since extensive work is being done by the hearing impaired children and their teacher with computers, it seems valuable to keep this class in the data collection but to consider their data separately whenever this is warranted. (Children from the special hearing impaired school go on to regular secondary schools). The opportunity to get this perspective on the impact of computer use is too good to miss.

2.4.4. What Computer Experience Do the Children Have?

While the children may be typical children, they are probably not typical in terms of computer experience, but this is to be expected in Phase 1, where researchers were asked specifically to find classes where considerable experience had been accumulated with respect to computer use in schools. In many countries, computer use in primary school is highly limited, for economic or theoretical issues or both. A primary class with regular computer experience is by definition atypical in many countries. What seems to be the case with the ITEC schools is that the computer use occurs, not because the children in the class are atypical, but because the school situation, for one of a number of reasons (to be discussed later) is atypical with respect to computer use. (This generalization does not pertain to the hearing impaired class).
What are the ITEC children's levels of computer experience? Only two of the 20 classes indicated that the children have no real computer experience, three of the 20 indicate that less than a half have regular computer experience, and the remaining 15 indicate most to all of the children have regular computer experience in the school setting. It appears that most if not all of these 15 classes provide regular computer experiences for all their children. Thus, in general, it seems the ITEC schools fulfill the expectation of the Project that we will be observing students and teachers who are already beyond the "familiarization" level of computer use. It was our intention to maximize the likelihood that higher-level thinking activities occur, and therefore it is desirable to have students and teachers who are not overly preoccupied with the mechanics of computer use. We feel the children (and also the teachers—see a later section) in Phase 1 meet this criterion.

It is interesting to note what the researchers cite as the children's regular experience with computer use. The following list is a summary of the researchers' descriptions:

- Word processing, drill and practice; once or twice a week for a 15 minute period
- Whole class doing BASIC since September
- CAI, Logo, painting, word processing graphics; once a week
- Logo, didactic packages; once a week since the children were seven years old
- Curriculum integration; working collectively, one hour, once per week
- Logo, math concepts and drill; two sessions per week, one of which is with a computer specialist
- Logo, educational games, projects with Logo; once a week go to the University to a lab with 15 computers (class has ten children), spend two hours
- All do BASIC; every week for three years, one hour per week
- Educational games and some BASIC
- Word processing; all children, three one-month periods during 1989
- Computer-aided design (Logo, Lego-Logo); in Feb. 89-June 89 all students had two lessons per week; Also 15 boys in Lego-Logo school club; 8 girls and 13 boys use educational computer games once a week
- All had informatics last year, logic, sets using pocket calculators, graphics tasks, construction games; this year, Logo with geometry/graphics, 2 sessions a week, one of which is practical, each two children have a computer
- Word processing, mathematics, geography, and language drill and practice, paint programs, art, reports
- Drill and practice, word processing; from the 3rd grade, at least once a week
- Logo, an hour twice a week for two months
- Word processing, painting and drawing
- Word processing; 1.5 hours per week; graphics, drawing; all students in the school use computers
- Logo, BASIC; 1.25 hours per week, two weeks out of three; also general preliminary experiences with computers prior to this year for all students

It can be seen from this list that the experience base of the Phase 1 ITEC children is broad and strong, with a good emphasis on activities that are suggested in the literature as likely to be associated with higher-order cognitive activity. Also, it is not an experience base which is unusual in type of computer experiences from that found in other computer-using primary classrooms, and thus allows us to generalize.

In summary, the researchers have done an excellent job locating computer-using children that meet the specifications of ITEC Phase 1.

2.4.5. Summary of Responses to Form D

As noted before, teachers were asked to indicate for each child how he would rate the child in terms of various personal characteristics, ranging from family socio-economic level to personal persistence characteristics when faced with a problem situation. Various analyses were done of the Form D data (i.e., by sex, country, etc.), but no stable patterns emerged in the results. Following therefore is an overall summary of the Form D responses.
Teacher's Response Sheet, Student Information FORM D

Child (Code number only): 654 children  20 schools

Gender: M 342  F 296 (rest are missing) (missing: Portugal, Portugal,)
(Japan, USA)

Age: (years) 8 = 8 11 = 75
9 = 210 12 = 39
10 = 292 other are missing = 29

For each of the following, circle the one response that best describes the child:

1. Family Socioeconomic level:

   Above average  Average  Below average  Cannot say or missing
   167  385  73  29

2. School Achievement Level:

   Above average  Average  Below average  17 missing
   200  323  114

3. Apparent experience with Computers:

   Variety of experience  Some  Little or none  17 missing
   104  358  175

4. Apparent Interest in Computers:

   Very interested  Some interest  Little or none  17 missing
   337  239  60

5. Work Habits:

   Prefers to work independently  Prefers to work with others  No particular preference  17 missing
   224  257  156
### FORM D  Children's Questionnaire (To be translated into language appropriate for the children in your setting)

Child's Code Number (Teacher substitutes this for the child's name)

<table>
<thead>
<tr>
<th>WHEN SOLVING PROBLEMS OR LEARNING NEW SKILLS...</th>
<th>Circle ONE</th>
<th>Answer</th>
<th>Missing or ambiguous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you get upset if you see that you have made an error?</td>
<td>84 Very often</td>
<td>799 Sometimes</td>
<td>238 Usually not</td>
</tr>
<tr>
<td>2. When given a problem, do you try to plan ahead how to go about solving it?</td>
<td>211 Very often</td>
<td>283 Sometimes</td>
<td>129 Usually not</td>
</tr>
<tr>
<td>3. When trying to solve a problem, do you feel irritated if someone reveals the answer?</td>
<td>190 Very often</td>
<td>234 Sometimes</td>
<td>199 Usually not</td>
</tr>
<tr>
<td>4. How often do you try to invent new tasks or problems yourself?</td>
<td>130 Very often</td>
<td>270 Sometimes</td>
<td>220 Usually not</td>
</tr>
<tr>
<td>5. How often do you offer help to your friends if you know how to solve a problem and they don't?</td>
<td>266 Very often</td>
<td>275 Sometimes</td>
<td>213 Usually not</td>
</tr>
<tr>
<td>6. Do you prefer being given instructions or finding your own way of solving a problem?</td>
<td>172 Prefer Instructions</td>
<td>104 Can't say</td>
<td>293 Prefer own way</td>
</tr>
<tr>
<td>7. When trying to solve a problem, how often do you experiment with different ways of doing it, if one method doesn't work?</td>
<td>241 Very often</td>
<td>267 Sometimes</td>
<td>114 Usually not</td>
</tr>
<tr>
<td>8. How often do you ask for the teacher's assistance if you find a problem to be difficult?</td>
<td>93 Very often</td>
<td>315 Sometimes</td>
<td>213 Usually not</td>
</tr>
<tr>
<td>9. Do you have your own &quot;tricks&quot; for solving problems, &quot;tricks&quot; that you have discovered yourself?</td>
<td>131 Quite a few</td>
<td>272 Some</td>
<td>220 Not really</td>
</tr>
<tr>
<td>10. Do you easily give up if the task turns out to be too hard to solve at once?</td>
<td>64 Very often</td>
<td>181 Sometimes</td>
<td>398 Usually not</td>
</tr>
</tbody>
</table>
2.5. The Teachers in ITEC Phase 1

The teachers were carefully selected for participation in ITEC Phase 1 on the basis of their reputations as instructors who were doing a variety of interesting things with young children and computers. In this section we look at a summary of the teachers' characteristics (Section 2.5.1) and also include the full results of the interviews which the researchers conducted with the teachers and which were summarized on copies of Form E (Section 2.5.2). The remarkable outcome of this section is that there is no common situational characteristic of these teachers - they vary in age, experience, training, and ways they use computers in instruction. What they do have in common is a belief in the benefit of computer use for their students.

2.5.1. Summary of Teacher Experience

The teachers participating in Phase 1 are also well experienced, both with teaching and with computer use in the classroom, although there is more variability here than apparently shows among the children. The years of general teaching experience achieved by the teachers ranges from 2 to 30, in the following categories:

<table>
<thead>
<tr>
<th>Years of Teaching</th>
<th>Number of ITEC Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - 5</td>
<td>3</td>
</tr>
<tr>
<td>6 - 10</td>
<td>4</td>
</tr>
<tr>
<td>11 - 15</td>
<td>7</td>
</tr>
<tr>
<td>16 - 20</td>
<td>3</td>
</tr>
<tr>
<td>21 - 25</td>
<td>3</td>
</tr>
<tr>
<td>26 - 30</td>
<td>1</td>
</tr>
</tbody>
</table>

The mean years of teaching experience is 14.4 years, the median is 14 years, and the mode is the 11-15 category, so this distribution is close to normal. It is also somewhat "abnormal" (not used in a statistical sense), in that surveys of teacher-use of computers in instruction often show younger teachers to be more likely than older teachers to integrate this innovation into their classrooms. Our teachers are probably not representative of teachers in general, or perhaps not even of computer-using teachers in general, but this is no problem for Phase 1 of the study, where teacher insight and experience are what is important. Thus the general level of experience of the Phase 1 teachers is very good and very good for the study. (It is also interesting that the teacher sample is nearly equally split with respect to gender, with 12 females and 9 males.)

The teachers have not only a good level of overall experience, but also good computer-related experience. Only two of the 21 teachers have had no computer-related training, (and those two teachers are each working with a large and active team of researchers). The researchers consider eight of the teachers to have had good prior training and experience with computer use. Twelve have had courses (a total of 28 courses in total, not counting the courses done by one teacher as he earned a post-graduate degree in computers in education) and eight clearly have extensive training. Three have done teacher education in the area themselves. Thus, with respect to experience with computers in schools, the ITEC Phase 1 teachers are not representative of a randomly selected sample of teachers, but are, in fact, highly experienced. This is excellent for the purposes of ITEC Phase 1, but this strongly biased teacher-variable also needs to be remembered when any generalizations are derived from the findings.

2.5.2. Summary of Interviews with the Teachers (Form E)

In the following section, the teacher's (translated) words are recorded as often as possible, to give the flavour of the teacher's way of expression as well as ideas.
FINAL RESULTS

FORM E: Summary of Interview with the Teacher
16 countries, 22 schools
Country: (USA missing) Date: June 10, 1990

1 Information about the Teacher

.1.1 How many years (including this year) has the teacher used computers in some way for teaching? _______

.1.2 Does the teacher have access to a computer for use at home?

10 Yes 12 No

.1.3 About how many hours per week does the teacher use a computer?

12 0-5 hours
4 6-10 hours
2 11-15 hours
3 More than 15 hours

.1.4 About which of the following computer-related topics did the teacher study during teacher and/or in-service training? Please check all that apply.

Not Little, More at all brief extensive

7 7 6 How to use a word processor
11 6 3 How to use a data base
11 6 3 How to use a spreadsheet
8 6 7 Programming topics
8 9 3 Social issues related to computers in society
6 10 4 Pedagogical applications of drill/practice/tutorial programs
13 7 0 Pedagogical applications of simulations
9 7 2 Strategies for evaluating educational software
4 12 5 Integration of software in existing lessons*
3 10 7 Organization of computer use during lessons**

(* This refers to the relation of software to curriculum and content)
(** This refers to the methodology of organizing time, equipment, and students in the classroom)
Canada and Zimbabwe answered only "not at all"

1.5 Does the teacher have a computer conveniently available for lesson preparation or other activities? 16 Yes 5 No
1.6 From whom can the teacher get support in case he or she encounters problems in using computers?

- 7 School administration
- 13 Other teachers
- 9 Computer co-ordinator for the school
- 3 Other non-teaching staff in the school
- 4 Students
- 11 Other educational agencies outside the school
- 8 Computer and/or software companies
- 6 Other (please specify) ________________
- No support available at all

2. The Teacher's Use of Computers with the Class Involved in the ITEC Observations

2.1. On most occasions when a computer is used for lessons in this class, where do students use these computers?

- 6 In the classroom where their class normally meets
- 7 In a computer laboratory
- 1 In another place

2.2. Who usually supervises the students when they use computers?

- 15 The classroom teacher
- 6 The teacher and another person
- 1 Another teacher in the school
- 2 A technical aide
- 2 A student
- 4 Other (please specify) lab attendant

2.2.3 On average, how many students in this class share one computer to work with at the same time? ______

- friends
- Ministry of Education
- Computer Advisory Agency
- National, Regional Tutors of the
  Omar Dego Foundation
- researchers
- manuals
- EDS (Dallas)
- Research Institute for Informatics
- Foundation

1 : 1
2 : 13
3 : 4
4 : 2
whole class : 3
2.4. With this class, how often has the teacher used the following approaches to using computers in his or her lessons?

<table>
<thead>
<tr>
<th>Approach</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
</tr>
<tr>
<td>Drill: Students do practical exercises on the computer</td>
<td>2</td>
</tr>
<tr>
<td>Instruction by computer: the software provides the actual instruction</td>
<td>9</td>
</tr>
<tr>
<td>Explanation/demonstration; the teacher explains and/or demonstrates an idea or skills</td>
<td>2</td>
</tr>
<tr>
<td>Testing: students take tests by using computer software</td>
<td>13</td>
</tr>
<tr>
<td>Enrichment: fast learners get additional instruction/exercises on the computer</td>
<td>4</td>
</tr>
<tr>
<td>Remediation: slow learners get additional instruction/exercises on the computer</td>
<td>6</td>
</tr>
<tr>
<td>Let students explore concepts on their own</td>
<td>0</td>
</tr>
<tr>
<td>Other (please specify):</td>
<td></td>
</tr>
</tbody>
</table>

Log: ___________

2.5 How many hours do students in this class spend, on the average per month, at the computer?

2.6. What type of computer activities does the teacher feel have been most successful with his or her students?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logo</td>
<td>7</td>
</tr>
<tr>
<td>comp. programming</td>
<td>1</td>
</tr>
<tr>
<td>problem solving</td>
<td>2</td>
</tr>
<tr>
<td>animation</td>
<td>1</td>
</tr>
<tr>
<td>interactive game</td>
<td>2</td>
</tr>
<tr>
<td>word processing</td>
<td>4</td>
</tr>
<tr>
<td>Data bases</td>
<td>2</td>
</tr>
<tr>
<td>language learning</td>
<td>1</td>
</tr>
<tr>
<td>drill/practice</td>
<td>2</td>
</tr>
<tr>
<td>translation</td>
<td>1</td>
</tr>
</tbody>
</table>


drill/practice for computer lessons:
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- 3: No, because there is benefit for everyone
- 2: Cannot say
- 16: Yes

If yes, what types of students, and why?

See attached sheets (Zimbabwe p. 4 is missing)

Too many different answers.

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

Too many different answers.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? If yes, in what ways?

No : 8
Yes : 12

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- [x] No, because there is benefit for everyone
- ______ Cannot say
- ______ Yes

If yes, what types of students, and why?

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

New skills in a regard to the usage of computer as a tool for learning and then - for a problem solving

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers?  Yes  If yes, in what ways?

The students become more self-reliant than before.
They look for a help rarely and they have the possibility to prove their own ideas.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7 Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

   No, because there is benefit for everyone
   Cannot say
   Yes

If yes, what types of students, and why?

The students who benefit the most are those who are self-motivated, confident, willing to ask simple questions, and whose work most closely resembles what was asked by the teacher. These students also like recognition and work well with a partner (co-operatively.) They are not necessarily academically gifted students, but know how and where to find needed information.

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

a. Recognition that decision making requires access to large amounts of information.

b. Being flexible enough to change their mind frequently - refusing ownership of a problem or a solution. They don't have preconceived notions of the finished product, i.e. the finished product doesn't have to resemble the expected outcome.

c. They expect to publish nothing less than perfect work (errors show so glaringly on a computer screen.)

d. Students learn they are responsible for what they do. The computer can't make changes to what they've done.

e. Students learn to be patient waiting for help or they find their answer from someone else.

2.9 Does the teacher feel he or she has changed the way lessons are taught or organized because of computers?  

   Yes

If yes, in what ways?

There are more student-centered discussions than teacher directions. The teacher-directed instruction portions of the lessons are much shorter (usually less than two minutes.) The teacher is able to make constant perception checks by looking at the students' computer screen. A much greater amount of individualized instruction occurs with computers. The teacher runs through the instructions once in class (with chalk, voice) for the entire group and then retouches or expands as needed with individual students in the computer lab. This individualized teaching occurs about 20 times per session in the lab. This same teaching procedure applies to students of any age level, i.e. to both adults and children (although children are much more patient.)

(Note: Items where a dot preceded the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- No, because there is benefit for everyone
- Cannot say
- Yes

If yes, what types of students, and why?

*Students who study intensively, and love to solve problems by him/her self may benefit more than others.*

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

*Logical thinking and independency of work.*

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? __no__ If yes, in what ways?

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- No, because there is benefit for everyone
- Cannot say
- Yes

If yes, what types of students, and why?
Children in general are creative, but she thinks that children that lack discipline and slow children benefit the most.

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

They are creative. In common lessons they are under pressure, but with computers they feel free.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? Yes. If yes, in what ways?

She feels stimulated and interested. She thinks that influences the children's motivation. In her classes she is less directive, this makes the children more enthusiastic and they participate more. The teacher tries the children to feel important.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- No, because there is benefit for everyone
- Cannot say
- Yes

If yes, what types of students, and why?

The children that are self-confident, because he will feel that he can deal with computers. Children that are good observers because they have good memory and then they can practice.

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

- Creativity (they can use what they learn)
- They pay much more attention in class, because they are doing a project in which they need information.
- Cooperation (they learn to help each other)
- Self assurance (because they feel they are making progresses).

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? Yes If yes, in what ways?

At the beginning she was insecure about computers. She felt they were cold and she did not see how could they help the child learn and develop new skills. Now she feels interested and she wants to learn more because she has seen how much do the children enjoy computers and how they develop their creativity, self-assurance, cooperation and attention.

(Note: Items where a dot precedes the number item are taken from the “Computers in Education Study” of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7 Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

Yes

If yes, what types of students, and why?

For M. Seguin the students who have a computer at home can get more benefit of school computer utilization but he said that this idea must be shaded it may occur some counter productive habits generated in the domestic usage.

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

M. Seguin thinks that the use of computer develops different skills: observation capacity, more structured, more logical and more pragmatic working capacity.

2.9 Does the teacher feel he has changed the way lessons are taught or organized because of computers? Yes If yes, in what ways?

M. Seguin thinks computer use has changed the way he teaches geometry: it promotes an acquisition process through observation and actual feature of object instead of a-priori definitions; in addition, word processing encourages writing expression capacities.
2.7 Does the teacher think certain types of students can particularly benefit from the use of computers in instruction? Yes

If yes, what types of students, and why?

M. Chaix believes that the use of computers can help children having difficulties because the computer is a convivial, attractive, up to date and especially a powerful tool: it can repeat the same thing many times. Its patience makes it a good teacher assistant;

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

The use of computers in instruction helps the children to be more autonomous, especially in their relationship with the teachers, with respect to knowledge (i.e. academic instruction and understanding of the society), according to M. Chaix.

2.9 Does the teacher feel he has changed the way lessons are taught or organized because of computers? Yes. If yes, in what ways?

For this teacher computers haven't changed the way he teaches: in fact computers came in his classroom because of his pedagogical conceptions.
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

_____ No, because there is benefit for everyone
_____ Cannot say
x Yes

If yes, what types of students, and why?
Creative students, those aspiring to produce new things, and students most inclined to play benefit the most. Creative children in these classes are typically not the ones achieving well in school and getting good grades.
Some pupils having negative attitude toward mathematics have benefited much, as they have a very favourable attitude toward Informatics and learned much mathematics under this "disguise".

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

1) At the most particularistic level, LOGO activities contributed to a quick development in spatial perception and orientation, in handling directions, rotations in plane, and geometric plane figures.
2) Divergent thinking in children has been advanced by a consequential effort to seek many different solutions to a problem.
3) The overall behaviour and interpersonal attitudes of children have changed quite a bit. They seem to have become more tolerant toward each other and each other's errors.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? _____ If yes, in what ways?

Not really. She feels that her basic pedagogical methods and ways of organizing work have remained the same: these basic ways including a high standard of requirements for children, dynamic succession of various activity forms during one lesson, attending to all pupils, methods to activize all pupils and letting all of them speak during each lesson, and individualizing smaller tasks as far as this is possible under the present scarcity of resources.

Continued below.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)

Nevertheless, she feels there has been significant changes in the overall atmosphere and emotional shade of lessons. Pupils are much more enthusiastic in working with computers than in most other subjects. Even parents typically encourage their children less to learn traditional subjects like Russian and Mathematics for which many parents have the old negative attitude coupled with the opinion that 'they themselves could not learn it' when in school, while they give strong encouragement to children to learn the 'skills of the future', i.e. informatics and computation.
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

_____ No, because there is benefit for everyone
_____ Cannot say
- x- Yes

If yes, what types of students, and why?

There are some highly motivated students who like to use the computers during breaks and beyond the usual computer time. They are usually more successful in using the software.

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

1. more interest in learning.
2. reducing anxieties related to technology.
3. knowledge how to plan based on the constraints of the software.
4. progress according to individuals performance.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? Yes If yes, in what ways?

Inducing motivation in weak students.
Pre-planning the lesson according to available software.
Planning assignments for groups with or without computers.
Students take more responsibility in generating content and creating assignments for their peers.

(Note: Items where a dot precedes the number item are taken from the ”Computers in Education Study” of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

________ No, because there is benefit for everyone
________ Cannot say
____X____ Yes

If yes, what types of students, and why?
Children who think freely and operate

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

Intelligent curiosity
Logical thinking
Trial and error

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? ________ If yes, in what ways?

He thinks lesson plans for individuals.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- Yes
- No, because there is benefit for everyone
- Cannot say

If yes, what types of students, and why?

To those students for whom the process of abstraction of knowledge is more difficult, since it presents the topics in a more logical and simplified manner.

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

The speeding of the logical-mental process in grasping the teaching.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? **No** If yes, in what ways?

(Note: Items where a dot precedes the number item are taken from the “Computers in Education Study” of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

— No, because there is benefit for everyone
— Cannot say
X —— Yes

If yes, what types of students, and why?
Every one because computer lessons let students help in their structure (and the way to write), in some way they organize the ideas. Also students modify their sociability, and motivations to study because many times parents tell us that they ask them to do "things" or "homework" and they permit them to go to the (*).

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

I feel there are many advantages it's possible to use the computer: help them to organize their think, to correct the writing problems, to put more attention, beside to permit to repit the exercise many times be need to understand the concept.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? ___yes____ If yes, in what ways?

The class is more dinamic. I'm more organized and I'm very motivate because to find different ways to explain the class when I use the computer.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the Internatiional Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)

(*) computing lessons
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- No, because there is benefit for everyone
- Cannot say
- Yes

If yes, what types of students, and why?

Students who cannot work independently, in order to motivate and stimulate their interest.
Students who can work independently because it permits them to advance more rapidly, and to collaborate with slower students.

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

It generates interest in instructional activities.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? Yes If yes, in what ways?

Yes, he thinks it has changed because his lesson plan preparation has to be more detailed and improvisation is not possible, at least not at the beginning.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

----- No, because there is benefit for everyone
----- Cannot say
----- Yes

If yes, what types of students, and why?

TYPES: PUPILS WITH LEARNING PROBLEMS IN THE APPRENTICESHIP. BECAUSE THE COMPUTER FULL THE APPRENTICESHIP PUPILS AND BEGINS IMMEDIATELY AN IDENTIFICATION.

TYPES: OUTSTANDING PUPILS. THEY LEARN FREELY IN ACCORDANCE WITH THEIR CAPACITY. THE REST OF THE GROUP DON'T MEAN A LIMITATION FOR THEM.

TYPES: PROBLEMS BETWEEN TEACHER-PUPIL. THE IDENTIFICATION WITH THE COMPUTER IS FAST AND THE PUPIL LEARN HOW TO WORK WITH IT BY HIMSELF.

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

* TO EXERCISE LONGER.
* IMMEDIATE FEEDBACK
* A FREE DEVELOPMENT
* INITIATIVE
* PERSEVERANCE
* A POSITIVE COMPETITIO
* HELP AMONG PUPILS
* MORE INTERESTING THE RESULT OF THE PROBLEMS
* THEY WISH TO USE COMPUTERS IN OTHER AREAS

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? NO If yes, in what ways?
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- X - No, because there is benefit for everyone but also
- - Cannot say
- X - Yes

If yes, what types of students, and why?

Slow learners, low achieves // own time.

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

Be able to follow the instructions in their own time.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? Yes If yes, in what ways?

- Students work more and more individual.
- Computer in the class provides an extra teacher.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- No, because there is benefit for everyone
- Cannot say
- Yes

If yes, what types of students, and why?

More able children who can extend abilities and the less able students who can use computer as confidence builder/support system with immediate feedback.

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

- Student has control over application of activity - no time pressure.
- Enables child to reassess results and make quick changes if feel need to.
- Final presentation looks professional and polished.
- Opportunity for more abled children to work successfully and to support less abled learner by working in peer tutoring situation
- Enables successful storing of information, retrieving it at will to reassess, update, change it without needing to reproduce the lot. (Wordprocessing)
- High motivational level encouraged by computers is a major factor - response to way programme presented, immediate feedback (major aspect), positive statement either verbal or a tune to reflect a good result.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? Yes If yes, in what ways?

- Look for methods to incorporate the computer in instruction/activity.
- Pose more problems for children to solve in lessons - set up problem solving situations (access/create own database)
- Incorporate lot more than prior to having the computer such things as publication of children's work, presentation of magazines/newspapers - use computer as tool to enhance presentation.
- Outcome of computer use is increase of small group tasks and social gatherings.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- [x] No, because there is benefit for everyone
- Cannot say
- Yes

If yes, what types of students, and why?

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

It has been noticed that this series of pupils - the first to learn programming from the 2nd had better results in mathematics than the previous series. Work with computers proved to contribute to the development to a higher degree of the logical thinking of children.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? No  If yes, in what ways?

I have not used computers during classes yet. I mean to try it under the supervision of specialists in informatics.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- No, because there is benefit for everyone
- Cannot say
- Yes

If yes, what types of students, and why?

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

Using computers children develop their intelligence, will improve their way of logical thinking; they gain more ability and better reflexes. In particular, as our children are still working 3 or 4 on the same computer in the same time, they can develop a certain feeling of working and cooperating with their team.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? __yes__ If yes, in what ways?

The way of organizing the lessons has changed, but not essentially. There was only a matter of adopting them to the new form.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

- No, because there is benefit for everyone
- Cannot say
- Yes

If yes, what types of students, and why?

2.8 What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

- More motivation
- Computer competence

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers? No

If yes, in what ways?

May gradually change my way of teaching to be more exploratory - search for information.

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.7. Does the teacher think certain types of students can particularly benefit from the use of computers in instruction?

No, because there is benefit for everyone  
Cannot say  
Yes

If yes, what types of students, and why?

With the software, which is available for us, we can provide the best learning conditions for the advanced students.

2.8. What does the teacher feel are some of the major advantages that can come to students from the use of computers in instruction?

- Activization of learning activities.
- Individualization.
- Teacher's concentration on the most creative and humanistic aspects of the instruction process.

2.9. Does the teacher feel he or she has changed the way lessons are taught or organized because of computers?  No  If yes, in what ways?

(Note: Items where a dot precedes the number item are taken from the "Computers in Education Study" of the International Association for the Evaluation of Educational Achievement. This study is now underway in 12 countries. We will be able to compare the classrooms involved in ITEC with a broad sample of classrooms to help us better judge the representativeness of our sample.)
2.6. Descriptive Videotapes For ITEC Phase 1

As noted in Chapter 1 (Section 1.4.4) the decision was made to videotape ITEC classrooms to better capture detail and interaction. Researchers were given guidelines for what types of observations to capture on the videotapes. In Chapter 3.2 we discuss in detail the procedures we developed for analyzing the ITEC videotapes, both the descriptive tapes meant to give an overall idea of the school in its various cultures and the videotapes focused more specifically on classroom lessons involving computers in which the teacher felt higher-level cognitive functioning might be likely to occur. In this section we look briefly at the so-called descriptive videotapes.

In these videotaped segments (approximately 15 minutes long) each researcher was asked to show the school as a whole, the typical way children interact, the typical way the class and teacher participating in ITEC interact and work when they are not using computers. Each researcher was asked to prepare a log of what was on his or her videotape, to help the coding and synthesizing process and also to explain or translate when valuable. As we discuss in Section 3.2, there was enormous variation in the way in which researchers accomplished this task, even within well-defined guidelines. The tapes are valuable, however, in showing the richness of the class and school cultures involved (something we could not capture with paper-and-pencil forms) and in showing the great diversity of situations in the participating schools. The valuable outcome of this recognition of diversity is to reinforce the awareness that there is no "one way" or "critical condition" that is necessary for good learning and teaching environments—with or without computers. The teacher is the major variable.

We conclude this section with a sample of the scripts submitted by the researchers (Form F) to accompany their descriptive videotapes.
**FORM F: Summary of Descriptive Videotape**  
**Country: Bulgaria**

**Date:** April, 1990

On this form briefly highlight for us the contents of your 15-minute descriptive videotape of the school, teacher, and class participating in the ITEC Project in your country. Begin your videotape with its counter at 0.

<table>
<thead>
<tr>
<th>Time Interval Counter (Example: From 1:00 to 2:00)</th>
<th>Brief Description of Contents (Example: Shots of student-student interaction during group work in various classes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00.00 00.14</td>
<td>Title of the film.</td>
</tr>
<tr>
<td>00.14 00.32</td>
<td>A geographical map of the world, Europe and Bulgaria.</td>
</tr>
<tr>
<td>00.32 01.01</td>
<td>A bird-flight view over Sofia.</td>
</tr>
<tr>
<td>01.01 02.27</td>
<td>The &quot;Istok&quot; area, the streets surrounding the school.</td>
</tr>
<tr>
<td>02.27 02.40</td>
<td>Children playing in the park of freedom.</td>
</tr>
<tr>
<td>02.40 03.31</td>
<td>Stairs in the corridor of the school. Students walking up and down the stairs.</td>
</tr>
<tr>
<td>03.31 04.03</td>
<td>A conversation in the teacher's room.</td>
</tr>
<tr>
<td>04.03 05.12</td>
<td>The class teacher presents the class.</td>
</tr>
<tr>
<td>05.12 05.45</td>
<td>Evgunia Sendova from the Research Group of Education speaks about the informatics in the Group.</td>
</tr>
<tr>
<td>05.45 06.16</td>
<td>Roumen Nicolov from the Research Group of Education speaks about the textbooks in LOGO designed by the Group activity.</td>
</tr>
<tr>
<td>06.16 09.09</td>
<td>A lesson in drawing.</td>
</tr>
<tr>
<td>Time Interval</td>
<td>Counter</td>
</tr>
<tr>
<td>--------------</td>
<td>---------</td>
</tr>
<tr>
<td>(Example:</td>
<td>Begin</td>
</tr>
<tr>
<td>From 1:00 to</td>
<td>Ends</td>
</tr>
<tr>
<td>2:00)</td>
<td></td>
</tr>
<tr>
<td>09.09</td>
<td>09.37</td>
</tr>
<tr>
<td>09.37</td>
<td>11.24</td>
</tr>
<tr>
<td>11.24</td>
<td>13.18</td>
</tr>
<tr>
<td>13.18</td>
<td>14.44</td>
</tr>
<tr>
<td>14.44</td>
<td>15.11</td>
</tr>
<tr>
<td>15.11</td>
<td>15.37</td>
</tr>
</tbody>
</table>
**FORM F: Summary of Descriptive Videotape**

**Country: Mexico**

**Date: March, 1990**

On this form **briefly highlight for us the contents of your 15-minute descriptive videotape of the school, teacher, and class participating in the ITEC Project in your country.** Begin your videotape with its counter at 0.

<table>
<thead>
<tr>
<th>Time Interval Counter</th>
<th>Brief Description of Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Example: From 1:00 to 2:00)</td>
<td>(Example: Shots of student-student interaction during group work in various classes)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Counter</th>
<th>Brief Description of Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00 to 7.19</td>
<td>Begins 1, Ends 338</td>
<td>It's shows a typical school, where most of our students assist. It’s also shown their general environment, so it is represented the way of life of the 80% of student population.</td>
</tr>
<tr>
<td></td>
<td>Begins 73</td>
<td>It's shows a Cultural Centre where there is given dance, aerobics and karate classes to the community.</td>
</tr>
<tr>
<td></td>
<td>Begins 117</td>
<td>It shows a deep cleft where there are some houses.</td>
</tr>
<tr>
<td></td>
<td>Begins 156</td>
<td>We can see the place where the dustmen meet to wait the trashcar.</td>
</tr>
<tr>
<td></td>
<td>Begins 203</td>
<td>It shows a balloon seller.</td>
</tr>
<tr>
<td></td>
<td>Begins 215</td>
<td>We can see the market of the district and the products are saled.</td>
</tr>
<tr>
<td></td>
<td>Begins 279</td>
<td>We can see a papers stand.</td>
</tr>
<tr>
<td></td>
<td>Begins 320</td>
<td>It shows the bus stop.</td>
</tr>
<tr>
<td></td>
<td><strong>THE NEXT</strong></td>
<td>5 MINUTES</td>
</tr>
<tr>
<td>7:30 to 12:60</td>
<td>Begins 348 Ends 607</td>
<td>It shows an example of typical classroom instructional with the teacher and the students of the 4th grade that are involved in the ITEC project. In this class is reinforcing the concepts of &quot;Common Fraction&quot;</td>
</tr>
<tr>
<td>Time Interval</td>
<td>Counter Begin</td>
<td>Ends</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------</td>
<td>------</td>
</tr>
<tr>
<td>13:10 to 22:13</td>
<td>Begins 420</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Begins 440</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Begins 445</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Begins 548</td>
<td></td>
</tr>
</tbody>
</table>

**THE NEXT 5 MINUTES**

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Counter Begin</th>
<th>Ends</th>
<th>Brief Description of Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:10 to 22:13</td>
<td>Begins 617</td>
<td>Ends 960</td>
<td>It shows a computer class without using the computer, we can see a typical example of interaction between students-students and students-teacher, that are involved in the ITEC project. In all of the tape we can see that the students are paying attention to the class in order to learn more.</td>
</tr>
<tr>
<td></td>
<td>Begins 686</td>
<td></td>
<td>You can see the student number 6 answering a question of a teacher.</td>
</tr>
<tr>
<td></td>
<td>Begins 800</td>
<td></td>
<td>It shows a scene of the children answering all together a question of the teacher.</td>
</tr>
<tr>
<td></td>
<td>Begins 805</td>
<td></td>
<td>We can see how the students are writing on the board, the meaning of each instruction.</td>
</tr>
<tr>
<td></td>
<td>Begins 831</td>
<td></td>
<td>It shows how all the students are interested in finding the correct answer on the blackboard.</td>
</tr>
<tr>
<td></td>
<td>Begins 859</td>
<td></td>
<td>We can see the student number 4 who is very interested in writing the correct answer on the blackboard.</td>
</tr>
<tr>
<td></td>
<td>Begins 943</td>
<td></td>
<td>We can see student number 6 doubting about the correct answer, and asking for help and approbation from the teacher.</td>
</tr>
</tbody>
</table>
**Date:** March, 1990

On this form **briefly highlight** for us the contents of your 15-minute descriptive videotape of the school, teacher, and class participating in the ITEC Project in your country. Begin your videotape with its counter at 0.

<table>
<thead>
<tr>
<th>Time Interval (Example: From 1:00 to 2:00)</th>
<th>Counter</th>
<th>Brief Description of Contents (Example: Shots of student-student interaction during group work in various classes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 - 28</td>
<td>1st Sequence: The neighbourhood, the district and the school. Old part of the district: &quot;Mihai Viteazul&quot; highschool - institution with an old tradition among other highschools of the type (Math and Physics)- it's placed at about 300 m away from school.</td>
</tr>
<tr>
<td></td>
<td>28 - 50</td>
<td>The usual aspect of the principal street (Republican Bulevard): cars, trams, waggons etc.</td>
</tr>
<tr>
<td></td>
<td>50 - 63</td>
<td>The Faculty of Constructions, placed at about 250 m away from school.</td>
</tr>
<tr>
<td></td>
<td>63 - 105</td>
<td>Principal street.</td>
</tr>
<tr>
<td></td>
<td>105 - 124</td>
<td>Little old streets in the district.</td>
</tr>
<tr>
<td></td>
<td>124 - 135</td>
<td>Construction (40 m away). - The church in the district.</td>
</tr>
<tr>
<td></td>
<td>135 - 155</td>
<td>Little old street in the district.</td>
</tr>
<tr>
<td></td>
<td>155 - 204</td>
<td>Panoramical view: - highschool &quot;Iulia Haşdeu&quot; (Physiology)- 100 m away from school; - the factory near the school (it produces sweets, candies, chocolate, etc.);</td>
</tr>
<tr>
<td>Time Interval (Example: From 1:00 to 2:00)</td>
<td>Counter Begin Ends</td>
<td>Brief Description of Contents</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>---------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>- front view of the school with the swimming pool (unused); - the new part of the district (different architectonal style, new block of flats in the district).</td>
<td>204 - 279</td>
<td>The little street where is placed the School no. 56.</td>
</tr>
<tr>
<td></td>
<td>279 - 346</td>
<td>The School no.56 with the swimming pool (it is not used anymore) and the mini-basket ground, - The (main) entrance of the school.</td>
</tr>
<tr>
<td></td>
<td>346 -406</td>
<td>Teacher’s room - corridors</td>
</tr>
<tr>
<td></td>
<td>406 - 436</td>
<td>The surgery and the dentist’s office.</td>
</tr>
<tr>
<td></td>
<td>436 - 495</td>
<td>Children during the break.</td>
</tr>
<tr>
<td></td>
<td>495 - 512</td>
<td>Girls workshop for hand work (there are, also, other workshops in the school: locksmith’s carpenter’s, electrotechnichian’s).</td>
</tr>
<tr>
<td></td>
<td>512 - 549</td>
<td>The sport room.</td>
</tr>
<tr>
<td></td>
<td>549 - 592</td>
<td>Children during the break</td>
</tr>
<tr>
<td></td>
<td>592 - 564</td>
<td>The biology lab (there is also a chemistr lab).</td>
</tr>
<tr>
<td></td>
<td>564 - 615</td>
<td>The physics lab and the computer lab (6 computes, one with floppy disk)</td>
</tr>
<tr>
<td>Time Interval</td>
<td>Counter</td>
<td>Brief Description of Contents</td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>(Example: From 1:00 to 2:00)</td>
<td>Begin Ends</td>
<td>(Example: Shots of student-student interaction during group work in various classes)</td>
</tr>
<tr>
<td>620 - 880</td>
<td></td>
<td>The 2nd Sequence: An usual Grammar Class: &quot;The number of the Noun&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There were given examples of nouns both in the singular and the plural. Then the pupils have changed in between these forms (from singular to plural and vice versa). The teacher has dictated a sentence; the pupils have written it down in their notebooks and one of them was asked to write it on the blackboard. The pupils had to rescribe the whole sentence, modifying the noun from singular (omul=man) to plural (oameni=men). In Romanian these change in the form of the subject als requires a change in the form of the predicat (i.e. merge - merg).</td>
</tr>
<tr>
<td>883 - 993</td>
<td></td>
<td>The 3rd Sequence: An usual Mathematic class: &quot;The order of operation&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Typical example of teacher-student interaction in instructional situations. The teacher had explained the order of solving exercises that contained different operations. A pupil was asked to solve an exercise written down on the blackboard. The child explains loudly why he has solved that way.</td>
</tr>
<tr>
<td>993 - 1084</td>
<td></td>
<td>Instructional arrangement of student working individually. The pupils are solving individually on their notebooks exercises resembling with the one already presented. The teacher helps some of the pupils.</td>
</tr>
</tbody>
</table>
### Time Interval

<table>
<thead>
<tr>
<th>Counter</th>
<th>Begin</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical example of student-student interaction in instructional situations. The teacher asks each row of pupils to solve a certain exercise. Therefore pupils in the same desk have to solve two different exercises. After solving them, the two pupils interchange their notebooks; each one checks the other one's results, explaining the mistakes if there have been any.</td>
<td>1084</td>
<td>1142</td>
</tr>
<tr>
<td>Parents waiting for their kids in front of the school.</td>
<td>1142</td>
<td>1145</td>
</tr>
</tbody>
</table>
FORM F: Summary of Descriptive Videotape

Country: United States

Date: February, 1990

Time interval: 1:00 - 7:25

Section one - General overview

1. Students playing on a large, well-maintained playground with teacher supervision before school begins. Two students speak about their school and are obviously proud of the school's emphasis on computer use.

2. A short view of the middle-class neighbourhood surrounding the school with its neat houses, green lawns, and two-car-driveways.

3. Just a few city blocks away a portrait of the largest shopping centre in the city with a four-lane road, the largest department stores in the city and a plethora of smaller service shops.

4. The school is also bordered by some churches, professional buildings, and two private schools associated with the churches (the school is obviously located in a complex social structure).

5. The principal's office is equipped with an IBM computer. Her outer office has a complex communications system that allows her to speak with teachers in every classroom in the school.

6. IBM donated this large computer lab to the school. It has a minicomputer that works as a fileserver and keeps all master records. Teachers are given monthly reports and student progress is monitored and controlled through the minicomputer. Every class works in this lab twice each week. This lab is used for basic skills development and word-processing.

7. Finally, a smaller IBM Writing To Read Lab is also available to teachers of younger students who wish to work on basic reading and writing skills.

Time interval: 7:25 - 10:00

Section Two - Uninterrupted sequence

During this sequence students are involved in two separate activities. One group is working on a project which teaches students the basic techniques for recycling paper. Students are working independently in the back of the room to complete their own paper while the teacher is in the front of the room working with another small group (which had completed the paper assignment the day before). The teacher's group is working on a prewriting activity which asks the students to contemplate "imponderables" and then write answers to a variety of thought-provoking questions. A lively discussion is in progress.

Time interval: 10:00 - 15:00

Section Three - Typical Classroom Activities

1. This scene begins with a large group discussion of Chinese sayings written on the blackboard. The teacher leads and attempts to elicit ideas from the large group.

2. The paper-making activity involves students working independently, assisting each other, and working with the teacher.

3. The teacher brings the group back to a large group to discuss current events. Each student was to have read the newspapers and comes to the front of the room to discuss the articles read.

This teacher obviously uses a variety of instructional methods during the school day. She is comfortable with a certain amount of "noise" in order to create multiple learning situations for her students. She mixes traditional large-group instruction with hands-on activities and small-group activities. This is typical of many elementary schools in the district.
2.7. Summarizing the Descriptive Data: What are the ITEC Phase 1 Settings Like? How Are They Similar? How Are They Different?

In this section we conclude by presenting the analyses of three of the ITEC researchers as they attempt to summarize the overall picture of the context of computer use in the ITEC Phase 1 schools. In Section 2.7.1 we have a summary of the software used in the ITEC Phase 1 classes and in Section 2.7.2 we have a more general summary and analysis of the contextual variables in Phase 1 of ITEC and their interrelationships.

2.7.1. Summary of Software Use in ITEC Phase 1 Classes

By V. Tsoneva, Bulgaria

The Software Dimension. A fifth of the observed lessons were related to the teaching/learning of Information Technology, based mainly on programming activity. From teacher's perspective, this particular activity's aims are to develop the student's skills in problem solving, or, to familiarize them with the computer and its software potential, or to teach them to develop more or less complex programs which could be applied in different subject matter areas (i.e. Geometry, Music, Language, etc.). The orientation to integrate the educational programming in a broader dimension of the teaching/learning process is presented in the following:

a) programming is combined with Mathematics instruction (in 10 of the observed lessons);
b) programming skills are applied in the realization of projects (in 6 of the observations);
c) programming is used to run robots (in 2 of the observations);
d) programming is used to write composed music (1 case).

In general, the programming language use in the classroom represents nearly 50% of the software in the ITEC Project Classrooms, 80% of which is LOGO.

At the computer-based LOGO lessons in the ITEC classrooms there are situations when the computer is used by individual or small groups and the interaction between the computer and the student(s) is direct. Following J. Rogalski's interpretation of this situation "the teacher as 'resource', as actor for validation of students' results or strategies is replaced by the computer. Some important elements concerning students/knowledge relationships are no longer under teacher's control. This situation gives to the group the responsibility of information purchase, strategies and result validation" (15). The classroom atmosphere at LOGO lessons stimulates students' initiative for interactions both with the teacher and the classmates. As a result, the student as a computer user may be put in an situation of "reciprocal teaching", when he/she is "explicitly instructed how to lead a dialogue (i.e. pose questions usually posed by teachers)" (20). As commented by J. Wertsch and J. Bivens, from the perspective of the general genetic law of cultural development the most important result in the reciprocal teaching sessions is that student improvement is not limited to performance but extended to intramental functioning as well. This talking with herself/himself is an example for a student's monologue mediated by the computer which enhances formation of her/his logical thinking (19). The potential of the discussion for the intramental development of the child could be used both student with the computer (when she/he tests ideas, hypothesis, etc.).

About quarter of the software are products especially developed for educational purposes. The software in question are Educational Software Programs (ESP) offering training exercises (i.e. "drill and practice" software, "tutorials"). The ESP of the "drill and practice" type are presented in 11 of the analyzed classroom settings and the "tutorials" - at 4 lessons. Their area of use is covered by the introduction to information technology (1), civic education (1), mother tongue (5) and mathematics (7).

The last quarter consists of computer games, software packages as databases, graphics composition tools and simulation software. The general purpose software packages are used at Geography lessons (Israel), Ecology lessons (New Zealand), for developing projects (Canada, France and the USA), at Mathematics lessons (the USA). Simulation software issued at Science lessons (the Netherlands). Concerning computer games, they are integrated by the teachers, on one hand, with the goal to introduce the students to the Information Technology and to arouse their interest and positive attitude towards computers in general (New Zealand, Romania, the USA). On another hand, the teachers want to use the games' education potential for the development of the cognitive abilities of the children (i.e. positioning in space, orientation of the collaborative activity approach in problem solving.

Data collected in 1990 on video tapes form classrooms in 14 countries participating in the ITEC Project show there is a variety of software use in the teaching/learning process:
2.7.1. Summary of Software Use in ITEC Phase 1 Classes

V. Tsoneva, Bulgaria

a) students in Bulgaria, Costa Rica, France, Hungary, Japan, Mexico, the USA, the USSR and Zimbabwe use the programming language LOGO;

b) students in Canada, France, Israel, New Zealand and the USA general purpose software (content free software) in different school subjects;

c) students from China and Romania use the programming language BASIC;

d) students in Romania, New Zealand and the USA play computer games at the lesson;

e) students from the Netherlands, Romania and the USA use tutorials or drill and practice software.

The goals of the video observed lessons vary from primarily: practice and mastery towards problem solving and experimentation and concept development.

These results from the ITEC project coincide at a high degree with the picture of computer use at school presented in the recently published survey of the International Association for the Evaluation of Educational Achievement (IEA), based on data collected in 1987-1989 in 21 countries in Europe, America and Asia (14). This picture is dominated for the elementary school level by the following particular types of software:

a) general purpose software (open tools, open ended software: word processors, spreadsheets, database programs, hypertext packages etc.);

b) drill and practice and tutorial programs (software which either complement or temporarily replaces the teacher from the lesson, if necessary);

c) programming languages (LOGO, BASIC, etc.);

d) computer games;

e) computer modelling and simulations, etc.

It is evident from both surveys that the "important distinction with respect to types of software is between general purpose software... that can be used in different contexts and special purpose software developed for specific applications" (14, p. 27). All these types of software are produced at present by the industry (16).

The ITEC sample shows some trends in the organization of lessons with computer use: evident preference for a number of machines allowing involvement of the greatest part of the class and a number of children per computer generally below or equal to three. It also indicates that the main software potential of Information Technology seems to become common. At present, Information Technology use at school is the success of one programming language - LOGO. This interest towards LOGO could be explained by the low cost of the software and by the possibility it offers the students to acquire some mastery to control a powerful modern technology. Moreover, learning to program in LOGO is supposed to develop thinking skills in general (1, 4, 7, 12, 18).
References


222
2.7.2. Contexts of Computer Use in Elementary School Learning Process

By G. M. Habermann and M. Csako, Hungary

The scope of the present paper can conveniently be defined by specifying sets of variables in ITEC. Fundamental objectives of our international project implied a system of variables to be studied, preferably by empirically measuring as many as possible of them. There are several ways of describing the system of variables. Guidelines for one of these taxonomies are provided by the General Theoretical Model of the ITEC (see Section 1.5.2).

The large blocks (sets) of variables in the system are:

(i) Background variables;
(ii) Variables of characteristics of computer use;
(iii) Variables covering social interaction surrounding computer use;
(iv) Variables covering instructional integration of computer use;
(v) Variables of cognitive skills development.

This paper is meant to report some cross-cultural findings of the 1990/1991 Piloting Phase of the ITEC Project. The findings to be explicated and interpreted are mainly findings from univariate analyses (in some cases reduced to a preliminary listing of some interpretive categories along variables of open-ended items on the measuring instrument; in other cases standard descriptive statistics). These will be completed by results from a few bivariate analyses of simplest kind.

The set of variables processed in order to reach the present results has been delineated by agreements on the duties of ITEC Task Forces. That is the reason for limiting the scope of this project to variables measured by Instrument "Form G".

The variables analyzed to reach the findings expounded here are either primary or secondary ones. By primary variables we mean ones preliminary selected to be studied in ITEC, i.e., the original variables embodied in measuring instrument items. It seemed to be necessary at a phase as early as this to perform transformations on, and generate other variables from, primary ones. The output variables of transformations and generated indices will be called secondary variables.

The primary variables relevant to this paper are the following (see Table 1):
Table 1: Variables relevant to the present paper. Arranged in the order of the overall taxonomy of the system of variables in ITEC.

<table>
<thead>
<tr>
<th>Subset/SPSS name</th>
<th>Short natural-language name</th>
<th>Information on measurement of variables</th>
<th>Level of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Item #</td>
<td>Response field no.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Variables of characteristics of computer use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii/i)</td>
<td>Availability and type of computing equipment (HW/SW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOCOMP</td>
<td>Number of computers</td>
<td>2.1</td>
<td>One</td>
</tr>
<tr>
<td>PRINTER</td>
<td>Availability of printer</td>
<td>2.2</td>
<td>One</td>
</tr>
<tr>
<td>SPCCOMSPC</td>
<td>Special characteristics of equipment</td>
<td>2.3</td>
<td>F1</td>
</tr>
<tr>
<td>HAR1</td>
<td>Special characteristics of equipment (text comments) 1</td>
<td>2.3</td>
<td>F2</td>
</tr>
<tr>
<td>SPCHAR2</td>
<td></td>
<td></td>
<td>↓</td>
</tr>
<tr>
<td>SPCHAR3</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>Software used in session/dimension</td>
<td>2.6</td>
<td>One</td>
</tr>
<tr>
<td>...</td>
<td>Arrangement and ergonomics of computing equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARRCOM1</td>
<td>Arrangement and location/dimension 1</td>
<td>2.4</td>
<td>F5</td>
</tr>
<tr>
<td>ARRCOM2</td>
<td></td>
<td></td>
<td>↓</td>
</tr>
<tr>
<td>ARRCOM3</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>LOCCOMP1</td>
<td>Location of computers/Regular classroom</td>
<td>2.4</td>
<td>F1</td>
</tr>
<tr>
<td>LOCCOMP2</td>
<td>Location of computers/Computer room</td>
<td>2.4</td>
<td>F2</td>
</tr>
<tr>
<td>LOCCOMP3</td>
<td>Location of computers/Library, General purpose room</td>
<td>2.4</td>
<td>F3</td>
</tr>
<tr>
<td>LOCCOMP4</td>
<td>Location of computers/Other rooms</td>
<td>2.4</td>
<td>F4</td>
</tr>
<tr>
<td>ERGCOM1</td>
<td>Ergonomics of computer environment/dimension 1</td>
<td>2.5</td>
<td>One</td>
</tr>
<tr>
<td>ERGCOM2</td>
<td></td>
<td></td>
<td>↓</td>
</tr>
<tr>
<td>ERGCOM3</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>Dispositional variables (children/judged only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAMTY</td>
<td>Perceived familiarity of children with computing activity</td>
<td>2.7</td>
<td>One</td>
</tr>
<tr>
<td>INTEREST</td>
<td>Children's level of being interested in computing</td>
<td>3.6</td>
<td>One</td>
</tr>
<tr>
<td>(ii/iv)</td>
<td>Activity variables (children/ outside perceptions)</td>
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<td></td>
</tr>
<tr>
<td>PROINV</td>
<td>Proportion/Frequency of pupil involvement with computers</td>
<td>3.1</td>
<td>One</td>
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<tr>
<td>DURINV</td>
<td>Duration of child involvement with computers</td>
<td>3.2</td>
<td>One</td>
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<tr>
<td>DIFFTIES</td>
<td>Perceived difficulties of children in computing activity</td>
<td>2.8</td>
<td>F1</td>
</tr>
<tr>
<td>DIFFSW1</td>
<td>Perceived difficulties of children in using software</td>
<td>2.8</td>
<td>F1</td>
</tr>
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<td>DIFFSW2</td>
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<td>DIFFSW3</td>
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<tr>
<td>...</td>
<td>Variables covering soc. interaction surrounding computer use</td>
<td></td>
<td></td>
</tr>
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<td>INTSS1</td>
<td>Student/Student interaction/dimension</td>
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<td>One</td>
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<td>INTSS2</td>
<td></td>
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</tr>
<tr>
<td>INTSS3</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>...</td>
<td>Teacher/student interaction/dimension</td>
<td>3.5</td>
<td>One</td>
</tr>
<tr>
<td>INTTS1</td>
<td></td>
<td></td>
<td>↓</td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>INTTS3</td>
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### Table 1 - continued

<table>
<thead>
<tr>
<th>Subset/SPSS name</th>
<th>Short natural-language name</th>
<th>Information on measurement of variables</th>
<th>Level of measurement</th>
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<tbody>
<tr>
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<td>Response field no.</td>
</tr>
<tr>
<td>ORGN1</td>
<td>Organization of students in computing activities/Individual</td>
<td>3.3</td>
<td>F1</td>
</tr>
<tr>
<td>ORGN2</td>
<td>Organization of students/In pair</td>
<td>3.3</td>
<td>F2</td>
</tr>
<tr>
<td>ORGN3</td>
<td>Organization of students/Group</td>
<td>3.3</td>
<td>F3</td>
</tr>
<tr>
<td>ORGN4</td>
<td>Organization of students/Observing teacher only</td>
<td>3.3</td>
<td>F4</td>
</tr>
<tr>
<td>ORGN5</td>
<td>Organization of students/Other ways</td>
<td>3.3</td>
<td>F5</td>
</tr>
<tr>
<td>(iv)</td>
<td>Variables covering instructional integration of computer use</td>
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<tr>
<td>INSTOBOV</td>
<td>Instructional objectives/Overall, abstract objectives</td>
<td>1.1</td>
<td>One</td>
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<td>INSTOBSP</td>
<td>Instructional objective/Specific</td>
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<td>Instructional objectives/Curricular units, areas</td>
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<td>INSTOBCR</td>
<td>Instructional objectives/Computer-related</td>
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<td>INSACT1</td>
<td>Instructional activity during session/dimension</td>
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<td>One</td>
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<td>INSACT3</td>
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<td>WINTEG1</td>
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<tr>
<td>(v)</td>
<td>Non-assignable variables</td>
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<tr>
<td>OCOMM1</td>
<td>&quot;Other comments&quot; at end of Form G, dimension</td>
<td>1</td>
<td>UN</td>
</tr>
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<td>OCOMM3</td>
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<td>(vii)</td>
<td>Marker variables</td>
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<td>IDENT1</td>
<td>Phase of work within ITEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IDENT2</td>
<td>Sub-phases of work</td>
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</tr>
<tr>
<td>IDENT3</td>
<td>Country</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IDENT4</td>
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</tr>
<tr>
<td>IDENT5</td>
<td>Observation/Serial number</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 summarises abbreviated (SPSS) and short natural language names of variables. It also provide information on the specific items and response fields in which they are embodied (on Instrument "Form G"). When a questionnaire item is divided to several response fields, they are designated in the order of administration (order of being printed on questionnaire page) by F1, F2, .... "One" in the response Field column of Table 1 means that an item has only one response field (although the response given on that field can be evaluated from several viewpoints and so values of several variables can be inferred form it; see for instance the response taxonomies for variables INSTOBOV, INSTOBSP, ... in the present paper). A column listing Levels of Measurement (dichotomous, nominal, ordinal, ratio) has been added to explain choice of statistical procedures.
The set of cases

The majority of present findings are based on analyses of responses on Form G’s received from 12 participant countries of ITEC. Following agreements of cooperation in the framework of this study, participants were expected to accompany each observed and videotaped session in school with data on a Form G. Until beginning work on the present analyses, we have received filled-in Forms documenting 43 observations. Each observation is handled as a separate case. Sometimes our collaborators filled in only one Form to document data concerning more than one observation. Such summaries could be deciphered easily and did not relativise processing of data. It is supposed however that there exist some Forms G accompanying further observations which has not so far reached us.

As the piloting data at hand represent values characterising whole classrooms and the represent them at the time of making one observation - irrespective to the fact that some variables refer to children as a community, others to the teacher and still others to material entities - a case is defined here as a classroom observed at a given time point. We are aware of the fact that other data files from the same pilot phase in ITEC may have needed other case definitions (e.g. a school as a case with no time specifications, an individual child as a case, etc.). It will be an interesting task to find a procedure to relate case definitions if the necessity of performing data processing in more than one file (of originally diverging case definitions) by a joint statistical procedures emerges.

The 43 cases will be referred to as the set of cases. The authors wish to avoid overstatement by carelessly using the term 'sample'. The set of cases under processing here does not, in a strict sense, constitute a sample. The concept of a sample presupposes a clearly defined target population and a sampling design which may together determine a sampling procedure.

The population ITEC researchers seem to have in mind is the global set of schools, or of classrooms, in which children of the relevant age cohorts are learning - and being taught - by using computers (computerised facilities). This is a population involving dozens or hundreds of schools per country (indeed, tens of thousands of schools and hundreds of thousands of classrooms in some industrialized countries taking part in the study). It is quite clear that in an initial phase of the project - the one we are doing now - the minimal number (1 to 3) of schools, and the one classroom in each school in each school, per country have been selected by preferential procedures. Those can hardly be considered as sampling in a strict sense. As we do not have enough information on national distributions, none on within-country stratification, neither in the position of the 1-3 schools observed (along ranges within each country), the results stemming from data processing over the present cases do not allow any generalisation.

We see functions of the results expounded below as follows:

(i) Describe the patterns within the set of 43 cases (results having no generalisability for any country or for the cross-cultural whole);
(ii) Orient the formulation of general hypothesis to be tested in later (after-pilot) phases of ITEC;
(iii) Focus our attention to some features of measuring process and measuring instruments which need further development or revision.

Function (i) may, as a matter of course include the possibility of finding unexpected cross-cultural homogeneity along some dimension or cultural (national) uniqueness. It should however be borne in mind that such results do not verify real cross-cultural homogeneity or diversity. Nothing is known of the relation of between- (among-) countries variance to within-country variance.

Preliminary results from the piloting phase

Interpretations reported in the present version of this paper cover only a part of our findings. The categorisation of raw responses in order to define final variables for data on open-ended questionnaire items has so far not been completed. Consequently, it is mainly results from data processing involving variables measured in "closed" items which will be published and interpreted in this version.

Results will be presented in the taxonomic order of variables (cf. Table 1).
2.7.2. Computer Use in Elementary School Learning Process

By G. M. Habermann & M. Csako, Hungary

2.0. Characteristics of computer use

2.0.0. Availability and type of hardware and software

The number of computers

One of the closed items on the questionnaire asked for recording the number of computers available. This value varies from 1 to 30. The average is 10.2, with a standard deviation of 8.8.

Without an illusion of inferring general tendencies, an exploratory computation concerning the relation of between-country (among-countries and within-country variance has been performed. An analysis of variance demonstrated a markedly significant effect for Country (variable IDENT3) as a factor "determining" the number of computer. The School within country (variable IDENT4) factor did not produce a significant F. This latter finding is to be interpreted with especial caution as only a few countries provided data on more than one school. The interaction of Country and School is again sharply significant.

Availability of printers

A printer was reported to be available in 65% of all sessions documented (variable PRINTER). It is a different question if a given computer-related learning activity actually made use of an available printer or not.

With an exploratory intent, we generated a variable representing broad sets of countries (variable WORLD) from primary variable COUNTRY. Industrialised nations including those in West Europe, North America and the Pacific (New Zealand, Japan) we grouped together (value 1), with East European ex-communist countries as well as the USSR forming a second group (value 2). Countries possibly assignable to what is usually called a Third World constituted a third group (value 3: including the China). We have 17 cases form five "First World" countries, 12 cases from three "Second World" countries, and 14 from "Third World" countries.

There seems to be a moderate association between the two variables, i.e. a set of systematic differences in the availability of a printer even among these larger groups. The chi-square test yields a significant value (p<0.02).

Special characteristics of computing equipment

Respondents were asked to indicate if available computing equipments had any special characteristics (yes or no; variable SPCCOMP). In nearly 64% of the cases, the response was negative.

A possible culture specificity of these responses was checked by cross-tabulating COUNTRY and SPCCOMP. In the great majority of countries responding was coherent, i.e. either all observations detected absence of special characteristics, or all detected the presence of such. France and Mexico are the nations whose data contain cases of both alternatives. Association between SPCCOMP and COUNTRY is signalled by a strongly significant value of chi-square (p < 0.001).

Possible association of response types with broader groups of countries (variable WORLD) was also explored. A cross-tabulation of WORLDS by SPCCOMP, appear to suggest that computers with special characteristics occur more frequently in schools of highly developed industrial countries, while 'no special feature' is a state more typical in the Third World. Chi square is marginally significant. This simple question has not revealed too much about the real nature of equipments. Processing textual information within the same item will clarify details (variables SPCHAR1, SPCHAR2,..., not reported in the present paper).

2.0.1. Arrangement and ergonomics of computing equipment

Location of computers

The item inquiring about location of computers contained 3 pre-specified options ('regular classroom', 'computer room outside children's regular classroom', 'library or general purpose room'). It also invited respondents to give further alternatives. It seems that these alternatives (fixed and free to add) have not always been treated by respondents as mutually exclusive. At least in a few cases, more than one location appeared in the questionnaire. This might have occurred because:

1. work of the observed session (=work directly related to what is seen on videotape) involved use of more than one room or other compartment;
2. Respondents interpreted the question as referring to the whole school and not only the group session observed.

3. They simply used the free response field to name by a more exact or locally used name the room already indicated.

In nearly 32% of observations, the alternative 'regular classroom' was positively marked. 'Computer room' was marked in almost 46% of cases, 'library or general purpose room' in one observation (2% of cases). Additional locations were specified as 'computer lab' (14% of cases), 'common area' in school building, possibly an area used by all children groups (1 case: 2%), 'spare classroom' (1 case), and special education classroom' (7% of cases).

To identify joint occurrences of the above categories in one and the same observation, a composite variable (LOCCOMP) "listing codes of primary variables LOCCOMP1 to LOCCOMP4 was generated. There was one case characterized by regular classroom and spare classroom locations; two cases by computer room and laboratory locations. These double markings may in fact stem from using two designators for the same environment. This possibility could be adverted by rephrasing the text of the question in a revised version of the measuring instrument.

2.0.2. Dispositional variables

This subset of variables contains those associated with individual psychological constructs in child personality. No data from direct measurement of children is available. Predictably, the questionnaire only included judgements of observing researchers on children (perhaps partly based on teacher perceptions). Although the constructs are individual, variables are defined so that children are characterized collectively along these dimensions.

The label 'dispositional' is used in full awareness of the multiple meanings of the term in the psychological and educational sciences. The present use resembles applications in contexts where a general set of covert mental factors are contrasted with a general set of covert behavioural factors (like in social psychological research on the attitude/behaviour relation). There is nothing specific (i.e. limiting to diverse subsets of personality-related or individual mental constructs) referred to by our present use of term.

Familiarity

A question about familiarity of the observed type of computer activity offered three options to respondents. Option labels are applied to the whole group of children, allowing only an "averaged judgement" of individual. Options were as follows: 'apparently quite familiar', displaying 'some familiarity', and apparently nor familiar'. Nearly 60% of observed sessions were described as children being apparently quite familiar with the activity. A further almost 32% of cases showed signs of at least moderate familiarity of children with relevant types of computing.

Cross-tabulation reveals that there were countries in which familiarity levels were uneven across observations. In Romania, even the two "extreme" levels are jointly represented, with at least one group of children who were characterized by (relatively) high familiarity in one session and absence of familiarity in two other sessions.

It is quite evident that this variable will be of greater use in checking bivariate hypotheses of multivariate models where familiarity levels is made to interact with exogenous type variables (factors potentially influenced by subjective familiarity). It would also be desirable to validate external (observational) judgements of familiarity by self-reports of children.

Interest

Levels of child interest in computer activity were again studied in the mirror of external perceptions. The questionnaire item was accompanied by a four-point scale (with verbal labels 'did not seem very interested', only a few of the students seemed interested', 'most of the students showed some interest', 'most of the students showed strong interest'; variable INTEREST).

The first two options received no vote. In more than 30% of cases, most children were reported to be at least moderately interested, while nearly 70% of observations stated that most children were strongly interested. This is a reassuring result for advocates of the introducing computer technology of lower grades to enhance interest and motivation.
We might note that although they may be viewed as an ordinal scale, the labels of the 4 options confuse two conceptually different dimensions. It would at least theoretically be possible to scale subjective levels of interest independently of scaling proportions of students who were characterized by a predefined (minimal) level of interest from each child individually and compute averages over them, which could do the job of assessing both conceptual dimensions united in this questionnaire item.

It is quite natural to ask if there is a relationship between the two psychological parameters in this subsection. A plausible hypothesis is that the lower the familiarity of children with the activity, the higher their levels of interest will be (with a slightly more complicated argumentation the inverse relationship may also be postulated). There are several statistical solutions for analyzing the relationship. As we cannot, strictly speaking, be sure of even an ordinal level of measurement in case of these variables, the safest way is to treat them as nominal and cross-tabulate them. The scarce data we have do not confirm the above hypothesis. They demonstrate a practical independence of the two dimensions (both chi-square and the contingency coefficient are non-significant).

2.0.4. Activity variables

Proportion of children involved collecting information on the percentages of children in observed groups who had (in the language of the questionnaire item) 'involvement with the computer activity'. A closed item was used with three options: 'fewer than 1/3', '1/3 to 2/3' and 'more than 2/3' of all children reported to have been 'involved' (variable PROINV). As attested, more than 65% of sessions were characterized by heavy involvement. The medium category comprises more than 25% of cases. There were only 4 observations with less than one third of children involved in interacting with the computer, if the item has been interpreted (as hoped) by respondents to refer to an immediate contact.

As with the above variables, we attempted to probe into cross-cultural variability of involvement. PROINV was cross-tabulated by COUNTRY showing that the two dimensions are systematically related. A chi-square test yields a markedly significant value. The contingency coefficient is not significant.

Cross-tabulating PROINV by WORLD, the variable representing broad groups of countries, resulted in confirming no systematic relationship. A dominance of the response reporting increased involvement characterizes all three "worlds".

Duration of involvement

Respondents made an estimate of the average duration spent by children 'engaged in involvement' with computers. The item instructed respondents to limit the scope of children who had actually been involved, i.e. to ignore zero values of children not having involvement.

A frequency distribution of this variable (DURINV), which can be considered a ration scale, was computed. Duration is measured in minutes. The minimal amount is zero, while the maximum is 50. The latter points at a possibility that some sessions were organized with each child facing a computers "of his/her own" and working on it from the beginning of the period to the end. As confirmed by data, children spent an average of more than 23 minutes per session at computing facilities. The standard deviation was 15.1

The two cases having zero value were checked. Both instruments have an empty response field, but one of them is clearly a case of no involvement (responses to additional items indicate that solely the teacher used computers). The other case is more controversial with different items referring to children's using computers.

Difficulties

Difficulties children appeared to have using hardware and software were also studied as reflected in external perceptions. The language of the questionnaire item explicitly asked respondents not to consider difficulties related to content of software but only - as formulated in the item - 'to the mechanics of using the computer and software'. Three prespecified options were labelled as children having 'generally no difficulties', 'some' and 'considerable difficulties'. More than 58% of observations reported no difficulties. The remaining cases expect a single case (2%) perceived minor difficulties (nearly 40%). The remaining cases expect a single case (2%) perceived minor difficulties (nearly 40%).

Cross-cultural and intra-cultural diversities have been explored by cross-tabulating Difficulties by Country. The distribution of Difficulty levels across countries is not random, as attested by a significant chi-square value. There is ni country reporting two sessions described by the two extreme values of DIFFTIES. In five countries (China, France, Mexico, New Zealand and Romania) children had no difficulties during any of the observed sessions.
Although different countries reported different arrays of Difficulty values, the latter seem to be entirely independent of group-of-countries categorisation. A cross-tabulation by WORLD reveals that the three broad sets of countries produced essentially similar distributions along Difficulty. Neither the chi-square nor the contingency coefficient is significant.

One may hypothesise that the more difficulty children have in working with computers, the more they will try to avoid involvement with them. An initial opportunity to test such a hypothesis is to compute measures of association between our variables DIFFTIES and PROINV. As the two variables are at best considered to have an ordinal level of measurement, the statistical index of association can be Somers's d or Spearman's rho (ANDREWS, KLEM et al., 1981; KOLOSI and RUDAS, 1988). We computed Somers's $d = -0.187$ (symmetric). The value is almost identical when computed with DIFFTIES dependent (-0.188) or PROINV dependent (-0.186). It seems better however to inspect the distributions through a full cross-tabulation. There is not any clearly interpretable pattern in this table. Chi-square fails to be even marginally significant.

The absence of hypothesised association between the two dimensions can be explained in several ways. It is thought that primarily the construction of measurement items and the nature of units of measurement (cases) should be kept in mind when interpreting this provisional result. It might be that there is an association at the level of the individual by the rather crude way of collectively estimating Difficulty and Proportion of involvement conceals the relationship. Both variables would preferably be embodied in items including a minimally 7-point scale to create opportunities of evaluating correlation by parametric methods. Considering problems of reliability it may be added that a construct like self-perceived subjective difficulty in an activity is usually measured in psychology by an instrument having several (typically 20-30) items in itself.

2.0.5. Interrelations of dispositional and activity dimensions

It is quite possible that dispositional constructs like those represented by our variables Familiarity and Interest are related to children's activity with computers. The first and truly preliminary, possibilities of testing hypotheses of this type are documented in this subsection.

In parallel with the hypothesis formulated in the previous paragraphs, we might assume that the more familiar children are with the given type of computer activity, the more they will be inclined to involve themselves with it. (A competitive hypothesis could be that it is the curiosity aroused by unfamiliarity which determines, and may heighten, levels of involvement.) The two variables being ordinal, we have computed Somers's $d = 0.082$ (symmetric). The value of $d$ with FAMTY dependent (0.084) or PROINV dependent (0.081) diverge minimally from the "symmetric" value. Inspecting a full cross-tabulation we may see that almost half of all cases fall into the cell defined by maximum familiarity and maximum involvement. Otherwise, there is little systematicity in the distributions of frequencies among cells. We had better be cautious in interpreting this result. The reasons are similar to those mentioned after findings concerning relation of DIFFTIES to PROINV in the previous subsection.

The assumption that interest levels may be related to proportions of involvement has also been checked. An intuitive hypothesis may be that higher levels of interest motivate children for stronger involvement. Although the univariate statistical description of INTEREST showed a very uneven distribution - with only two values represented by any frequency - , an attempt has been made to test this hypothesis. With INTEREST being practically dichotomous there are several statistical possibilities. The distribution among cells is far from random as attested by a chi-square value significant at the $p < 0.01$ level. Somers's $d$ yields values 0.323 (symmetric), 0.354 (PROINV dependent) and 0.297 (INTEREST dependent). Although not all conditions of using Pearson correlation are met (not even if categories along PROINV), an $r$ has also been computed. It gives a value of 0.40 which is highly significant even at a low number of cases like this ($p < 0.005$).

There is some ground therefore to assert that the more children are interested in computer-related activities, the more involved they will be in those activities. This is a finding consistent with a richness of results concerning the interest/behaviour relation in educational psychology.

The hypothesis that Familiarity is related to the level of Difficulties has also been tested. A simple assumption may be that the more familiar children are with (elements or means of) an activity, the less difficulties they will have to face. The data processing was similar to the ones above.

The hypothesis is not confirmed by data. The distribution of frequencies among cells is nearly random, with chi-square not reaching a value being significant even at the $p = 0.05$ level. Somers's $d = 0.330$ symmetric) with negligible deviations from that value under the assumption that either of the variables is dependent on the other.
Hypothesising that there is an association between the level of Difficulties and those of Interest (we may start by presuming that the more difficulties children encounter, the less interested they will become) a statistical analysis of those two variables has also been performed. It appears at first sight that most cases are characterized by strong interest and no difficulty. The chi-square test however yielded a non-significant value. Somers's d = -0.084 (symmetric), with values -0.092 when DIFFITIES and -0.077 when INTEREST is made dependent. These numerical results cannot confirm relationship between the two dimensions with any certainty.

Before discussing independence we may consider the methodological caveats mentioned in previous subsections. It is probable that we can attempt a more reliable test of such a hypothesis only if both subjective levels of difficulty and those of interest are measured individually (i.e. with the individual as a unit of measurement), by self-report instruments, and by more than one item per variable.

2.1. Social interaction surrounding computer use

Organization of computer activity

Interpersonal aspects of work organisation were probed by an item listing several pre-defined options of 'how students were organized for their involvement with the computer'. Labels were 'using the computer individually', 'with one other student', 'with a group of two or more other students' and 'observing the teacher use the computer'. These categories corresponded to those along one of the most frequently cited dimensions in educational research, instructional organization (individualized versus small-group versus frontal instruction). Respondents were also given the opportunity to list further alternatives of organization. No protocol included a note on a further type of organization.

It has been previewed that a session might combine two or more forms of organization. Response patterns verify this. Many cases are characterized by the marking of more than one option. Quite often our collaborators also informed us of which kind of activity. For instance, session No. 2 in New Zealand was, as documented by remarks in Form G, characterized by three different ways of organization. 'Most of the time observed' children worked in groups of two or more. They were also working individually 'sometimes'. Finally, they observed the teacher 'when introducing new programme, e.g. Sorcerer’s Apprentice'.

Frequency distributions of variables ORGN1,...,ORGN5 confirm that individual organization was reported in nearly 35% of cases. Pired-partners organization was noted in more than 46%, group organization in more than 53% of cases. Students observed the use of computer by a teacher in 14% of all sessions. There are 2 cases with individual and in-pairs organization combined, 1 case with individual and group organization, and 2 cases with in-pairs and group organization combined. Three-way organizations are: individual, in pairs, and group method combined in 3 cases; individual, group method and observing teacher combined in 1 case; while in-pairs, group method and observing teacher combined in 1 case.

2.2. Instructional integration of computer use

Instructional objectives of the lesson

An open item inviting free responding in text was designed to report the teacher's instructional objectives. Permissive phrasing ('...what were the instructional objectives of the lesson') elicited a great amount of diverse responses. This is the first corpus of textual responses on which we have attempted to perform a full analysis of response dimensions. It has become clear from the outset that reducing responses to categories along a single variable would not be conceptually adequate to what is actually contained in responses. It would also have resulted in losing much of interpretable data.

These considerations led to the definition of more than one (at present, four) conceptual dimensions. Each of these dimensions is made to correspond to a nominal-level variable.

Some respondents mentioned overall, abstract objectives devoid of specific didactical, even more curricular, content. These abstract labels are borrowed form a general set of designators of educational (in particular, teaching) activities. They can in most cases be used to label a full period or session, irrespective to the fact that dissimilar sub-goals and activities are integrated in it. Other responses referred to more specific didactical categories still covering broad sets of purposes, activities, and predicted outcomes. A number of responses also mentioned curricular areas, or domains, single topics and focuses. Finally, the respondents varied enormously in whether computer-related operations, or leaving the problem of computation rather (e.g. treating them as - ingredients of - the means of attaining objectives only).
It should be noted that although partially similar to Bloom type taxonomies of educational objectives well known from earlier literature (e.g. BLOOM, e.d., 1965; KRATHWOHL, BLOOM, and MASIA, 1964), the used systems does not reflect any attempt to elaborate a full taxonomy. Only the categories actually found during an analysis of responses in the present corpus were listed, with a least amount of logical gap-filling where it seemed strongly necessary.

In what follows some initial results form a tally of responses will be presented. These results will later be found to be in need of refinement. After having a relatively adequate system of categories, classifying (coding) raw responses is still indeterminate in several respects. We may need rules of quantification in terms of explicit and implicit mention. Another problem is that many psychological processes named in defining instructional objectives are ubiquitous and automatic (non-conscious). In that sense, their establishment, elicitation or "starting" cannot be an instructional target, or is implied by almost all instructional targets.

**Overall objectives**

Most of the objectives defined so are related to child activities. Objectives defined by desired output characteristics of children or merely by what the teacher is planning to do are less numerous within the set of abstract descriptions of objectives.

Among types of objectives related to child personality, arousing or developing interest, motivation, or directing attention is the type most frequently mentioned (3 cases), followed by the establishment of anticipation, prediction, or planning skills (2 cases). Other types received one or zero mention.

Among types of objectives defined by constituents of child’s activity frequencies of mention are ranked as follows: discovery or experiential learning (7 cases), establishing interpersonal or social activities, cooperation (7 cases), repetition, memorisation or consolidation of information (6 cases), making children complete some more comprehensive activity (4 cases - counting rather unusual as a didactical aim of its own), establishing habits in general (3 cases), practising of behaviours, exercises (3 cases). Other valae had a frequency of 2 or less. Objectives related to what the teacher should do are mostly mentioned as repeating, revising old information (7 cases) or introducing new information (5 cases).

**Specific didactical objectives**

Responses including the relevant descriptions are scattered among categories, most values having a mention frequency of one. Relatively more popular categories are ‘Making/constructing/creating’, ‘Learning/Acquiring’ and ‘Interpersonal/group/social activities’. Under Constructing, Pictures/Images/Graphs/Maps are mentioned most often (9 cases). Under Learning the acquisition of particular information is what often cited in definitions of aims (5 cases). Interpersonal activities were used to define objectives in 7 cases.

**Specific topics**

Not surprisingly, mathematics and informatics (computing) per se are the "subjects" the teaching of which is cited in many descriptions of instructional objectives. Mathematical objectives are usually related to more specific areas. Geometrical topics lead the frequency rank order (8 cases) followed by arithmetic (3 cases). Although it is far from universal in the present corpus, many sessions have an instructional objective directly linked to informatics or computers. Programming languages were mentioned as objectives in 11 cases (with various versions of LOGO being the popular language). Natural language, mainly first (native) language topics were mentioned 4 times and aesthetic, arts education topics (literature, music) 4 times.

**Computer-related instructional objectives**

The variable INSTOBCR was designed to categorize descriptions of educational objectives which do not only mention computing as a disciplinary or curricular area, but specify an objective as the concrete instantiation of some abstract aim via the computer. These descriptions are distinguished by containing reference to more concrete operations and acts in using computers, specific hardware units or software products.

Among the pertinent categories, solving graphic problems are mentioned most often (7 cases). Handling a configuration (e.g displays, printers) and debugging or editing programs are further terms cited rather frequently (4-4 cases).
Relation of software to instructional objectives

The extent to which software applied during a session related to 'overall instructional objectives' was examined. A three-point scale measured the ordinal-level variable RELSOFT. As revealed by data processing, no respondents claimed that software had little relationship with objectives. In more than 90% of cases, the relationship was reported to be 'close'. There were only 4 sessions (9% of cases) where the relationship was moderate.

Although in this way the number of values of RELSOFT having any frequency were reduced to two, it seemed interesting to check between-country (among-countries) and within-country variation. Most countries only reported sessions in which software was closely related to chosen objectives (and possibly, to the realisation of those objectives). There is a single country (China) which reported no session with a close relationship. Two countries (the Netherlands and Romania) had both periods of close and of moderate software relatedness to objectives. That the variable Country has some effect on the relation of software to instructional objectives id confirmed by a significant chi-square value.

We have also tested if broad groups of countries reported distinctively close or weak relationship of software to objectives. It seems that there is no significant differences among "Worlds" in this respect, at least in this limited set of cases.

Contribution of computer-related activities to the attainment of instructional objectives

A variable conceptually similar to the previous one concerns the extent to which computer-related activities (not only the use of software) contributed to the structure and efficiency of sessions. It might be noted that the item at hand asks about contribution to the 'attainment of the instructional objective' while the software item about that to the 'objectives' themselves. There is a possibility to ask respondents both in case of software (or other specific elements) and of computer activity as a whole about extent to which these have either been related to chosen objective or contributed to the attainment of these objectives. The fact that only two of these four issues were embodied in questionnaire item may limit our explanations of findings.

Almost 63% of observations were characterized by a strong contribution of computing to the attainment of objectives. More than further 30% report that at least some contribution was made, with only 3 sessions depicted as computing having contributed minimally or not at all to attainment.

Levels of contribution seem to fluctuate quite strongly across countries. It is salient that there is only one country reporting minimal contribution (Zimbabwe), but here all sessions were similar in this respect.

Belonging to broad groups of countries (variable WORLD) does not seem to have an interpretable effect on levels of contribution. The absence of a significant chi-square value signal that arrays of frequencies are nearly random.

It may be assumed that the two factors mentioned last are associated in some way. Namely, if software has been selected to fit instructional objectives well, the contribution of computer-related activities to the attainment of those objectives may turn out to be heavier.

Data collected on the present set of cases confirm this hypothesis. A chi-square test yields a strongly significant value. Somers's d 0,306. The d for CONTRIB made dependent on RELSOFT is more than three times greater (0,615) than for the inverse assumption of dependence (0,204). So it seems quite probable that the closer the kinds of software are related to objectives, the better computing activities can support the realization of those objectives. In interpreting this result, we may recall that both dimensions were only measured by an external observer's perception (at best, based on the perception of a teacher) whose reliability is certainly limited.

References


CHAPTER 3: MEASURING METACOGNITIVE DEVELOPMENT

3.1. Introduction: Review of Issues and Processes

In this chapter we turn to the major problem in the ITEC Project, what we came to call "the search for the dependent variable." The motivation for ITEC from its first conceptualization's was to investigate the relationship of in-school computer use on children's metacognitive development (See Chapter 1, Sections 1.1 and 1.2). We deliberately chose not to do some kind of a cross-cultural survey with respect to computer use in schools, partly because such an international investigation was already taking place in another project (the IEA "Computers in Education" Study, chaired by Prof. Tj. Plomp, also, like B. Collis, a member of the Department of Education of the University of Twente in The Netherlands.)

Our motivation was not to capture a broad landscape but instead provide an in-depth analysis, in-depth within the mind of the child himself as he made use of a computer as part of his learning environment. We were not interested so much in what he learned, but in his overall processes of thinking and learning themselves: did computer use change something about his overall way of thinking, about his strategies for dealing with intellectual problems? In other words, we were interested in the relationship of computer use with the child's metacognitive development.

In this chapter we look at this aspect of ITEC Phase 1 in detail. We review first (Section 3.1.1) the theoretical and logistical issues confronting the cross-cultural measurement of the impact of in-school computer use on children's metacognitive development. Then we describe the procedures used in ITEC Phase 1 with regard to this appraisal of change in metacognitive development (Section 3.1.2). We describe in detail one of our strategies - making videotaped observations of classes engaged in computer use (Section 3.2) and finally our "findings", impressions, and conclusions (Sections 3.3 and 3.4).

3.1.1. Issues

From a conceptual perspective, our major problem was converging to an agreement of what "metacognitive development" meant in operational terms. Everyone had some general agreement about the domain, but unless this domain is described in a highly abstract way ("How one thinks...") it immediately became apparent that there are many, many different facets of "metacognition", with many, many different sorts of definitions and operationalizations when used as the dependent variables in research. We collected research studies and measuring instruments related to the construct "metacognition", we tried to harmonize definitions, we commissioned preliminary studies by cognitive psychologists (see, for example, Section 1.3.1 and 1.3.2); the more we assembled, the more we came to feel that convergence has not yet occurred in the field itself as to what, operationally, is meant by metacognition, except at abstract levels ("Thinking about thinking"..., "Reflection....", etc.).

Clearly the processes by which one reacts to perceptual stimuli and to information - processes which include aspects relating to perception, decoding and encoding, analyzing, assimilating, extending, and creating new cognitive structures - will be multifaceted, interacting, and not appropriately reducible to a simplified label or variable. Differences in language and background scientific training also compounded the difficulty of conceptualizing our "dependent variable" (metacognition) within our multi-researcher team. But in order to measure changes in metacognitive development, we had to find a way to reach convergence on a concise way to conceptualize metacognitive activities so as to have a meaningful synthesis of the findings of researchers in many different countries. Even the phrasing to use to describe our target required much discussion; we finally agreed (during October 1990) to use the phrase "higher-level cognitive functioning" as a reasonably well understood common term for what we were studying. Thus, in these many ways, the "quest for the dependent variable" was one of our major preoccupations.

Other critical issues relate to measurement and observation. One cannot talk about "change" without agreeing on some sort of indices, direct or indirect, so that "change" can be described as different levels in these indices. As metacognition is not directly measurable, we must rely on indicators that imply what we label as metacognitive activity. How valid and reliable are these indicators? Can these indicators be seen by watching children as they work and learn? Can they be found by listening to children as they talk, or by asking them to respond to questions? Must they always be intertangled with a task and contextual situation, or can we find some indicators that relatively independent of task and context? Our analysis of more than 100 research projects showed us that almost as many strategies as there were researchers were used with regard to this indicator problem.

234
3.1 Introduction: Review of Issues and Processes

Selecting any one or two or three indicators for use in ITEC would clearly represent only part of the metacognition domain; but practical constraints could not let us consider a broad bundle of psychometric measures, to be administered in close to 20 participating countries to hundreds of children. We could go ahead and select two or three out of the collection, but how much would this selection be influenced by our own cultural backgrounds, as well as being only a subset of the target domain?

Further complicating the issue is the problem of measuring "development" in something (metacognitive processing) which is functioning all the time in everyone; "pre" and "post" test strategies are difficult to meaningfully apply when dealing with an abstraction such as cognitive processing - to what extent are "pre-test scores" and "post-test scores" meaningful? What does "metacognitive development" mean? Faster thinking? More creative thinking? More efficient thinking? More diverse thinking? More logical thinking? Getting more "right" answers? On what kinds of tasks? The answer is all of the above, and much more. Certainly "development" in this domain cannot be meaningfully measured by pre- and post-test change in some kind of univariate score.

Thus, as was noted earlier (see Chapter 1.4.4) we took the decision to separate ITEC into two phases and have as two of the purposes of Phase I the better articulation of the so-called dependent variable in ITEC, metacognitive development, and the identification of a manageable, valid, and reliable strategy to measure change in this development in children in countries throughout the world as they make use of computers in schools. In Section 3.3 we will indicate to what extent we think we succeeded.

3.1.2. ITEC Phase 1 Procedures Relative to the "Quest for the Dependent Variable"

We decided during our various working sessions in 1989 that an important principle during Phase I of ITEC would be, as much as possible, to try not to prematurely impose an operational definition on metacognitive development which may not be shared by researchers in difficult cultural and contextual settings and with different backgrounds and ways of conceptualizing metacognition. The way that "computer use" was related to metacognitive development might be manifested in various different ways in different cultural contexts.

We hoped during Phase I of ITEC that, by examining closely the different local and "naturally occurring" conceptualizations of metacognitive development in the context of computer use in schools that we would see a trend or pattern emerge that would, in an inductive way, suggest a cross-culturally robust measure for metacognitive development in the context of school computer use. Thus we decided to use Phase 1 to look and listen; to ask the teachers and researchers in the different ITEC classrooms to set up for us a computer-use situation in which they expected, based on prior experience, that "something" they would categorize as higher-level cognitive functioning was being well stimulated. Could we see a convergence in what they described and showed us in terms of student behaviours? Something tangible enough to measure? Could we see a convergence in the sort of contextual variables that were associated with these indicator behaviours?

This led to an immediate problem - as the researchers discussed this task with the classroom teachers in their many different respective countries, how would they explain what they meant to the teachers? What language and words and examples should be used to communicate this abstract problem? To what extent would the researcher influence the teacher by what he asked her to describe? If we had difficulty explaining what we really meant by metacognitive changes, how likely was it that teachers in many different countries, hearing about the issue from many different researchers, using many different languages, would, in fact, be thinking about the same kind of cognitive processes? We decided, after much discussion among the researchers, to describe what we wanted to the teachers with words like "higher-level thinking" or "problem-solving behaviour" or with whatever the researcher felt in his mother tongue was closest to the popular description of the type of cognitive development we were investigating.

Given this framework, the researcher was to arrange with the classroom teacher to observe at least three full lessons, each of which involved some kind of computer-use activity that the teacher selected as likely to stimulate the type of "higher-level cognitive functioning" in which we were interested. We asked the researcher to described carefully for us the classroom context for each of these three "observation sessions". These descriptions were organized on copies of Form G (See Section 1.5.1) and included comments about the organization of the entire lesson as well as the component of it involving computer use. How and what the children did, and with whom, was carefully described; how the teacher developed the lesson and how the computer activity related to it was also described; and characteristics of the student-student and teacher-student interaction were noted. Our general theoretical model of factors that influence the impact of computer use on children's metacognitive development (see Figure 1.2, Section 1.4.1) guided the inclusion of descriptive sections in Form G.

In addition to being described in Form G, the lesson was also videotaped according to certain specifications (i.e., including footage of the teacher introducing the lesson and the computer use, of the children as they interacted with the computer and each other, of the teacher as she interacted with the children, and generally of the classroom atmosphere and organization). Researchers were particularly to be alert for behaviours that might be interpreted as indicators of "higher-level cognitive functioning" and to
capture these on the videotape for later discussion with the teacher. The researchers were asked to augment each videotaped segment with a detailed description of what occurred, including English translations of any particularly interesting comments by the children. Form H provided a common format for each of these lesson/videotape segment descriptions.

The researcher not only observed the entire lesson, but also interviewed the teacher before and after as to her ideas and impressions about the lesson and the computer use within it. In particular, the teacher was asked if she felt the computer use stimulated "higher-level thinking" among the children, and if so, in what ways? Why did she think so? What indicators did she have? Could she "point something out" when she looked at the videotape that had been made of the lesson? Which children in particular did she notice displaying some higher-level thinking in a way unusual for them in "ordinary" settings? What added value did the teacher feel the computer use brought to the lesson? The researcher translated his notes of the interview into English and submitted a summary of the main points on a copy of Form I (see Section 1.5.1). Finally the researcher added his own thoughts on what he had observed and how much his perceptions agreed with those of the teacher. These reflections were expressed on a copy of Form J (see Section 1.5.1).

In Section 3.2 we will discuss the videotaping procedures in more detail before we turn to our results in Section 3.3.
Chapter 3: Measuring Metacognitive Development

3.2. Videotaping "Observable" Evidence of Metacognitive Processing

In this section we discuss in more detail our experiences with videotaping classroom lessons involving computer use in the attempt to capture visual "evidence" of higher-order thinking (Section 3.2.1) and our procedures to try to analyze and synthesize the videotapes (Section 3.2.2).

3.2.1. Characteristics of submitted videotaped segments

Videotapes received. For most of the teachers participating in Phase 1, there were received two or three videotaped lessons involving computer use, each accompanied by a set of Forms G, H, I, and J capturing observations and impressions about the lesson from a variety of perspectives. Although there were some missing forms and videotapes (two videotapes, for example, were lost in the mail en route from Romania and Zimbabwe to Bulgaria and could not be replaced), ITEC has a library of 44 complete sets of videotaped lessons, with accompanying translations, descriptions, translated interviews, and researcher impressions. One or more complete sets of videotaped lessons and accompanying descriptive material (Forms G, H, I, and J) were received from: Bulgaria, Canada, China, Costa Rica (two schools), France (two schools), Hungary, Israel, Japan, Mexico, The Netherlands, New Zealand, Romania (two schools), Russia, and Sweden. Appendix A contains the full list of received and analyzed materials relative to videotaped lessons involving computer use and "higher-level cognitive functioning" with accompanying forms of descriptive and interpretative material. The videotapes and the contents of the forms are available in the ITEC archives at UNESCO, Paris.

Characteristics of the videotapes. There was considerable effort involved in accumulating the videotapes and their accompanying descriptive materials. We had originally intended that ITEC provide for all its researchers standardized videotaping equipment, but funds were not found for this purpose. Thus, each researcher in each of the 16 countries that completed participation in Phase 1 had to provide his own videotaping equipment and personnel and was supposed to provide his own editing, so that a concise, 15-minute segment (with accompanying material) could be submitted to ITEC of each observed computer-use lesson.

This resulted in much variation. In some countries, the researchers were able to involve professional video technicians for both the taping and the editing; in others, quality of the video is more of the home-movie standard. This raised an interesting question: for our purposes (comparative international research) where are the boundaries of acceptability with respect to quality of videotaping? We wished the videotapes to give us as best a glimpse into the dynamics of the class and lesson as possible; to enrich what the researcher would describe in words or even may notice. But do "professional techniques" such as voice-over narrative and musical background add or detract from the research value of the videotapes? (In some countries, these techniques were used in a way that may have worked to the disadvantage of the research aspects of the video even while they may made a much more interesting video as we found ourselves being influenced by the commentator or music rather than letting the children and teacher communicate their own messages). We did ask the researchers to add some (English) titling to the videos to at least identify the school and some major aspects of the observational setting. When researchers did this, it helped the interpretation and synthesis of the videotape considerably. Without it, the process of trying to watch the video, read the accompanying translation and overview (Form H), and also code and make notes for later synthesis became very difficult.

Also, although we gave directions for the sorts of material we wished included on the videotaped lessons (see Section 1.5.1), researchers (or their videotapes) generally did not follow our plan, partly because of the enormous variation in types of lessons and lesson situations. For example, we requested two to three minutes' worth of footage showing how the teacher introduced the computer-use activity, but in many cases this sort of introduction did not occur as a discrete event that could be isolated and videotaped, but instead was part of a variety of other activities or, more frequently, had taken place at an earlier lesson so students already had an orientation of what they were meant to do.

There were other sorts of variation. Some researchers presented very long videotaped segments with little or no camera variation (i.e., almost as extreme as turning on the video camera from a corner vantage point and letting it run for 45 minutes), while others were much more alert to variations in camera position. Some included sound and conversation, others not. Some showed transitions between lesson and computer-use activities; others not. Some tried to show as many of the children as possible; others chose to focus on smaller groups of children.

Another layer of logistical difficulty related to the physical videotape itself. Some researchers, for convenience or to save money, waited until all four videotaped segments (one from the "Descriptive" portion of the Project (see Section 2.7) and the three involving computer-use and higher-level cognitive functioning) were completed from a school; then submitted them on a single videotape. This became very difficult if the researcher didn't include titling to indicate to subsequent viewers of the videotape where one segment ends and another begins. Considerable time was spent trying to match the English-language descriptions of the videotapes (Form H) with the mother-tongue video segments, to try to figure out where and on what segment...
of the tape a certain videoed observation described in the print materials occurred. Unlabelled videos were occasionally received, some with and some without accompanying descriptive materials. Some videos had technical flaws, which frustrated viewing and subsequent coding. Materials sent to one of the co-chairs of the project sometimes took a long time to be copied and sent to the other co-chair, which also caused considerable time delay, and in general, copying the videotapes for the various researchers who were to be involved in their analysis and mailing the videotapes to them, along with appropriate print material (Forms G, H, I, and J) also cost time and money that had not been expected. As was noted before, some videotapes disappeared in the mail (Romania, the USA, and Zimbabwe); others failed to end up with the project for a variety of reasons, as happened with those of Sweden. Also, the different formats of videotapes (PAL, NTSC, SECAM) from different parts of the world resulted in continual difficulties in terms of the viewing and synthesizing the videos.

Central funds were never found to collect all the videotape segments onto one interactive videodisc, which would have enormously opened up the research value of the tapes by allowing researchers to move quickly and accurately from different sections on different tapes for comparative purposes. Thus even the organizational aspect of assembling the videotapes for subsequent analysis took considerable effort.

Effort, of course, was also involved at the school sites themselves, and in some countries the acquisition of videotape and the arrangements involved in getting someone with a video camera to the school on a number of occasions in order to complete the videotaping of three different lessons was a considerable hardship. Sometimes no facilities were available for back-up and/or editing, so that when a videotape was lost in the mail, those valuable visual data were lost for good to the project.

Audio aspects also were a challenge; even when one understands the mother tongue of the lesson, it is difficult to hear what is occurring on the video unless a person speaks very specifically into a microphone. To avoid disturbing the naturally occurring interactions among children and children and teacher in the classroom, many researchers chose not to intrude on spontaneously occurring discussions. But the consequence was that the conversations were not then available for subsequent analysis. Deciding how much to translate in the accompanying print materials (Form H) was also difficult, as much formal and informal talk occurs during a lesson, much of which cannot be captured by the researcher even before the translation decisions. And once translated from another tongue into English, how accurate a feel of the casual conversation between two children remains?

Despite all these variations in quality and quantity of analysable material, the videotapes still provided us with a rich look into the 26 classrooms involved in ITEC Phase 1, giving us a much better impression of the settings than could have occurred if only text descriptions had been provided. But with this richness came also the problems of coding and synthesis.

3.2.2. Coding and Synthesizing the Videotapes

"Observing" higher-level cognitive functioning on videotaped observations. Once the organizational aspects of obtaining and viewing the videotapes were solved, at least two dimensions of challenge arose in terms of using the videotapes as research tools. One dimension related to synthesis. With a total of about 20 hours of videotaped footage relating to the lessons involving computer use, how could we synthesize the material on these tapes in a valid and reliable way? How could we test interrater reliability in our codings? The second dimension related to the more conceptual problem - how do we identify "higher-level thinking" by observing children's behaviours on a videotape? How much can we tell about their metacognitive activity by seeing physical activity or other behavioural indicators? How much can we "see", when we do not know the child, when we know little or nothing about how he might have "appeared" prior to computer exposure? We evolved no objective procedure for this second aspect, but instead used our "professional impressions" from watching and discussing the videotapes, in conjunction with analysing the teachers' and researchers' written impressions to form our opinions. We will discuss these opinions in Section 3.3 and the process of observing indicators of higher-level thinking through videotapes of classroom interactions in Section 3.4. We did devise two validation strategies for our appraisals of indicators of higher-level thinking, one of which we will describe in the next two sections, and the other of which we will discuss in Section 3.3.1.

CODING THE CONTEXT OF PRESUMED HIGHER-LEVEL COGNITIVE FUNCTIONING. We gradually evolved a strategy for coding many aspects of the videotaped lessons, aspects which were not as internal as a child's metacognitive activity, but were critical elements of the context in which the child's presumed higher-level cognitive functioning was occurring. These contextual aspects included the type and characteristics of the computer-use activity; the way the learning activity was organized; the physical setting of the classroom; the "classroom climate" and environment; the teacher's style of lesson delivery, guidance, and interaction; the types of activities in which the students were involved; and the interaction patterns among the students. We based our approach to coding these contextual aspects on the work previously done by Dr. Zimra Peled involving the use of "mapping sentences" to code observations of classroom computer use situations (see Section 1.3.11). The instrument we developed to code from the videotapes the context of the schools, lessons, classrooms, and instructional setting in which the presumed higher-level cognitive functioning occurred appears in the next section.
sections, and instructional setting in which the presumed higher-level cognitive functioning occurred appears in Section 3.2.2.3.

Mapping sentences for coding the ITEC Phase 1 videotapes. The following two forms were developed for coding the videotaping submitted by the researchers during Phase 1 of ITEC. One form relates to a general descriptive summary of the school and class environment and was especially appropriate for the first, so-called "descriptive" videotape segment giving a view of the overall school context. The second form was meant to summarize the settings for the videotape segments relating to computer-use situations in which the teacher predicted "higher-order thinking" would be associated with the computer use. Both forms were developed after all the videotapes had been submitted, after preliminary attempts at analysis indicated some replicable method was necessary in order to concisely describe the computer-use context in which presumed higher-order thinking was taking place. The researchers present at a May 1990 project meeting in Bulgaria validated the approach by applying it individually to various of the ITEC tapes, discussing points of disagreement in coding, and reworking the sentences until consensus over meaning was accepted. (The numbers in brackets in the forms are for coding purposes). The mapping sentences were then sent to the rest of the researchers with the request that they apply them to their own videotapes.

ITEC Phase 1
Coding sheet for
TAPE 1, Descriptive Summary of School and Class Environment

Country:
School:

Instructional segment#
Time Period on videotape: ______ (min) ______ (sec) to ______ (min) ______ (sec)

A. Activity
The activity is a (1) __________________ lesson, whose goal appears to be primarily
(2) 1. concept development
   2. practice and mastery
   3. problem solving or experimentation
   4. creative expressions
   5. other
   6. can't say

and whose overall organization is generally
(3) 1. the whole class being involved in an activity at a time
   2. the class being involved in different activities at a single time

B. Physical Setting (classroom level)
The physical setting of the classroom can generally be characterized as showing

(4) 1. a large
   2. a moderate variety of instructional materials, including
   3. a little

(5) 1. more than one type
   2. one type
   3. no type

and whose atmosphere could be described generally as
(6) 1. noticeably crowded
   2. neither crowded or spacious and
   3. noticeably spacious

(7) 1. giving a sense of being very light
   2. neither very light nor somewhat dark
   3. giving a sense of somewhat dark

organized (8) 1. with rows of seats facing the teacher
   2. with seats arranged in groups
   3. with a variety of seating arrangements
and giving the impression of a

(9)  1. high noise level form the students and a
    2. moderate
    3. low

(10)  1. more regulated environment with
      2. moderately
      3. less

(11)  1. much evidence of students' work on display.
      2. some
      3. little

C. Teacher
The teacher predominately

(12)  1. instructs
      2. manages the class in instructional practice
      3. manages the class in discussion
      4. facilitates student activity

in a manner that as an overall impression looks

(13)  1. dominant
      2. a mixture of dominant and unobstructive
      3. unobstructive
      4. can't say

giving feedback that is mostly

(14)  1. content specific
      2. related to management and organization
      3. related to affective aspects
      4. can't summarize

D. Students
The students are mostly doing

(15)  1. small group
      2. individual
      3. whole-class

activities in which they are predominately

(16)  1. responding
      2. initiating
      3. can't say

in a context which can best be described as

(17)  1. drill or practice oriented
      2. inquiry oriented
      3. creative
      4. other:
      5. can't say

and relate to each other in generally a

(18)  1. competitive
      2. cooperate
      3. parallel (working without specific reference to one another)
      4. can't say
manner, with communication that is generally

(19) 1. task oriented  
2. non-task oriented

and they generally can be described as displaying

(20) 1. restrained  
2. moderately enthusiastic  
3. exuberant  
4. can't say

(21) 1. a noticeable level of smiles and laughter  
2. neither particularly serious or particularly animated expressions  
3. generally serious expressions

and with apparently

(22) 1. high  
2. moderate  
3. limited

absorption in their tasks, and their communication with the teacher is most typically

(23) 1. responding by raising their hands and being called on when the teacher asks a question  
2. responding without being called on when the teacher asks a question  
3. initiating communication with the teacher themselves.

E. Overall View of School

The school is in a setting which is predominately surrounded by

(1) 1. many buildings  
2. a mixture of buildings and open space  
3. trees and open space

in which the children appear to have

(2) 1. extensive  
2. moderate  
3. limited

area for play. The school interior seems

(3) 1. spacious  
2. somewhat spacious and  
3. somewhat crowded  
4. crowded  

(4) 1. particularly light  
2. moderately light  
3. somewhat dark

with

(5) 1. much  
2. some  
3. little

art or decoration on display and where the students appear to move about in a

(6) 1. regulated and orderly  
2. casual and non-regulated  
3. can't say

way when they move about outside of the classroom.
ITEC Project
Coding sheet for
Computer Use Situations (Involving Presumed Indicators of Higher-Order Cognitive Functioning)
Videotape Segments 2-4

Country:
School:
Observation (Circle one): 1  2  3

There were (1) one
two
three
more than three (how many?)

computers available, which were being used by

(2) less than fourth
between a fourth and a half
between a half and three-fourth of the
more than three-fourths

students in the class during the time of the videotaping.

The computer(s) were

(3) in the regular classroom
in a computer room
somewhere else.

The software used was

(4) drill or practice (not a game format)
an instructional game
a simulation
a tutorial
a programming language
a data base
a word processor
other (__________________)

and the activity was a

(5) __________________ lesson, whose goal appears to be primarily

(6) 1. concept development
2. practice and mastery
3. problem solving or experimentation
4. creative expression
5. other
6. can't say

The students using the computer in the video spent approximately

(7) less than two
two to five
five to ten
more than ten
it varied considerably between children

minutes at the computer, showing in general an apparently

(8) high
moderate
limited
varies considerably among children
Videotaping "Observable" Evidence of Metacognitive Processing

can't say
degree of on-task concentration on the computer-use activity. In general, the children worked

(9) individually
in pairs
in threes
in groups of more than three
as a whole class, watching one computer
other

with the computer(s). They interacted with each other

(10) continually
occasionally
little or more
some a lot, some very little
can't say
during the computer use and related to each other in generally a

(11) 1. competitive
2. cooperative
3. parallel (working without specific reference to one another)
4. can't say

manner with communications that were generally

(12) 1. task oriented
2. non-task oriented

The students generally could be described as displaying

(13) 1. restrained
2. moderately enthusiastic
3. exuberant
4. can't say

(14) 1. a noticeable level of smiles and laughter
2. neither particularly serious or particularly animated expressions
3. generally serious expressions

and with apparently

(15) 1. high
2. moderate
3. limited

absorption in their tasks. The students' communication with the teacher was most typically

(16) 1. responding by raising their hands and being called on when the teacher asks a question
2. responding without being called on when the teacher asks a question
3. initiating communication with the teacher themselves

The teacher apparently had structured the computer use activity

(17) thoroughly
moderately
left it relatively open ended
can't say

and interacted

(18) frequently
some
little

with the students during the activity, giving feedback that appeared mostly to be
(19) 1. content specific  
   2. related to management and organization  
   3. related to affective aspects  
   4. related to how to use the computer  
   5. can't summarize.

As an overall impression of the classroom, there was

(20) quite a bit of sound and
     some
     little

(21) quite a lot of movement of the students.
     some
     little
3.3. What Did We Find?

Did we find an appropriate way to conceptualize metacognitive development? Did we find some kind of indicator of this development that we could reliably measure or at least observe so that we could look for change in it, stimulated by computer-use experiences? In this section we describe our results relative to two summaries of the impressions of the teachers and researchers (Forms I and J, Section 3.3.1 and Section 3.3.2); and a summary of what we observed in the videotapes (Section 3.3.3).

3.3.1. Summaries of Forms I and J: Teachers' Impressions

In October 1990 most of the ITEC researchers were able to meet together for a week-long working meeting in Victoria, British Columbia, as guests of the Provincial Educational Technology Centre. One of the main tasks of this working session was to deal with the dependent variable issue. What had we found? Had we converged on an efficient way for international measurement of metacognitive development usable in classroom situations as children worked with computers?

To address this question, in addition to discussions and debate about the videotapes, we synthesized the comments of the teachers when they described the indicators of higher-level thinking that they felt confident were displayed among their students during the videotaped lessons involving computer use. We were able to group the comments in the following 11 categories, each of which is illustrated by translated extracts from the teachers' comments given in interviews after each videotaped lesson.

(1) Reflection/Evaluation

(a) of one's own work:

"They reflect on their work"
"They control their own work"
"They evaluate their own work"
"They comment about and analyse their own work"
"They develop a personal plan for work"
"They analyse a problem and plan their work"
"They explain their own work"
"They look for alternatives, self-evaluation, reflection"
"Through debugging they practice self-evaluation"
"They show a high absorption in their work"
"They are self-monitoring"
"They can explain their own way of solving a problem"
"They show logical reasoning; they can document and explain things"
"They stop to think; they learn from reflection"
"They evaluate and make decisions after trial-and-error"

(b) of the work of others:

"They evaluate and analyse each other's work"
"They demonstrate critical thinking about the actions of others"

(2) Consideration of Alternatives

"They investigate new material"
"They discuss alternatives with their peers"
"They look for alternative solutions"
"The categorize information, looking for similarities and differences"
"They try different approaches" (mentioned three times)
"They plan via various representations of a problem"
"They use trial and error"
Chapter 3: Measuring Metacognitive Development

"They look for alternatives and reflect on them"
"They arrange facts in different ways"

(3) Creativity
"They found more creative examples" (x 2)
"There was more creative expression"
"They try different approaches" (x 3)
"They use alternate representations and more creative analysis"
"There is evidence of creative thinking"
"They generate new ideas"
"They arrange facts in different ways"

(4) Transfer and Extrapolation
"They extrapolated from previous experiences"
"They expanded previous experiences to new situations"
"They generalized to reach a solution"
"They applied personal experiences in new, abstract work"
"They related a new problem to past experiences"
"They could quickly and correctly transfer an idea to similar tasks"
"They reconciled previous experiences with new problems"
"They could select and transfer an appropriate strategy"
"They could transfer newly acquired knowledge, being the goal of learning to being a means of learning"

(5) Seeing New Forms of Representation
"They plan via various representations of a problem"
"They use different language and images"
"They can develop a cognitive map to visualize/organize information spatially"
"They can move from one to another representational system"
"They find new representations"

(6) Debugging
"They can analyse a problem"
"They debug and self-evaluate"
"They can analyse and explain their mistakes"
"They correct their mistakes"

(7) Developing Strategies for Working with Others
"They discuss alternatives with their peers"
"They are more involved in organizing their own activity"
"They construct new tasks for others"
"They collaborate in project development"
"They demonstrate team work and collaborative learning, even with the teacher"
"They work in cooperation"
"There is more discussion among peers"
"They share the work in their groups"
3.3 What Did We Find?

(8) Showing Better Performance

(a) Better results:
"They get the answer faster and more often correct"
"They can produce a report from an outline"

(b) Better questions:
"They ask more questions"
"They are formulating appropriate questions"

(c) Better work habits:
"They find more efficient approaches to solving a problem"
"They develop personal plans"
"They show high absorption in their tasks"
"They synthesize and take notes independently"
"They are more involved in class activities"
"They persist"
"They concentrate, are quiet, and do not waste time"
"There is more involvement"
"They show initiative"
"They find additional material, use a research approach"
"They have high motivation, initiative taking"

(9) Generate or Compare Examples

"They have found more creative examples"
"They provide more examples" (x 2)
"They combine, generate similarities and generalities, and show this by asking good questions"
"They compare"
"They categorize information, looking for similarities and differences"

(10) Planning

"They develop personal plans" (x 3)
"They plan via various representations of the problem"

(11) Problem Solving

"They analyze information" (x 3)
"They integrate concepts and subtasks to accomplish a larger task"
"They make decisions after evaluation of trial and error"
"They plan for and analyze problems"
"They can decompose a problem" (x 2)
"They can integrate parts and sub-solutions"
"They show insight into the levels of complexity of a problem"
"They can explain their way of solving a problem"

This is an impressive list, especially when we remember that these teachers were describing behaviours in nine- and ten-year old students. The list shows a certain amount of convergence (with some overlap) but also clearly that we are dealing with a complex domain. It is not surprising that "a" measurable dependent variable does not seem to have emerged, but the generic consistency of these comments from teachers in 16 countries responding to unstructured interview prompts supports the overall similarity of the
teachers in 16 countries responding to unstructured interview prompts supports the overall similarity of the metacognitive indicators identified by the teachers. Something very good is obviously happening in these classrooms, according to the teachers, but the multifaceted aspect of the good thing makes this something difficult to measure. The teachers perceived it, and were enthusiastic about it, in its various manifestations. But did the researchers agree?

One way to check the convergence of the researchers' opinions with those of the teachers was to compare what the researchers noted as indicators of presumed higher-level cognitive functioning (as noted by them in Form J) with the comments of the teachers (found in Form I). But the researchers differed widely in how much comment they made on Form J, making this kind of cross-check inconclusive in many of the observations. A second strategy we developed to compare the researchers' impressions of indicators of higher-level cognitive functioning with those of the teachers was to take the list of indicators derived from the interviews (given earlier in this section), reorganize them slightly to improve on the redundancy in some of the categories, and then send the list to the researchers (as Form K) with the request they indicate how many of these indicators they felt they observed in the videotaped lessons in which they took part. The analysis in the following section, Section 3.3.2, is that of one of the ITEC researchers, who was given the task of synthesizing the teachers' and researchers' impressions about the appearance of indicators of higher-order cognitive functioning. He made use of both of these strategies in his analysis.

3.3.2. Summary of Teacher's and Researcher's Observations about the Appearance of Higher-Order Cognitive Functioning

Introduction

This report summarizes the teachers' and researchers' observations about the appearance of higher-order cognitive functioning in the ITEC Phase I study. Three observations were undertaken in each participating class in this Phase. After each observation, the teachers were interviewed and asked to comment on what they felt were examples of children's behaviour with the computer use that demonstrated higher order thinking or problem solving (Form I). The researchers were also asked to comment and respond to two separate questionnaires (Forms J and K). This preliminary report is based on data collected from 12 countries (Canada, China, Costa Rica, France, Hungary, Mexico, The Netherlands, New Zealand, Romania, United States, USSR and Zimbabwe). Observations form 44 lessons in which computers were used (from 16 classes) were collected for analysis.

Were there any higher-level cognitive functioning skills displayed?

From the 44 observations undertaken by the participating teachers, the majority (91%) reported that indicators of some higher-level cognitive functioning skills were observed in these classes. Higher-level cognitive functioning skills were not observed in only four observations. In general, the researchers concurred with the teachers' observations, although in nine instances they gave some slightly different responses and provided additional comments. No formal evaluation procedures (e.g. tests or written activity) were used during or after the observations to solicit information on the acquisition of higher-order thinking skills, although in five lessons involving computer use, performances tests and informal interviews were conducted.

What were the higher-level cognitive functioning skills displayed?

In addition to the open-ended questions on the characteristics of higher-level cognitive functioning skills displayed in the lessons that used computers, the researchers were also asked to respond to a list of ten indicators of higher-level cognitive functioning, indicating to what extent were these indicators were displayed in the computer-use sessions (The answer alternatives were: "generally, no"; "can't say"; "yes, for some students"; and "generally, yes"). These indicators included: (1) Relating a problem to a previous problem; (2) Formulating appropriate questions; (3) Trying alternative approaches; (4) Evaluating one's action; (5) Analyzing problems; (6) Recognizing relationships; (7) Generating new ideas; (8) Synthesizing information; (9) Observing central issues and problems; and (10) Comparing similarities and differences. The results are summarized in Table 1.
### Table 1: Higher-order cognitive functioning skills displayed

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>(1) Generally No (%)</th>
<th>(2) Can't say (%)</th>
<th>(3) Yes, for Some students (%)</th>
<th>(4) Generally Yes (%)</th>
<th>(5) Total (3)+(4) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Relating a problem to previous problems</td>
<td>16</td>
<td>12</td>
<td>32</td>
<td>40</td>
<td>72</td>
</tr>
<tr>
<td>2. Formulating appropriate questions</td>
<td>24</td>
<td>0</td>
<td>64</td>
<td>12</td>
<td>76</td>
</tr>
<tr>
<td>3. Trying alternative approaches</td>
<td>24</td>
<td>8</td>
<td>36</td>
<td>32</td>
<td>68</td>
</tr>
<tr>
<td>4. Evaluating one’s actions</td>
<td>21</td>
<td>0</td>
<td>37</td>
<td>42</td>
<td>79</td>
</tr>
<tr>
<td>5. Analyzing problems</td>
<td>12</td>
<td>8</td>
<td>44</td>
<td>36</td>
<td>80</td>
</tr>
<tr>
<td>6. Recognizing relationships</td>
<td>13</td>
<td>33</td>
<td>29</td>
<td>25</td>
<td>54</td>
</tr>
<tr>
<td>7. Generating new ideas</td>
<td>32</td>
<td>28</td>
<td>28</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>8. Synthesizing information</td>
<td>17</td>
<td>21</td>
<td>33</td>
<td>29</td>
<td>62</td>
</tr>
<tr>
<td>9. Observing central issues and problems</td>
<td>20</td>
<td>8</td>
<td>40</td>
<td>32</td>
<td>72</td>
</tr>
<tr>
<td>10. Comparing similarities &amp; differences</td>
<td>16</td>
<td>56</td>
<td>12</td>
<td>16</td>
<td>28</td>
</tr>
</tbody>
</table>

Column 5 of Table 1 shows that the majority of the researchers have observed some students displaying higher-level thinking behaviours in the computer-use classes. In fact, only three indicators of higher-level cognitive functioning (comparing similarities and differences, generating new ideas, and recognizing relationships) occurred in less than 60% of the classes.
However, most of the indicators were not generally found (refer to Column 4, Table 1) in the computer-use classes (from 12% to 42%), although it is noted that computer use was particularly conducive to evaluating one’s actions (42%), relating a problem to previous problems (40%), and analyzing problems (36%). Computer use was less helpful in generating new ideas (12%), formulating appropriate questions (12%), or comparing similarities and differences (16%).

Several teachers and researchers provided comments on the contexts where these higher-level cognitive functioning skills occurred. These comments are categorized under the ten indicators in the following sections.

1. **Relating a problem to previous problems**

   Forty per cent of the respondents in this study reported that this higher-level cognitive functioning skill was generally seen in the computer-use environments (refer to Column 4, Table 1). When learners are given a problem to solve, it is important for them to understand the problem in order to solve it. As pointed out by the Russian researcher, students usually failed to solve their problem in their first attempt and they had to go back and try to understand the problem. One way to better understand the problem is to relate it to previous problems, or to relate it to one’s previous experiences. Several researchers in this study pointed out that learners in a computer-use environment were able to relate their own concepts to the computer programs they were using. For example, in the New Zealand class, when students were engaged in the setting up of a database, they used their personal experiences (i.e., their visit to the beach to see what was washed up by the tide) to establish key word processes for the database development.

   In the Canadian class, students were involved in a new activity which was not familiar to them (i.e., accessing clip art drawings and incorporating them into a HyperCard stack). It was pointed out by the researchers that students would need to use analysis skills to figure out what was expected form them and reconcile it with their previous experience. They then needed to determine the best way to take their experience and apply it to the new situation. It was suggested by the researchers that any student who could successfully complete the task on his or her own would have displayed behaviours that could be examples of higher-order cognitive functioning or problem solving.

   One efficient way of tackling a problem is to represent it in another way. In several programming situations in this study learners were seen using aids to represent their problems. For example, students in a French class used notes and diagrams to represent their problems and do their initial planning before programming in Logo.

2. **Formulating appropriate questions**

   This higher-order cognitive functioning skill was not generally seen (refer to Column 4, Table 1) in the computer-use classes (only 12%) although it was reported that some students (refer to Column 3, Table 1) did display this skill in traditional-curriculum classes (64%).

   The New Zealand team commented that in the construction of a database the students did formulate good questions and tested these questions at the computer. It was suggested that to pose appropriate questions students needed to come up with a plan of attack, and to find out which key words should be used to obtain the information they wanted.

3. **Trying alternative approaches**

   Thirty-two per cent of the ITEC researchers reported that in general (refer to Column 4, Table 1) this higher-level cognitive processing skill was observed during the study while 24% reported that it was not observed at all. The researchers form New Zealand commented that discussions following each computer session seemed to show that children had recognized the importance of trying alternative solutions to problems. Similar comments were given by the French researchers who reported that students seemed to search for a better or more economic solution than the one which already been found. In one of the French classes the students defined their goals and discussed alternative solutions to reach the goals. This higher-level cognitive functioning skill was also observed by the Hungarian teachers and researchers. According to them, when a task was given to a group of students, two or more solutions were readily given and there were critical discussions within the group, involving reflection about the procedures proposed by different children. The Chinese research team also reported similar findings.

   Also, students used different methods to achieve their goals. For example, in a Russian classroom, the method used by the boys was different from that of the girls. The following excerpt illustrates this:

   T: What troubles do you have?
   B: I’m trying to understand where in the procedure I have made a mistake.
   T: How are you developing the program?
   B: I divided it into parts: wheels, windows, etc.
   T: In your opinion, what is the best way to develop a program....
   B: First I should divide the picture into parts and now I’m trying to combine them with the help of the special procedures.
The teacher turned to the girls.

T: How are you developing a program?

G: We decided it was better not to divide it into parts but work it out at once as a whole.

4. Evaluating one's actions

Self-evaluation was one of the most commonly observed behaviours in this study. Forty-two per cent of the observers reported that this behaviour was generally (refer to Column 4, Table 1) observed in the computer-use classes.

The Hungarian researchers reported that many children in the study were able to monitor their own work, checking validity and generality of solutions and to comment on such analyses. Also, several children were very good at evaluating the work done by their classmates, in both structure and content.

5. Analyzing problems

In general, the computer-use lessons were quite conducive to planning. In 36% of the classes this skill was generally observed (refer to Column 4, Table 1), and the figure increased to 80% if classes where only some students (refer to Column 5, Table 1) displaying this skill were included.

Several researchers observed that some students had expressed the notion of goal achievement. For example, some French students had clearly established their goals of finding or transferring Logo primitives in their computing activities. In Russia, it was also reported that students achieved their goals by coordinating the solutions of various sub-problems. For example, initially some students tried to construct one long program. To them, dividing the task into sub-tasks (problem decomposition) was extra work. But they failed to debug the program and finally came to realize that they should deal with one part of the program at a time, e.g., constructing a picture of a fantastic creature’s head instead of the whole creature.

It was also noted that in analyzing their problems, many students used trial and error. For example, when New Zealand students use "Transylvania", a problem-solving program where the user is to rescue a woman who is trapped inside a statue, they mainly used trial and error methods. However, as their confidence increased, they started formulating plans.

Another example, give by the Canadian researcher, showed that the computer-based environment was conducive to problem solving. The computer-use lesson required the students to select six words to describe themselves to an alien visitor. It was pointed out that students needed to analyze what kind of things described a person and what characteristics made him or her unique as an individual or a culture. Students also needed to use analysis skills to figure out what was expected of them and reconcile it with their previous experience. They were also using a new computer skill in this activity—combining the paint and draw modes of the program "Superpaint" to create a picture. They needed to determine the best model for each part of their picture and synthesize their experience with each mode individually to make the combined picture. Another activity involved collection of data, analyzing it, and then creating a bar graph to display the results. Again, reconciling their previous experience with what was expected for this activity and required analysis and higher-level cognitive functioning. Analysis would also be needed to ensure correct size of the different bars on the graph to best represent the data.

6. Recognizing relationships

Only 25% of the researchers reported that this skill generally (refer to Column 4, Table 1) occurred in the computer-use sessions. No specific comments were given by teachers or researchers about this metacognitive skill.

7. Generating new ideas

This was the least commonly observed higher-level cognitive functioning skill in the study. As many as a third of the researchers reported that they had not seen any indicators of this behaviour in the observed classes, while only 12% reported that this skill was generally displayed (see Column 4, Table 1).

Of the few comments in this category reported, the Mexican researcher noted that some students in their class brought new ideas and got involved in a positive and active way in the class project. The Hungarian researcher also commented that several children were clearly able to construct new tasks for themselves or for other students.

8. Synthesizing information

Twenty-nine per cent of the ITEC researchers reported that the students, in general (refer to Column 4, Table 1) did synthesize information in the computer-use sessions (but 17% reported no indicators were observed).

An example was given by the Hungarian researcher. He reported that consideration of and comparisons among alternatives for solving a problem were given by the students, such as choosing different values for a parameter in drawing a rectangle, or assembling parts in the more complex task of drawing the "Castle with Towers". The students also synthesized sub-routine procedures in making up the entire program in order to draw the Castle.
Chapter 3: Measuring Metacognitive Development

9. Observing the central issue and problem

Thirty-two per cent of the ITEC researchers reported having generally observed (refer to Column 4, Table 1) this higher-order cognitive functioning skill in their classes.

An example was given by the New Zealand researcher. Again, the students were using "Transylvania". The group tried to establish a plan and the teacher asked them whether they had made a decision about their problem. From this he was able to find out that the students did have an ultimate aim: the group was determined to "get rid of the werewolf."

10. Comparing similarities and differences

It seems that it was difficult to observe this skill in the study. The majority of the researchers reported 'can't say' (56%) when asked if they noted indicators of it in the lessons they watched. Only 16% of the researchers reported that this behaviour generally occurred (refer to Column 4, Table 1) in the computer-use classes.

The only comment on this category came from the Netherlands where the research team reported that the students were able to combine information and generate similarities and relations between information. The students showed this by posing the "right" questions when combining information.

Other observations

Besides these ten indicators of higher-level cognitive functioning, additional indicators were also suggested by the teachers and researchers.

New strategies for working with others

There were various comments made by some ITEC researchers regarding working in groups. For example, the Romanian researchers commented that students working in groups provided stimulation to other members. They explained to other pupils within the group their mistakes when each pupil's results were analyzed. As a result, the group succeeded in performing the task in a minimal number of steps and spending less time per move. Similar comments were also reported by the French researchers.

Motivating factors

The learning environment was a highly motivating one. For example, in Costa Rican classes it was reported that some students were active, concentrated, and did not easily give up. They showed interest and had initiative. They worked quietly and did not waste their time. Some of the children were very motivated; they brought materials and books to the class without being asked by the teacher. They enjoyed their work, and became very self-confident.

Concluding remarks

From the data collected from the Phase 1 study, there appears to be no doubt that computer use is related to the acquisition of higher-level cognitive functioning. However, it is not yet clear under what conditions computer use is most effective. Also, a few methodological concerns were raised by some researchers.

The role of the teacher

One researcher commented that no higher-level cognitive functioning skill was observed in his component of the study because the teacher had never really thought of using the computer program (in this case the Logo language) to help students develop these skills. If the teacher had more knowledge about computing the result might have been different.

The importance of the role of the teachers was pointed out by another researcher. He suggested that computers were excellent tools with good teachers and a bad and expensive tool with not-very-good teachers. A good teacher could help students develop higher-order thinking with or without computers. But with computers it would be easier and faster, for a good teacher. The computer "helped" (not performed alone), but it was the teacher who made the difference. The big challenge is to find ways to use the computer to make better teachers and better education.

Methodological considerations

It was pointed out that it was unclear how to measure gains of higher-level cognitive functioning skills in this study. Some researchers suggested that if the students have successfully used a computer program or performed the required computer-related tasks (in terms of efficiency and effectiveness) they must have acquired the necessary computer-use skills. This may be correct if the researchers have conducted a task analysis and are sure that certain cognitive skills are involved in the problem-solving process. There was little indication that any task analysis had been performed. Also, very little verbal information was solicited from the students (e.g. interviews, protocol analysis) to confirm gains in these skills.

Another concern was how to attribute the gains of higher-level cognitive functioning to computer use even when these gains (or at least indicators of them) were observed in the computer-use classes. In at least
one country the researcher noted that the participants chosen by the classroom teacher had already displayed higher-level cognitive functioning skills in other lessons. It was therefore difficult to evaluate the outcome of the computer use unless adequate baseline data on the problem-solving abilities of the participants was obtained.

3.3.3 Impressions from the Videotapes

In addition to the sorts of lists, tables, and cross-checking that we have described in the previous sections of this chapter (Sections 3.3.1 and 3.3.2), there is also something that can be said about the "results" of the efforts to find a measure for children's metacognitive development in the context of school use of computers. Impressions gained from many different views and discussions of the videotapes by the co-principal researchers are also available. These impressions fall in three main points.

Something "good" is happening in these computer-using classes. A dominant global impression from looking at the videotapes is that these look like happy and productive learning situations. Another dominant impression is that the teachers are good teachers, they are in turn with the students and the students with them, and the students are pleasantly absorbed in learning. All these phrases beg concrete definitions, as difficult a problem as providing concrete indicators of "higher-level cognitive functioning", but after two decades as a professional educator, one can feel reasonably confident that one identifies a positive learning climate even if its characteristics are difficult to itemize. These are happy and productive classes. Probably this is not because of the computer use, but more fundamental to something about the teacher and the school and the community themselves. There is no way to say, given the entry point for our study, classes where computer use was already going on, and where the teacher had acquired a reputation for "doing good things" with computers and children. However, at least it can be said that young children absorbed in computer-use activities are not, apparently, unhappy or operating in unsocial ways or as robots not in control of the learning situation (all fears which have been expressed about computer use in schools for primary children). No indicators of these kind of negative things were visible in the videotapes.

Measuring the "something good" is still difficult. We have some encouraging convergence toward visible indicators of presumed higher-level cognitive functioning, and teachers and researchers in many different parts of the world have come up with the same types of indicators in very different cultural and physical settings. This suggests a convergence is occurring, the sorts of "good things" that a teacher in one country perceives accompany computer-use activities in school would likely also be perceived as "good things" in another country. However, this is hardly the same as finding a dependent variable, valid and reliable enough to give sensitive measures of growth and development.

There seems to be only one consistent contextual variable associated with the "something good"—a good teacher. The videotapes and forms make it abundantly clear that there is no particular "rule" to follow with respect to computer use in school and young children. We have seen many different kinds of lessons, computers, software, student-computer use patterns, and student-student interaction patterns—it didn’t seem to matter. Perhaps researchers only sent us tapes where positive classroom environments were perceived (but we had no indication of anyone redoing or rehearsing an observation session), and certainly from our selection procedure of participants for Phase 1 we had by definition good teachers and school situations. So we cannot say anything about factors that lead to negative or no indicators of metacognitive development. But, it is encouraging to be able to say that "At least some teachers can do good things with computers and young children, regardless of how much time or money or training or software they might have available". The tapes seem to support this conclusion.
Chapter 3: Measuring Metacognitive Development

3.4. Reflections on the "Quest for the Dependent Variable"

By: G.M. Habermann, Hungary

Did ITEC succeed in its "quest for the dependent variable" - in finding a method for measuring the impact of computer use in schools on children's metacognitive development? In the first the following two sections, one of the ITEC researchers says "no:. The last section says, "well, no, but....".

3.4.1. Methodological Comments

Higher-level cognitive processes and abilities

One of the declared aims of Phase 1 was to study higher-level cognitive processes. The measurement of such processes may indeed be the prerequisite of assessing anything like (higher-level) cognitive abilities, aptitudes, or skills. The cognitive abilities, or "levels of development", were the chief dependent variables in the overall model interconnecting the sets of variables to be measured in the Project and the assumed relations among them.

It seems that observational data (taking 'observations' in the classic sense of personal observers categorizing occurrences of events they perceive, or more contemporary ways of using audio or video recording to allow repeated observation) are not sufficient to prove cognitive processes.

The problem has several interconnected aspects:

- Although some overt performances clearly necessitate the execution of underlying cognitive processes, observational data concerning these performances are usually too coarse-grained to prove either the presence or the structure of processes. For instance, if 'recognizing relationships' is a higher-level cognitive process we may almost be sure that a child successfully writing a LOGO program to draw a plane figure (similar to one exposed to her or him before) has at least once recognized a relationship. She or he has in fact had to do this several times (in estimating the relative lengths of sides, in estimating their relative positions, in evaluating whether the procedure has given an output similar to the figure exposed as a task, etc.). But we can never be sure if he or she actually executed any of these cognitive operations or processes.

- In a naturalistic observation setting there is no possibility to acquire data of the same format for each individual, not even the raw data of the above kind. E.g., we may see that a child tackled or solved a problem in a given away, even may have her or his introspective report, but not have the same data for all children.

- Any overt behavioural episode can have a number of alternative mental explanations. Although this is partly true of experimental data as well, in a naturalistic observation there is great room for uncontrolled and irrelevant explanations. A specific task solution may, e.g., constitute a manifestation of a higher-order cognitive process for an individual child if the solution is not retrieved in total from memory, if it is not secretly provided by a classmate, if it is not resulted by using a faulty strategy accidentally leading to an acceptable outcome, and so on. There is no way in observational data to exclude these non-pertinent, confounding explanations.

It seems that observational data have to be complemented by less natural but more confirming data.

In the last few years, cognitive science came to work almost exclusively by highly controlled laboratory experimentation and (computer) process simulations. This applies to complex reconstructions of what happens when a skilled versus non-skilled individual solves problems on a non-verbal intelligence test (see, for example, Carpenter and Just's findings concerning Raven's Progressive Matrices), or to multi-level models of natural language understanding. The same research methodologies appear in cognitive studies concerning computer-assisted learning and educational computing. For instance, LOGO understanding and the use of LOGO commands in children has been investigated by Mayer and Fay by building multi-level operational models, using different approaches for what seems to be different (individual) levels of competence. The empirical confirmation of such models needs data going beyond observation in natural settings. These may be from paper-and-pencil tests with carefully designed stimulus material and instructions, but better might be laboratory experiments with measured responses like reaction time or eye fixations.

It will of course depend on the resources of the ITEC project whether we can go far in collecting experimental data. It appears however desirable to adopt a theoretical position that naturalistic data should be complemented by data collected from individual children in standardized and controlled measurement settings.
Prediction of cognitive development

Let us assume now that we have found a satisfactory way of measuring cognitive processes and abilities. If we have also been successful in finding some well-specified cognitive constructs (process or potentially) we shall be in a position to measure relevant variables to be predicted by circumstances of computer use.

The present way of collecting data may however endanger the study of determination. Irrespective of the complexity of predictors, their individual or joint effects will influence cognitive development over a period. This period is characterized by:

- a beginning with non-zero levels of cognitive development;
- influence from non-measured determinants inevitably affecting cognitive development.

It is questionable if we could produce any solid results in the absence of:

- controlled measurement of the same cognitive variables at the beginning and the end of the period (i.e. pre-testing and post-testing);
- the inclusion in the measurement of groups which are probably (or certainly) distanced from the influence of variables most relevant in our model as predictors.

A multivariate design having several sets of variables seems to relativize the weight of these preconditions. This impression may however be misleading.

- There appears to be no way of compensating statistically for the absence of start-level data. The end-of-period output cannot be made a dependent variable of a predictor system (of any complexity) if start levels had not been assessed. The presence of some cognitive performance at a given point of the time is useless in a model where determinants of cognitive development are involved.

- The problem of so-called "control groups" seems to be more equivocal. In contemporary multivariate methodologies like multiple regression, factor analysis, discriminatory analysis, or linear equations models (including path analysis) there seem to be ways of estimating the predictive strength of sets of variables without having a group devoid of all "experimental" treatment.

The adoption of research strategies has however to rely on considerations concerning possibilities of quantifying widely differing international practices. It seems that the ITEC Project - with no a priori constraints whatever on which kinds of computer use are intended to be studied - will comprise a multitude of different settings and contexts. Many of the differences will probably lend themselves to categorisation only (leading to nominal scales for many predictor variables) and not ordinal or interval measurement levels. It is to be seen how strong interpretations the multivariate results permit but it might be advisable to let ourselves a path to say something about the effects versus non-effects of computer use (even in the absence of well-interpretable coefficients). In my view, each participating nation would act wisely if included several experimental (computer use) programs and several classrooms in which no computer-associated programs are taught. With age level fixed, the computer education programs and the familial backgrounds of children's groups should be as diversified as possible within each participating country.

Transferability and generality of outcomes

The working documents of this Project have listed cognitive variables at different levels. This list may now be revised in view of:

- actual educational or instructional programmes studied in participant countries during Phase 1, and their probable cognitive outcomes;
- claims in international literature to the transferability or convertibility of outcomes of computerized education.

In the case of LOGO, studied in the Hungarian constituent study, for instance, a significant part of the research literature claims wide transferability (although some specific studies disprove it). There is at least the possibility that abilities (aptitudes, skills) of 'thinking' or 'problem solving' targeted by specific educational programmes may be conceived quite generally. This would mean that effects of some computer-assisted programmes and activities would not only extend to thinking or problem solving in the curricular domain but to many other, unrestricted, contexts and domains.

If this is accepted the question will be raised if we had better measure the most general - and most reliably measurable - cognitive processes and potentialities (abilities, aptitudes, skills) rather than processes and potentialities traditionally associated with the behaviours shown on particular video recordings.

One of the interesting possibilities in this respect is the study of syntactic and semantic processing in natural versus artificial language comprehension. Modern psycho-linguistics has amassed a wealth of models and data on language comprehension. This is an area where experimental designs and measurement techniques became very advanced and there are great numbers of measurement solutions we could borrow. Language
comprehension processes (especially those at or above the lexical level) are general in the sense of penetrating almost every interpersonal and educational activity. At the same time, typical uses of computers in education involve some programming language learning and there could be interesting parallels and oppositions in cognitive functioning in an artificial and a natural language setting.

3.4.2. Did We Identify a Cross-Culturally Relevant Way to Measure the Impact of Computer Use on Children’s Metacognitive Development?

Probably, our fairest answer to this question is "No, we didn’t, but we have made a contribution." We doubted from the beginning that there would be a useful way to try to express "metacognitive development", in the range of meanings that educators and society include when they think of the term, in terms of a variable which we could then measure in some sort of pre- and post-test fashion in order to make some comments about "the impact of computer use". Study after study in the educational literature has grappled with this same problem - how to study the impact of a multifaceted innovation in multifaceted social systems such as those found in the classroom, school, community, and culture. Those who end up by choosing one or some variables inevitably only look at a part of the whole system of interest to educators and the community. Those who try to look at the system as a whole drown in complexity. ITEC Phase 1, like the educational research community in general, has not solved this problem.

But we have made a contribution. Our efforts at videotaping and coding and synthesizing our videotapes can help others who wish a richer view of the social system than can come from test scores or text. Our finding that teachers and researchers in many countries around the world perceive similar indicators of what they agree to call higher-level cognitive functioning shows more cultural convergence than we expected. Our list of indicators (see Section 3.1.1) although hardly revolutionary, can be helpful to researchers who wish to start where we left off, and design more controlled studies in this area. Our experiences, both positive and frustrating, based on researchers, teachers, and students from 16 countries all working together on a common problem, should be of interest to others for a number of reasons, methodological, scientific, and human.

In this section, and also Section 3.3.3, we have reflected in particular on one aspect of ITEC Phase 1, the so-called dependent variable issue. In Chapter 4 we turn to a broader perspective, in which the researchers involved in ITEC Phase 1 provide a wide variety of comments and reflections on the overall project.
CHAPTER 4: REFLECTIONS ON PHASE 1 OF THE ITEC PROJECT

4.1. Introduction to Chapter 4: "Reflections"

In this chapter, the researchers who participated in ITEC Phase 1 contribute their own thoughts and reflections on ITEC. Some of the articles consider Phase 1 as a whole, others reflect a national perspective on participation in ITEC. The 12 articles in Section 4.7 are in this latter category. Each of the leaders of a national research team was asked to contribute a reflection about the project, organized around a number of common themes: (a) motivation for joining the project; (b) observations related to the community, school, teacher, and class involved in ITEC; (c) description of the computer-use lessons; (d) reflections on observed behaviours assumed to be associated with higher-level cognitive functioning; (e) reflections on ITEC's research questions; (f) overall reflection on Phase 1; and (g) recommendations for a follow-up to ITEC Phase 1. The eleven teams who contributed these reflections show an interesting diversity of perspectives.

In contrast, the reflections in Sections 4.2 through 4.6 are comments on the overall project, but from the point of view of an ITEC researcher or researchers who was asked by the project to prepare an analysis around a particular overall perspective. These five sections will also appear in UNESCO's Prospects journal.

Section 4.8 is a summary reflection on the entire chapter.

Chapter 4 has been designed so that it could be read independently of the rest of this Final Report. Thus there is some repetition in some of the sections for the reader who has already read Chapters 2 and 3 of this Final Report of the ITEC Phase 1 study. However, the content of the articles is predominantly reflections on the ITEC experience; the reader who is familiar with this experience (through reading this Final Report) will find the sections much more meaningful than if they are read without this context. The researchers reflections on the issues in Phase 1 and their recommendations for subsequent research of this type are particularly interesting.

4.2. Cross-Cultural Assessment of the Impact of Computer Use in Education: Reflections from the ITEC Project

B. Collis, Netherlands, and A. Jablensky, Bulgaria

The ITEC Project (Information Technology in Education and Children) is a longitudinal, cross-cultural study of the relationships between different types of computer use, different types of school settings, different patterns of social interaction in the classroom, and children's higher-level cognitive functioning. In this paper, we briefly outline the ITEC project, its goals, and some of the insights emerging from the 16 countries participating in the project. Our primary consideration in this article however is more general: What are major issues in conducting cross-cultural research about technology in education? Is such research valuable? We use our experiences from the ITEC Project to reflect on these questions.

4.2.1. Introduction

Information technology, involving the application of computers in the educational setting, is perceived by educators and the public in countries throughout the world as capable of having a significant effect on the developing child. The study of this effect - what mediates it and how it may be channelled to the best advantage of the child - is a topic of major interest to researchers, teachers, and educational decision makers throughout the world.

Despite this extensive interest in the use of computers in education, it remains difficult to draw conclusions from the experiences which are occurring. Partly this is because the field of information technology is continually changing in its characteristics; partly it is because "the effect" of computer use cannot be expressed in a straightforward fashion, but instead must be considered in the context of the

(1) This article also appears in the UNESCO journal, "Prospects"
Reflections on Phase 1 of the ITEC Project

complicated network of variables in which the use is embedded (Collis, 1988; McGee, 1987; Salomon, 1990). These variables include characteristics of the computer use itself, such as software types and design aspects, as well as hardware variations. They also include variables related to various characteristics of the students and teachers involved, and of teacher decision making, including how effectively the teacher integrates computer use into a meaningful learning experience for the child. The social interaction between student and student and between teacher and student also influences the impact of computer use in school (Feldman, 1989; Tharp, 1989). In addition, school, regional, and national culture also are part of the system of influences as culture in its various manifestations embeds and shapes the system and the subsequent "result" of computer use.

4.2.2. The ITEC Project

Despite these and many other problems involved in conducting credible research into the impact of computer use in schools on children, there is consensus that such research still must be done - but it must be done in a way that is sensitive to the system of variables that shape and are shaped by it. In response to this challenge, UNESCO, the Bulgarian Ministry of Science and Higher Education, and other sponsors representing researchers in 19 countries have collaborated in the "ITEC Project". ITEC stands for "Information Technology in Education and Children". ITEC formally began in May 1988 at an international meeting in Bulgaria initiated by UNESCO and finished its Phase 1 analysis and reporting in early 1992. Sixteen countries have been actively involved throughout the study as settings for school observations.

4.2.3. Conceptual Framework and Goals of the Study

The conceptual starting point for the study was derived from the theoretical work of the Russian psychologist, Vygotsky. Vygotsky emphasized the important role that social interaction plays in cognitive development (Gallimore & Goldenburg, 1989; Vygotsky, 1978; Wertsch, 1985). Vygotskian theory gave the project its rationale for the expectation that computer use in the social context of the school and cultural setting can affect the child's higher-level cognitive functioning (see also, Perret-Clermont & Schubauer-Leoni, 1989). Vygotskian theory also underscores the necessity of studying the complex of variables pertaining to teacher and student interaction with regard to computer use in any consideration of the eventual effect of such use.

Research questions. The ITEC Project addressed the following research questions:

- In the context of various combinations of background variables, under what combinations of
  - characteristics of computer use,
  - social interaction surrounding computer use, and
  - instructional integration of computer use
  is a positive impact on children's higher-level cognitive functioning more likely to occur? How do these sets of conditions vary in different cultures and countries?

In order to address these complex questions, particularly in a cross-cultural study, ITEC was divided into two phases, the first of which was focused on instrument development and cross-cultural validation, and also conceptual sharpening of what is meant by "higher-level cognitive functioning" in field settings. Thus Phase 1 of ITEC (1988-1992) also addressed the following auxiliary research questions:

- In the context of children using computers in the classroom, what are measurable or at least observable indicators of presumed "higher-level cognitive functioning"?
- Do these indicators vary cross-culturally?
- If the cross-cultural variation in the observable indicators is not too great, can a reliable methodology, usable in countries around the world, be found to measure their appearance and change over time?

Project organization. Arriving at these questions took compromise and much discussion over a series of international meetings, held in Bulgaria between May 1988 and November 1989. A first invitation to participate in the Project was extended during the UNESCO International Congress "Education and Informatics: Strengthening International Cooperation", held in Paris in April 1989. The Project identified its Co-Principal Investigators, a six-person scientific steering committee, a methodological adviser, and Chief Collaborating Researchers and their teams in 17 countries: Bulgaria, Canada, China, Costa Rica, France, Hungary, Israel, Japan, Mexico, Netherlands, New Zealand, Portugal, Romania, Russia (then the USSR), Sweden, the USA, and Zimbabwe. By the end of 1989 procedures were in place for systematic observations, interviews, and various sorts of data collection which subsequently took place in a total of 24 schools participating in the Project. Data were collected through 1990, involving 665 nine- and ten-year old students, and 27 classroom teachers. Although the students involved in the study were not exceptional, the teachers were carefully selected as representatives of innovative practice with computer use and the nine- and ten-year-old age group.
4.2 Impact of Computer Education: Reflections

A. Jablensky, Bulgaria  
B. Collis, Netherlands,
Reflections on Phase 1 of the ITEC Project

experience with computers, teacher attitude about computer use and about innovation in instruction, availability of computers and usable software, school and community support for computer use, and experience of the students involved with computer use in an instructional setting. A consequence is that we cannot draw causal conclusions from the study; these teachers and schools may have been "different" even before computers were part of the picture. At best we have correlative data. Even a quasi-experimental design was not possible; how should one compare a class, school, and teacher who have experience with computers and young children with a setting where this is not the case? Is it the computer that makes the difference, if differences are found? Probably not.

**Standardized Observations.** Throughout the Project we have sought strategies for synthesizing our observations and experiences. One decision we made was to supplement our various observation and interview procedures with a standardized protocol for videotaping school- and computer-use situations. From this decision, we now have approximately 100 video segments, each of about 15 minutes. The tapes have helped us very much in capturing the environments of the different schools, classrooms, and lessons. However, they have not been as good a vehicle as we hoped with respect to capturing visual "evidence" of presumed higher-order thinking. The teachers assured us "good things were going on" but these sort of cognitive developments are difficult to capture on a naturalistic videotape of the entire classroom setting. The problem of obtrusiveness constantly arose; if the researcher stood closely enough to a group of children to follow what they said and how they interacted and what they did with a computer, how did this affect the nature thinking and problem-solving behaviour of the children?

**Measuring Metacognitive Activity.** Is thinking something one can see? And yet the teachers had, generally only their sensory perceptions to convince them of the metacognitive activity going on, as we were not able to find a cross-culturally realistic and valid test to measure metacognitive activity. This remained a major problem of the study and we believe, will continue to be a problem in other cross-cultural studies - once one moves away from "countable" comparisons (how many computers? what software?) or from comparisons of opinions ("Do you think the students are exhibiting higher-order thinking?") how do we meaningfully abstract mental processes cross-culturally? Every test we looked at appeared to be culturally biased or limited in its representativeness of the construct "metacognitive functioning". We have never solved this "dependent variable" problem, although we believe the clusters of behaviours teachers and researchers in the different countries described as appearing in their target children showed a reasonable convergence.

**Management.** There are many logistic difficulties in conducting cross-cultural research of the sort we attempted in the ITEC Project. An obvious one is finding ways to sustain adequate interaction among the researchers. This is not only a matter of money but also of time and availability. Even if we had had extensive external funding to bring the researchers regularly together (which we didn't), it is not possible for 19 busy professionals to be available at the same time in the same place on more than a few occasions. We wanted experienced researchers with strong reputations in their own countries and the ability to attract local support; such people are by definition busy and involved in many activities and thus they cannot give ITEC (or any one project) top priority over a three-year span. Also, the limited access of some of our colleagues to fast communication or even affordable photocopying and mailing meant long delays in exchange of experiences and in opportunities for midstream synthesis and reflection. Certainly the Project needed a full-time manager throughout its life-span but there were no resources for this, and thus the Co-Chief Investigators also had to be the managers of the project. The radical changes in Bulgaria during the course of the Project made administrative support in Bulgaria impossible to sustain and changes in many of the other participating countries during the life span of the Project also made continuity difficult. We commend all of our colleagues for their sustained commitment to the Project, even in the face of severe local challenges. However, these problems will beset any cross-cultural study that extends over a period of time.

**4.2.5. Contributions and Further Developments.**

Despite our difficulties, we believe we have made a contribution. For the field in general, we have documented examples of good practice with computer use in widely varying conditions around the world, giving encouragement to those teachers with vision and enthusiasm regardless of their local situations. We have made the case that there is no "right" way to use computers with young children, but a myriad of ways, so that fit to local situations can be found. We have shown a wide variety in types of teacher training, in types of software used, in types of facilities available, but in all cases, enthusiastic children apparently happy and absorbed in their learning activities involving computers. Thus no one needs to feel that he or she "must" have certain resources or opportunities in order to enrich children's learning with computers, or that one's culture will be automatically threatened by introduction of computer use (such a threat is, of course, possible; we studied good teachers who had already found ways to use computers that fit into their existing situations. What can happen in less than these optimal situations was beyond the scope of our study).

For researchers interested in cross cultural comparisons, we have a standardized observation and videotaping protocol. In addition, we are pleased to share the resources and experiences of the Project with others considering such an enterprise. In our final report to UNESCO we have reflections from each of the national teams, which offer a particularly rich resource to those organizing other international projects.
For ourselves, we have learned much about each other. We have developed a strong network of relationships over the nearly four years of the Project which has already resulted in a number of other collaborations. We have watched ourselves evolve and compromise and interpret and synthesize. We have seen among ourselves the phenomena of the computer as a stimulus to reflection and creative thinking - the same sorts of phenomena as we saw among the 665 children observed in the study. As with our observed children, we cannot measure the impact of this metacognitive activity in ourselves but we are confident we have grown from it.

4.2.6. References


4.3. International Trends in Computer Use in Elementary (Primary) School

By P. Gabriel, France

4.3.1. Introduction

The ITEC Project, has generated a wealth of information about examples of computer use by nine- and ten-year old children in school settings in 16 countries. One of the resources of this project is a collection of videotapes of classroom computer-using situations in the different countries. In this note we will summarize trends seen in these classrooms with regard to the way computers are being used. The intention of the article is not to summarize the research study, but to use its results to address the larger question—are there guidelines for computer use in school? Do these guidelines differ for developing countries?

In educational systems throughout the world, the decade 1980-1990 has been marked by the introduction of computers linked to a multiplicity of experiences and to the development of a growing body of research. The computer phenomenon has affected many countries, less developed as well as industrial. However, different factors constrain the choices which are being made in education about computer use, and have led occasionally to policy decisions at the state level as well as in the school. One of the goals of the ITEC Project is to examine how differently the appearance of computer use in schools appears in various countries, given these different contexts and constraining factors.

4.3.2. A world-wide sample

As noted earlier (Collis & Jablensky, Section 4.2) 19 countries have, at various times, been involved in Phase 1 of the ITEC Project. This article relates to an analysis of 55 reports and videotapes of computer-use settings involving 21 classes as submitted by 15 of the researchers. The pupils were generally 9 or 10 years old.

These studies were realized during the 1989-1990 school year. The protocol for the investigations included the observation of each class for three “normal” lessons involving the use of computers for some learning activity that the teacher felt stimulated higher-level thinking among the students. The teaching sequences in question were not “special events”. They were planned and delivered by the usual classroom teacher, reflecting what he or she felt to be an effective use of computers as instructional media. The teachers were volunteers, self-motivated, and familiar with conducting the kinds of lessons that were observed. Observations were videotaped and accompanied by reflective interviews with the teachers before and after the sessions.

A complete set of three observations per country and participating class was not always at our disposal or sometimes even when a set was, it had been produced in a form making it difficult to synthesize with the other observations. However, many problems of interpretation have been overcome. This was due to the network of personal contacts which developed among the ITEC researchers and also to the considerably helpful video recordings of the various computer-use settings.

4.3.3. The Teaching Contexts

Is there a preferred instructional setting for computer use that emerges from these observations? A first impression of the data collected in the ITEC Project relates to the great heterogeneity of the observed computer-use settings. It appears notably that the time spent with the computer can range between a few minutes to two hours in any one lesson session. Moreover, the number of computers available also varies, from one system per class to one system per child. However, it seems possible to contrast two dominant forms of computer integration from a physical perspective: the computer in the regular classroom and the computer laboratory.

These forms of integration are not equally employed. For example, in six of our observed lessons, only one computer is being used. In a frontal-class setting, it is put into service in order to present some summary of the course material. In other examples, a single classroom computer is put at the disposal of some group of pupils. The children settle down in front of the machine, individually or in a small group, in turn or after being named by the teacher. With this latter approach, the teacher often is offering a complementary activity to some of the students. Six other lessons involve two computers, but used in the same variety of ways as with a single classroom computer—for demonstration to the pupils or, very often after a demonstration, to put at the disposal of small groups of students.

(1) This article will appear in the UNESCO journal "Prospects". It was prepared in cooperation with Dr. V. Tsoneva, Bulgaria.
In contrast to these kinds of lessons, which take place in the regular classroom, a majority of our observations show the pupils of a class or perhaps half of a class, working simultaneously around the computers in a place especially equipped with a number of computers. The pupils work two or three per machine but seldom alone. In some cases, there are up to six pupils per computer although this is less likely. Often, some pupils are in the computer laboratory while their classmates stay in the regular classroom. This choice requires that the teacher moves back and forth; he or she leaves for some moments the pupils to work on their own, in one or in the other room. It seems as if, for some teachers, the introduction of computers could be the preamble to a greater autonomy in their relationship with the pupils. It is a possibility accompanying an overture toward different learning paths and learning sequences. In general though, we see no “one” preferred arrangement for computer use, relative to number and placement of computers or organization of student access to computer.

4.3.4. Computer Activities and Software

If there is no general pattern as to number or placement of computers, are there trends in the types of computer activities and software appearing in our 16-country sample? Again we can make conclusions about heterogeneity.

In the classes we observed when computers are being used, the involvement of the pupils in the same activity or in activities having an identical goal is far from being the general rule. There is often a difference among the themes of activity going on in the same class: between those offered to the children working with the computer(s) and those offered to the other children. This occurs in a number of our observations. In one, for example, while half of the class explores the field of geometry in the computer laboratory through the use of Logo programming, another group programs a graphic plotter, and a third area another group of pupils prepare, with a word processor, an article for the school newspaper. Of course, this example does not reflect the majority of the observations. Nevertheless, it does illustrate the multi-focus trend and it also suggests the important role played by programming language in our observed classrooms. (in the above example, programming for development of mathematics concepts).

4.3.5. The Software Dimension

A fifth of our ITEC observations relate to lessons that involve specific teaching about information technology. This is mainly realized from programming activities. For the teachers, the aims of these activities are to promote children's abilities in problem solving, or, to familiarize the children with the computer and its "software potentialities" (i.e., insights related to programming or text publishing), or also, to create more or less complex programs which can later be related with the learning of other teaching subjects (i.e., geometry, artistic expression,...). This desire to integrate educative programming into a broader dimension of teaching appears frequently in our observed lessons. Programming is combined with mathematics teaching (10 times), applied to the realization of projects (6), and used in activities in the fields of robotics (2) and music (1). Consequently, the use of a programming language represents nearly 50% of the software use in our observations; 80% of this programming involves the Logo language.

Approximately 25% of the software used in our observed lessons are products especially developed for content-specific teaching. This category of software sometimes offers training exercises (i.e., "drill and practice software") or guidance in knowledge appropriation (i.e., "tutorials"). Drill and practice software are involved in 11 of our observation settings and tutorials four times. Their fields of application are the introduction to information technology (1), civic education (1), mother tongue (5) and mathematics (7).

The remaining 25% of the software used in our observations consists of games (5), software packages such as data bases (4), graphic composition tools (2), and one example of simulation software. This last type of software is used in science teaching. The other software packages are combined with geography teaching, project work, or mathematics. Concerning games, some reasons they are integrated by the teachers are to initiate the pupils to information technology, to arouse their interest, and sustain positive attitudes with regards to computer use. Other reasons for games include the teachers' belief that they can make use of the pedagogical interest the games can present for the development of cognitive abilities (i.e., positioning in space or problem solving) or for a inter-individual approach to problem solving.

Our sample of ITEC observations shows some trends in the organization of lessons involving a computer: there is a marked preference for an amount of machines that will allow the involvement of as many students as possible from the class and a number of children per computer generally below or equal to three. It also indicates that many software potentialities of information technology still seem far away from becoming common. At present, little use of content-specific educational software appears. At the schools in our sample, information technology is, more than any one other application, related to the success of one programming language, Logo. This interest for Logo can be attributable to the low cost of the software and also to the possibility it offers students to acquire some mastery of a powerful technology.
4.3.6. Conclusion

These are trends we have noticed in our ITEC observations. Those we have mentioned, in many aspects, are still to be evaluated in terms of their real contribution to education. This perspective leads us to resist a hasty comment. We cannot say there is a “guideline” which emerges from these observations for other countries or settings with respect to computer use and nine-and ten-year-old children. Perhaps our clearest observation relates to heterogeneity: the computer can be employed in many different ways in different classrooms. This is good news for countries with relatively little resources available for computer use as well as for countries with enough resources to explore different types of computer applications.
4.4. Computer Use in Schools: Reflections on the Impact of Economics, Politics, and Culture\(^{(1)}\)

By M. Murray-Lasso, Mexico

4.4.1. Introduction

This article contains reflections on some influences of economics, politics, and culture on a country’s response to computers in its schools. It identifies concerns related to appropriate technology transfer of educational resources, particularly in less developed countries, and notes that in an interconnected world, respecting each country’s culture and identity is of great importance.

It appears that many countries, both developed and developing, have decided that it is important that they introduce computers into their educational systems. However, the ways computers are introduced will depend heavily on how each country perceives its economic, political, and cultural situation. The cost of introducing computers, acquiring or developing educational software, and training teachers in the use of modern information technology is considerable, and in many countries there are many problems such as feeding the population and caring for its health that have a much higher priority for the use of the scarce financial resources available. In many of the poor countries there is essentially no computer hardware or software industry, thus all resources have to be imported—at very high prices relative to the cost of local products and salaries. In addition, because modern information technology is very heavily dominated by English-speaking countries, most systems software, applications software, documentation, magazines, and journals about computers are in the English language and geared to the culture of the English-speaking society, forcing countries that introduce computers into their educational systems and whose native tongue is not English to work in a foreign language. This in turn contributes to a weakening of the country’s cultural identity. These are some of the problems of an economic, political, and cultural nature that arise in the consideration of the use of computers in schools. We now proceed to analyse each in turn.

4.4.2. The Impact of Economics

Not even the most wealthy countries seem willing at the moment to spend the money required to provide all students with sufficient computers to achieve, say, a five-student-per-computer ratio. It is reasonable to assume that less developed countries will have to do with much higher ratios. With high ratios, either the use of the available computers will be concentrated within elite groups—which is presently the case and is a very undesirable situation—or it will be very difficult for poor countries to achieve sufficient personal interaction between students and machines to be worth the effort.

There are, of course, some possibilities when working with high computer-student ratios, as was seen in some of the ITEC observations. In Mexico, the Federal Government’s program introducing computers into public schools involves placing one computer per school (typically, 800 students). Parallel to this, software is being developed which is specifically designed for group interaction rather than individual interaction. The computer is placed in a special classroom where different groups of students (30 to 50 per group) take turns in using the room. The teacher uses the computer, which has a 36” screen, as a flexible blackboard with which he/she can demonstrate certain topics which are very laborious to do on the blackboard, such as graphing functions, animation, changing the colours of portions of geometric figures when referring to them in proofs, doing “What if?” studies aided by simulation programs, and even drill and practice in which polls of the class are taken and opinions discussed before the correct answer to a question is exhibited.

This methodology seems to work only for teachers that really prepare their class very carefully, studying the possibilities of each piece of software and carefully designing the activities to be performed during each session. But extra preparation time is not available during the work period and teachers’ salaries are so low that many of them resort to second jobs to make ends meet and thus have essentially no time to devote to out-of-hours training. Thus the economic problem is again manifested.

4.4.3. The Impact of Politics

In many countries there is at present a political debate about the quality of education and its importance in surviving world-wide trade competition. Computers in education are argued in terms of their presumed link to economic competitiveness in a global market. In the short term, this could mean concentrating on using the computer to improve productivity, to promote the creation of new products, or to modernize and improve old ones. In the long term, it could mean improving the reasoning and problem solving skills of a nation’s young people. Most probably, the short-term emphasis will dominate and we will see more focus on the use of the computer as a tool to improve productivity, such as with word processors and spreadsheets. As it is also easier to teach students and teachers how to use these sort of productivity tools than it is to improve

\(^{(1)}\) This article will appear in the UNESCO journal, “Prospects”.

265
the thinking skills of students, these applications may be as far as we go with the potential of computers in schools.

Another aspect of the impact of politics in the use of computers in schools relates to international politics. After the collapse of communism in the former East-block countries, the international problems of the world will more and more concentrate on North-South relations, that is, the struggle between the rich and the poor. The inequality between the wealth of peoples in the world is certain to cause grave problems in the future. The use of technology in education has the potential to decrease the gap, but only if care is taken that it be so, because the facts are that the computer and other information technologies are polarizing the groups of people more and more. Just as there is concern about the opportunities in computing for males and females in some countries, a problem which is probably more important is the inequalities between the haves and the have-nots, both internally within a country and between countries. How this situation will evolve is a political matter. However, the problem has a tendency to be self-perpetuating.

4.4.4. The Impact of Culture

The question of language has already been mentioned as a problem in spreading the use of computers in the classroom in non-English speaking countries. Although it is one of the main cultural problems that confront the use of computers in the classroom in less developed countries, it is by no means the only one. To introduce computers into non-Western countries often involves the assumption that underlying Western ideas about competitiveness and efficiency should also be introduced. People with little experience with modern electronic equipment require broad social adjustments to become productive computer users.

More generally, common sense and informal observations make it almost certain that culture has an important effect on the application of computers in education. It is important to find out more about the ways that culture does affect the impact of computers in education—which are the significant variables? which ones can be controlled and which must be accepted in the way they appear naturally? These issues, central to the ITEC Project, are not only important educationally, but also economically as manufacturers of new information technology hardware and software wish to expand the markets of their products and want to know what aspects they need to revise and monitor in exporting a product from one culture to another. We are not only thinking of exporting products from developed countries, but also of the possibility of taking advantage of low wages in countries with idle intellectual resources, such as India and Latin America where educational computer-related materials could be developed at lower costs for world-wide export.

The computer can be an important aid in processes almost universally accepted as healthy for education, such as the decentralization of aspects of education. While admittedly educational centralization can improve cost efficiency (for example, the centralized nature of Mexican education has allowed the government to distribute free textbooks to all public school students in elementary education at a relatively low cost), the world has evolved in such a way that it is indispensable to provide variety, quality, and local appropriateness in education and not merely quantity. Thus current philosophies such as that popularized by Brazilian Paulo Freire in the Latin American region place great importance on popular and regional education as opposed to universal and centralized education. To achieve this, it is necessary to prepare human resources such as researchers, developers, and trainers, with sufficient technical training in each region to take over local development. Technology can be a tool as well as an object of study in this process.

4.4.5. Technology Transfer

The question of appropriate technology transfer has obvious cultural importance. All nations wish to transmit their culture from one generation to the next; this is one of the main purposes of education. Technology has undoubtedly had an important effect on human history, so much so that many periods have been named after the dominant technology of the time—the Stone Age, the Bronze Age, the Iron Age, the Industrial Revolution, and now the Information Age. The computer is of course the principal actor now and any nation that does not participate is doomed scientifically and economically given the current world trends of global interconnectedness. Nations naturally want to participate without losing their identities. The recent wave of resurgence of nationalism and ethnicity is evidence of this. Thus to avoid stagnation and at the same time conserve cultural identity, it is very important to jump into the Information Age with as much knowledge as possible of the way culture affects an educational system's experiences with information technology. In the face of global communications, transportation, trade and economic competition, it is critical to keep respect for the cultures of individual nations and groups, because everyone loses when a culture is lost in the same way that everyone loses in the biological world when a species is lost.

When carefully handled, it appears that the computer because of its enormous flexibility will be able to be adapted to the different cultures existing in the world. The ITEC observations of computer use in 17 countries bear witness to this. No doubt special efforts will have to be made for this adaptation to occur on a wide scale, just as efforts have to be made to save disappearing species of animals and plants. The efforts are justifiable not only because of the importance of saving cultures but also because of overall global stability.
We are not arguing that it is easy to respect culture while attempting to introduce computers in education. Probably the fact that computers have been slow, relative to their spread in more developed areas, in penetrating the educational systems of developing countries and less-developed parts of developed countries is due to either a lack of awareness of the need to respect culture or the unwillingness to do it. In spite of the possible future market potential, very little effort has been made by the hardware and software industry to do what is necessary to make their products suitable for and available to poor countries. Economic, political, and cultural problems present a complex situation for poorer countries confronting policy choices with respect to computer-related technology in education. But their problems and perspectives cannot be ignored by wealthier countries in our interconnected world.
by Kwok-Wing Lai, New Zealand

4.5.1. Introduction

Many feel that a major outcome of computer use in education could be the improvement of students' thinking and reasoning skills. In this article, a reflection is given on this outcome, and is illustrated with observations from the ITEC Project.

4.5.2. Metacognitive Processing and Learning

Within the last decade, there has been a growing interest among educators in the concept of metacognition and the role of metacognitive processing in learning. According to Brown (1981), the term metacognition can be divided into two interrelated components: (a) knowledge of cognition, referring to information about one's own cognitive processes; and (b) regulation of cognition, referring to the planning, monitoring, checking, testing, revising, and evaluating activities necessary to orchestrate cognition. Research suggests that metacognitive skills are important in learning. The skill of self-regulation is particularly important in problem solving because it is not only what one knows, but how to use it that matters.

A great deal of research has been conducted to investigate how students' metacognitive or higher-order thinking skills can be enhanced; some of this research focuses on the use of computer-related technologies as an aid for acquiring these skills. In this note, the impact of the use of computer-related technologies on children's metacognitive processing is briefly considered, making reference to data collected from the international ITEC Project.

4.5.3. Computers and Metacognitive Processing

The recent advent of microcomputers in classrooms has generated an expectation that the use of computer-related technologies can foster the development of children's metacognitive processing and thinking skills. It has been suggested that computers can be used to help students learn how to learn, learn how to set cognitive goals, how to apply effective strategies for comprehension, self-monitoring, and organization of knowledge and problem solving (Pea, 1985). For example, computer tools can display the cognitive and metacognitive processes overtly, thus providing the opportunity for the learners to internalize these processes. As another example, some writing programs have features that provide the learners with metacognitive guidance such as identifying and formulating a topic, organizing and reorganizing their compositions, and finally analyzing and revising them (Kozma, 1987). Salomon, Globerson, and Guterman (1989) also suggest that the computer can be used successfully to provide reading-related, metacognitive guidance to young learners. And there is indeed some evidence to suggest that in certain situations, the computer language Logo (Papert, 1980) can help develop metacognitive skills such as planning and monitoring (Clements, 1986). It seems that computer-based learning environments can be set up to encourage students to think more about their thinking processes.

However, although a great deal of research on the impacts of computers on learning has been conducted, the results are far from conclusive. It has become clear that the impact of computers in education can not be evaluated without taking the wider educational and cultural contexts into consideration (Salomon, Perkins, & Globerson, 1991). Consequently, one of the aims of the ITEC Project was to document the impact of different situations surrounding computer use in schools on the development of children's metacognitive processing.

4.5.4. The ITEC Experience

In the ITEC Project a variety of computer-based problem solving situations were set up in the 16 participating countries to investigate under what conditions computers could be used most effectively in fostering the development of metacognitive skills for young learners. The most commonly used computer tools in this study included Logo, word processing, database applications, and the use of instructional software for problem solving. The comments in this note are based on observations from 44 computer-based lessons in 12 countries.

Ten indicators were used to evaluate whether metacognitive processing skills such as planning, monitoring, and evaluating were displayed by the children in these computer-based learning situations. The indicators chosen were: relating a problem to a previous problem, formulating appropriate questions, trying alternative approaches, evaluating one's actions, analyzing problems, recognizing relationships, generating

(1) This article will appear in the UNESCO journal, "Prospects".

268
new ideas, synthesizes information, observing central issues and problems, and comparing similarities and
differences.

From the study it was found that the computer-based learning environments were particularly conducive
to the skills "evaluating one's actions" (42% of the children observed were felt by their teachers to be
displaying this behaviour when using the computer), "relating a problem to previous problems" (40%), and
"analyzing problems" (36% of the observed children). However, computer use was less helpful in the skills
of "generating new ideas" (displayed by only 12% of the observed children), "formulating appropriate
questions" (12%), or "comparing similarities and differences" (16%).

A few examples can illustrate how computers were used in different educational and cultural contexts
but resulting in similar sorts of displayed behaviours.

Planning. When learners are given a problem to solve, it is important for them to understand the
problem in order to solve it. This is the first step in planning. As pointed out by the ITEC's Russian
researchers, students usually failed to solve their problem in their first attempt and they had to go back and try
to understand the problem. One way to better understand a problem is to relate it to previous problems, or to
relate it to one's previous experiences. Several researchers in the ITEC study pointed out that learners in a
computer-based environment were able to relate their own concepts to the programs they were using. For
example, in the New Zealand class, when students were engaged in the setting up of a database, they used
their personal experiences (i.e., their visit to the beach to see what was washed up by the tide) to establish key
words for database development.

In the Canadian class, students were involved in a new computer activity which was not familiar to them
(i.e., accessing a file of computer graphics and incorporating these into a database). It was pointed out by the
researchers that students would need to use analytical skills to figure out what was expected of them and
reconcile it with their previous experience. They then needed to determine the best way to take their
experiences and apply them to the new situation.

One efficient way of tackling a problem is to represent it in another way. In several programming
situations in the ITEC Project learners were seen using aids to represent their problems. For example,
students in a French classroom used notes and diagrams to represent their problems and to do their initial
planning before programming in Logo.

In general, the computer lessons were quite conducive to planning. Several researchers observed that
some students had expressed the notion of goal achievement. For example, some French students had clearly
established their goals of finding of transferring Logo primitives in their computing activities. In the Russian
classroom, it was also reported that students achieved their goal by coordinating the solutions of various
subproblems. To them, dividing the task into subtasks (problem decomposition) was extra work. But they
failed to debug their programs and finally came to realize that they should deal with one part of the program
as a time, e.g., constructing a picture of a fantastic creature's head instead of the whole creature.

It was also noted that in analyzing their problems, many students used trial and error. For example,
when New Zealand students using a problem solving program, they mainly used a trial and error method.
However, as their confidence increased, they started formulating a plan.

Monitoring and Evaluation. Another metacognitive skill observed in the study was that of trying
different approaches. The researchers from New Zealand commented that discussions following each
computer session seemed to show that children had recognized the importance of trying alternative solutions
to problems. Similar comments were given by the French researchers who reported that students seemed to
search for a better or more economic solution than the one which has already been found. This higher-order
thinking skill was also observed by the Hungarian teachers and researchers. According to them, when a task
was given to a group of students, two or more solutions were readily given and there were critical discussions
within the group, involving reflection on the procedures proposed by different children. The Chinese
research team also reported similar findings. Also, students used different methods to achieve their goals.
For example, in the Russian classroom, the method used by the boys was different from that used by the girls.

Self-evaluation was one of the most commonly observed behaviours in this study. The Hungarian
researchers reported that many children in the study were able to monitor their own work, checking the
validity and generality of solutions and commenting on such analyses. Also, several children were very good
at evaluating the work done by their classmates, in both structure and content.

4.5.5. Concluding Remarks

From the data collected in the ITEC Project, there is no doubt that a computer-based learning
environment is conducive to the acquisition of metacognitive skills. Although it is not yet clear under what
conditions computer use is most effective, there are two factors which stand out as particularly important for
the success of a computer-based learning environment. One is group interaction and the other is the role of
the teacher.
Reflections on Phase 1 of the ITEC Project

**Group Interactions.** It is now generally accepted that group interaction is important to cognitive development and learning (Vygotsky, 1978). In the ITEC Project the benefits of working in groups were mentioned by researchers from various countries. For example, the Romanian researchers commented that students working in groups provided stimulation to other group members. The students explained to other pupils within the group their mistakes when each pupil's results were analyzed. As a result, the groups succeeded in performing the task in a minimal number of steps and spending less time per move. Similar comments were also reported by the French researchers.

**The Role of the Teacher.** The role played by the teacher in a computer-based learning environment is crucial for its success and this has also been emphasized by the ITEC researchers. The teacher needs to integrate the computer activities into the existing curriculum, and coordinate them with other instructional means. Since computer activities are generally organized around small groups of students, the teacher also needs to facilitate and direct the interactions among the groups. The job of the teacher is indeed very demanding in such a learning environment, but the rewards are great.

4.5.6. **Conclusion**

The ITEC Project has provided encouraging evidence of the potential contribution of the computer to the development of children's metacognitive processing. Similar sorts of observations of children displaying behaviours such as planning and monitoring and evaluation in varying cultural settings and educational situations also are encouraging. The ITEC Project has allowed us to study these behaviours in many different cultural contexts; the similarity and strength of the behaviours across cultures reinforces our expectation that the use of computer-related technologies can foster the development of children's metacognitive processing and thinking skills.

4.5.7. **References**


4.6. On the Uses of Computers in Schools: Is the Cup Half Empty or Half Full?\(^{(1)}\)

*by J. Oliveira, Switzerland*

4.6.1. Introduction

In this article, the ITEC Project experiences are used as a basis for reflecting more broadly on issues related to evaluating the impact of new technologies in education. Some of the experience obtained from the use of earlier technologies can help us address questions about reasonable criteria for this evaluation, particularly in the context of how little we can "prove" about the effect of other technologies in education.

How should we interpret the results of the ITEC Project? What have we learned? What new insights did we gain about the ability of using computers to develop higher-level intellectual skills? Are computers being used intelligently in schools? Or is the ITEC Project only confirming that the best we can say about the impact of computers in education is that we do not know?

The response to these questions can be either positive or negative, depending on one's point of view and that types of evidence that convince him, one way or the other. It is similar to asking: Is the cup half full or half empty? This note briefly analyzes two sets of evidence, empirical and historical, to help improve our perception not only of the results of the ITEC Project, but more generally with respect to computers in education.

4.6.2. The Empirical Evidence

Although rich in observational details, the quantitative, measurable, empirical evidence contained in the ITEC dossiers is rather weak by conventional standards. The methodology as carried our by many different research teams in different cultures and settings, cannot be seen as yielding strong measures of effect; the samples are not random or representative of the universe; the data are difficult to synthesize; and the conclusions are preliminary at best. Because of the decision of ITEC to look closely at specific classrooms and teachers, we do not learn very much about the extent of computer utilization in each of the countries, or even within the schools where the observations were made. Much less do we learn about effects on cognitive ability associated with computer use.

But before discussing what we can learn from the ITEC evidence, let us first consider what we know about educating without computers.

4.6.3. What is Effective in Education?

The prevailing paradigm of schooling throughout the world—in the form of one teacher, a set of students, plus a varied quantity of materials (books, notebooks, school libraries, etc.)—appears to be extremely powerful, practical, robust, and time-tested. Yet, are all of us convinced that schools teach? Or that this method of teaching works universally? That it is equally good for all types of students? That it is the best we can do with what we know about teaching and learning? Are we happy with the fact that in spite of over two thousand years of experience with schooling, most students in the best countries only reach the level equivalent of six to eight years of education? Are we happy with the negative externalities associated with this form of learning—learning by being taught—and by the uniform pace of teaching required by this paradigm reflected by the rates of absenteeism, withdrawal, indifference, drop-out and repetition that occur in so many countries? Despite all this, we "know" that teaching as currently practiced is a good method of instruction, don't we?

4.6.4. Technology in Education

Schooling, particularly in developed countries, hardly exists without other inputs. In many countries, for example, textbooks are conceived according to the best available knowledge on instructional design. Many schools use non-conventional grouping and teaching techniques, including modularized and individualized instruction; these innovations derive from the same theories as those on which computer education and computer software are based. Why do we think that the application of these theories to computers would make instruction less effective?

Moreover, as social expectations develop, it would be difficult to conceive that schools could maintain legitimacy by refusing to look into new tools and techniques—particularly those used in the society at large, such as television and computers. Besides, schools are expected to be more flexible and to cater for

\(^{(1)}\) This article will appear in the UNESCO journal, "Prospects".
Reflections on Phase 1 of the ITEC Project

individual differences. How could they accomplish these functions without using alternative instructional techniques?

Finally, the nature of the evidence which convinces different people of the merits of different instructional strategies is far from being set once and for all. Many people are convinced that conventional schools "work"—yet some countries have classrooms with 100 students, no textbooks, and a semi-illiterate teacher and call it a school. Other countries claim that classrooms should have no more than 15-20 students to be effective, and we are to believe that their systems are cost-effective. Others, as in the case of most Western European countries, are happy with an educational system which manages to bring in 15-20% of their students up to the level of the BAC, Maturite, or A-level exams, after a century of implementing mass education for all. Is this a good or a bad performance? Are these school systems cost-effective, or should we not try to ask? Are students reaching their potentials? Are they minimally happy and motivated in these schools? Is there good evidence that conventional education works? Or does it merely maintain the normal distribution of intelligence provided by nature?

Yet, before we are able to answer these questions about conventional education, innovators are being required to give even more precise responses to justify the work of a new technology. Of course, this justification process is a good, methodological exercise, and should be required at some stage. Any changes should be eventually justified—on educational and economic grounds. But is it fair the way this justification is being required now in educational research and policy circles—when computer technology is considered? Is this a effective approach to managing and nurturing change in education? Is this how change, technology, and innovation are approached in other sectors of human life? To reflect on this, let us briefly examine the historical evidence on educational innovations.

4.6.5. The Historical Evidence

Computers are only a new species in a long history of different types of educationally used technologies. Consider 70 years of instructional film, 60 of instructional radio, 50 of audio-visual aids, 30 of programmed instruction, 20 of modular and personalized instruction, as well as the approximately 10 years of experience we have with computers. Are we convinced that any of these technologies "work"? Do we know how the older variants were first introduced into the classroom? Based on existing evidence, should any technologies be used at all in education?

Taking wisdom based on conventional methodologies for educational research as a guide, the answer is probably negative. The previous research comparing different technologies and educational methods is flawed by intrinsic methodological caveats: most researchers finally became convinced that it was impossible to compare different things. Then came the idea of aptitude-treatment interaction, and the difficulties were even greater, with less than satisfactory results. Some economists tried the cost-effectiveness approach to compare technologies, but very few would consider acceptable any evidence that does not match the standards set by Levin and his colleagues (Levin, Glass, & Meister, 1987). A few critics still doubt that they had an adequate sample, or that their results are more convincing than others. In spite of the widespread uses of technologies in training and education, and whatever the quality and nature or the evidence to support its worth, many researchers and decision makers remain unconvinced (Oliveira, 1990).

However, when we attempt to evaluate new educational technologies, are we asking the right questions?

4.6.6. Three Lessons

The historical evidence on the uses of innovations in general seem to teach us three important lessons that can be applied to computers in education, and to interpreting the results of the ITEC Project. First, in order to innovate, one needs to challenge existing wisdom. Otherwise, one does not innovate. Most innovations come before thorough information and certitude is available. Convincing others about the worth of an innovation is at least as important, if not more, than the innovation itself. In many cases innovations come first, and later innovators have to figure out how to use the innovation and prove its worth.

A second, and related, lesson refers to evaluation criteria. When markets exist, as in industrial and service sectors, it becomes relatively easy to know whether innovations are being disseminated or not. In captive markets—such as in education, it is harder to evaluate the reasons why some innovations stand the test of time while others fade away. The recent developments in the productive sector caused by the introduction of high technology into the workplace seem to illustrate that the ability to innovate, and to innovate quickly, is becoming a consideration for survival. Those who are not threatened in their survival—as is the case with most educational systems—perhaps should consider how to emulate such situations, in order to evaluate the degree and relevance of selected educational innovations. Otherwise they may eventually find themselves out of business, even if their business is education.

The third, and more important question, refers to how technologies affect business, and why they do not affect education. This discussion brings us back to the nature and quality of the evidence concerning the effectiveness of introducing technology into education and training. There is sufficient evidence to show that to be effective, new production technologies require substantial modifications in the work place. They way
work is organized and divided, the way workers are recruited, promoted, trained and supervised, the quality of the work place, determine productivity and quality improvements to a much greater extent than introducing technological artifacts per se (Hoffman, 1989).

Applied to the world of education, the implication becomes obvious: technologies are brought into the classroom as an add-on cost to whatever already exists. No wonder that they will never become cost-effective, even though other benefits on effectiveness, motivation, and flexibility are not difficult to demonstrate. Moreover, the costs of innovating, in business firms, are part of the investment, not the operational budget. The education sector never invests more than 1% of its expenditures on R&D in any country. The costs of computers and other innovations are only meaningfully interpreted when analyzed within the long-term framework of investments in R&D, and not on a pay-as-you-go basis. We need different, longer, yardsticks.

4.6.7. New Educational Paradigms

Computer-related educational technologies are part of a new learning and teaching paradigm. Changing paradigms is not trivial—some people had to pay their lives or risk their careers and reputations for it. Changing paradigms is particularly difficult within educational systems. However, the evidence from the cost-effectiveness of training with technologies as well as that coming from more flexible educational arrangements show that education and training technologies can indeed meet broader educational goals with effectiveness and efficiency. Paradigms, however, are slow to change, and it takes more than empirical evidence for this change to happen.

Compared to other educational technologies, microcomputers are making their way into the classroom at an impressively faster rate. When we invest now in implementing computers in the classroom, we are not paying to show results in the short-run; we are paying to learn. Projects like ITEC contribute to an increase in our collective awareness about the potential of these still-new educational technologies, and such projects might eventually add to the evidence about their worth. Meanwhile, projects such as ITEC allow countries and schools to engage in a process of social learning and to learn from each other with respect to promising uses of these new technologies. Thus, in answer to our original questions, although the empirical evidence generated by ITEC may be at best tentative, it is not necessary to judge it, and computers in education, by more stringent standards than we bring to other innovations in education. As a learning experience, we have gained much from it.

4.6.8. References


4.7. Summary Reports of National Participation in ITEC Phase 1

In Sections 4.7.1 through 4.7.12 appear the summary reports of 12 of the countries participating in ITEC Phase 1. Each report contains the researcher's responses to key questions of the study, including reflections on methodology, on results, and overall ITEC participation. The sections end with recommendations for subsequent research studies of the scope and ambition of ITEC.

4.7.1. Summary Report of ITEC Participation, Phase 1, Canada

By L. Francis & L. Ollila, Canada

Motivation for joining the project

The Canadian team for the ITEC project was headed by Lloyd Ollila of the University of Victoria. As one of the co-principal investigators, Betty Collis, was a former faculty member of the University of Victoria, Lloyd Ollila was invited to head up a team to represent Canada in the ITEC study. Victoria was also a suitable choice for a Canadian participant as one of the elementary schools in the area is an Apple Centre for Innovation and has been actively involved in computer use for several years. Participation in the ITEC project not only allowed the researchers access to a classroom actively involved in computer use, but provided the participating elementary school with information they could use to fulfill their commitment to Apple Computer as an Apple Centre for Innovation. Researchers were able to not only collect the data requested as part of the ITEC project, but also data relating to questions not directly addressed by the ITEC study. For example, data were collected to examine the impact of computer games on students' computer use and higher-level thinking skills. Interviews were also conducted with the students as they worked at the computer to attempt to study the metacognitive aspects associated with computer use, and data were collected from both the group of students participating in the ITEC project and from a control group to examine the influence of technology on the writing process. Thus, the opportunity to address several questions of interest to the researchers as well as to learn from what other countries are doing were the main motivating factors in joining the ITEC project.

Description of the community, school, teacher, and class

Victoria, the capital of the province of British Columbia, is a small city located on the southern tip of Vancouver Island. Most people in the community are of white, Anglo-Saxon origin, although there are major subgroups of Chinese, Indian and native origin.

Students in Marigold School reflect these general population groupings. Students come from homes whose economic structures range from upper middle class to poverty level with the school mean being also the national mean. Marigold has a heterogeneous population. Students score right about at the national mean on all tests, both academic and socio-economic.

Marigold School has a special orientation as a technology school. It is an Apple Centre for Innovation and a charter member of the Apple Global Network. As an Apple Centre for Innovation, all teachers in Marigold School are encouraged to use computers in some way in their classes. Marigold School also employs a special teacher with qualifications in electronic technology to work in the computer lab and as a resource person for classroom teachers.

The teacher of the class selected for the study, Steve Hambleton, has been involved in using computers in education for about six years. He had no formal training on using computers in the classroom, being mainly self-taught with additional help from colleagues. Mr. Hambleton has been actively involved in educational applications of HyperCard, winning honourable mention last year in a contest sponsored by Apple Computers for an educational stack which he developed. The class is also assisted in the computer lab by a computer teacher. Having such a resource person frees the teacher to work with groups of students in the classroom while other groups of students work on assigned tasks in the computer lab.

The class selected for the study is typical of those found in Marigold School. About 44% of the students come from homes where they have access to computers. This class was selected on the basis of being in the target age group and the willingness of the classroom teacher to participate in the project.

Description of the computer-use lessons

All three lessons taped as part of the ITEC project were highly structured with regard to expected student output. The first of the taped lessons required students to use Hypercard in conjunction with a "clip art" file. Students were to collect pictures from the computer network to store on their own stacks. The pictures were to become topics for future stories. The students were then to write one or two words about each of five animals on the clip art.
The other two lessons required the students to use the software program "Superpaint" to accomplish desired tasks. In the first of these lessons, students were to select six words they could use to tell an "alien visitor" from another planet about themselves. They were to draw six boxes using Superpaint and then draw pictures in each of these boxes for each of the six words chosen to describe themselves to the alien.

The third activity involved creation of a bar graph using Superpaint. Students had surveyed each other to collect data on students' preferences for certain fast food restaurants. Students then created a bar graph to display their results. Students were to create their graph using both the draw and the paint layers of the Superpaint program.

All three tasks were carefully laid out for the students, including step-by-step instruction on how to accomplish the task. The flexible component of the assignment was in such things as the students' choices of pictures to draw or fill patterns to use in their grid. Page layout of the final product was specified before.

**Observed behaviours assumed to be associated with higher level cognitive activity**

Students were observed in Lesson 1 accessing and sorting material, activating computer commands, and writing words to describe selected clip-art pictures. Higher-level thinking would be used in some or all of these processes. Students would need to analyze a situation to determine the needed computer commands as well as to think of possible stories to match selected clip art copied to their Hypercard stacks.

In Lesson 2, students were seen creating six appropriately sized boxes to fill a standard page when printed. These boxes were then filled with the students' original drawings created using a draw-and-paint program. Drawings were to match six selected words describing themselves to another "alien visitor" from a distant planet. Higher-level cognition would be involved in the selection of the six words, analyzing the page to appropriately size the boxes, determination of the correct mode (draw or paint) to use for various portions of the pictures, and relating the required task to previously performed tasks to aid in selection of the various paint and draw tools to use in creating the pictures.

Behaviours observed in Lesson 3 included collection of data, analysis of the data, and creation of a bar graph using a paint-and-draw program to display the data. Higher-level cognitive activity here would include relating the task to previously performed tasks in both setting up the bar graph and the creation via computer of this graph. Analysis and synthesis skills would be needed to determine appropriate sizes for the bars in the graph and the best form to display the data.

In general, all three lessons involved tasks that provided opportunity to relate the task to previously performed tasks, evaluate one's actions, observe central issues and problems, and compare similarities and differences. The high degree of interaction allowed the possibility for students to question each other, analyze another student's approach, analyze problems, and recognize relationships, but these behaviours were not always observable if they did indeed occur. New ideas were probably not generated, as students were given fairly explicit tasks and seemed only concerned with finding the most efficient way to complete the specified task.

**Suggested response to ITEC's general research question**

Although the videotaped lessons provided an interesting view of the action and overt behaviour in the target class, the actual conditions likely to have a positive impact on children's higher-level cognitive functioning were not easily discernible. Since only one class was observed with very little difference between taped observations on characteristics of computer use, social interaction surrounding and during the computer use, and instructional integration of computer use, the actual impact of the observed conditions on higher-level thinking could not be determined. No contrasting situation was observed which could allow one to assess with certainty that more or less cognitive functioning seemed to be associated with certain conditions.

The videotaped observations' primary benefit seems to be the snapshot they provide of current practice in instructional integration of computer use and social interaction surrounding this computer use. Patterns of student social behaviour can be observed and quantified. Task completion can also be observed as well as procedures used to accomplish the said task. However, it does not seem possible to say with any degree of certainty exactly which higher-level cognitive functions were occurring and to what level. This type of conclusion seemed more appropriate to the interview data that were collected from the students as part of the additional questions addressed by the Canadian group. Individual interviews lasting approximately 45 minutes each were conducted with students while they worked at the computers. Students were asked to work with programs and to talk about what they were thinking while using the computer. Comments made by the students during the observation time were used to help evolve questions which could be further explored.

Results obtained here seem to suggest that higher-level cognition is more likely to occur when students get beyond the mechanics involved in the actual operation of the computer. At this point, students feel a greater freedom from the labour intensive tasks often involved in completing an equivalent assignment by paper-and-pencil techniques and are able to concentrate on the creative aspects of an assignment. Higher-level cognition also seems more likely to occur if students perceive the task as their own project.
Reflection on Phase 1

Participation in Phase 1 was of great interest to the Canadian team. It enabled the team to establish a good working relationship with the Marigold School and our international colleagues, address some questions of both personal interest and international interest, and collect information that could be of interest to other educational institutions in the province of British Columbia.

Although the videotaped observations provided good anecdotal data and served as a starting point, they do not seem to be particularly well suited to identifying with any degree of certainty the desired higher-level cognitive functioning. Also, the videotapes only captured a small portion of the actual activity involved in the computer lessons. If the camera is focused on one particular student, other behaviours and interactions which may be of importance are being excluded. The fifteen-minute time limit imposed on the videos also gave an incomplete picture of the lesson and computer activity. This makes it difficult for an independent observer who views only the tape to give an accurate assessment of both the overt and assumed behaviours occurring the lesson.

Recommendations for Phase 2 of ITC

- Other data collection techniques should be developed for Phase 2 which would allow a more detailed profile of an individual student's cognitive process to be determined. Such techniques could involve individual observations of a student's performance of a computer-related task, individual interviews, or psychometric measures of a student's cognitive processing. A standardized psychometric instrument or interview format would also facilitate cross-national comparisons.

- Control groups in the form of classes with varying computer-use conditions or classes not using computers would also help researchers determine whether observed higher-level cognitive functioning is actually a function of the computer-use conditions or some other factors.

- Better dialogue among international participants would be desirable. This would provide perspective for national teams to view their findings as well as alert them to problems, concerns or suggestions.
Reflections on Phase 1 of the ITEC Project

4.7.2. Summary Report of ITEC Participation, China, Phase 1

By Hou-can Zhang, China

Motivation

In China computer education in elementary school is not widespread. But in recent years the education circles have paid more attention to it. In Beijing, there are some computer courses in the so-called "key" schools, a few of them already having three or five years' experiences with computer education. Participating in the ITEC Project is good for us to exchange with and learn from other countries. Also, it will benefit the solving of problems we will meet while promoting the development of computer education in our country. Moreover, we would like to make our own achievement in this field available to others for discussion and to make our contribution to the development of international computer education.

Community, School, Teacher and Class

Computer education in the middle school in China is relatively developed in comparison with that in elementary school. Not many elementary schools yet have computers. In general, different schools use computer in instruction in different ways according to the conditions they have. For some schools only computer programming is taught; for others the trial of CAI is underway.

The elementary school where we did the ITEC experiment is "Beijing Second Experimental Elementary School" which has a history of more than eighty years. It located near the centre of Beijing, not far from the well-known Tian'an Men Square. There are 101 teachers and 1632 students in the school. Some of the students come from local residences near the school. Some are from senior cadres. Most of the teachers come from the teacher training schools. The principal is a middle-aged man of great ability. He is honoured as a national model worker. He backs all kinds of educational experiments and has much experience in that field.

As an experimental school, there are many national and international education experiments running in that school. The teachers are glad to bring forward new ideas in teaching and the school's educational quality is among the best 2% in Beijing. There are many courses in the school, such as Chinese, English, arithmetic, music, painting, physical education, and computer education, etc. Length of schooling is six years.

There are about 50 students in each class in the school. The class we selected is one of the Grade 4 classes, where there are 57 students. Before this experiment, they had a half year's computing course. Seventeen students of the class have computers at home. Thirty-three students can often get in touch with computers outside of school.

Two teachers are involved in this experiment. They are Mr. Dau-Lin Liu and Mr. Xue-jun Zhang. Mr. Liu is preparing to go to Italy for training. The computer course is taught by Mr. Zhang. Liu is a senior teacher and has five years' computer teaching experience. Zhang has only two years' computer teaching experience.

Computer-use Class

Computer education is usually started in Grade 4. Since there were many kinds of computers in this school, some of which aren't compatible with each other and some of which can't use the Logo Language, they did not teach the Logo language, but neither did they use CAI.

The computer-use activities observed in ITEC Phase 1 involve BASIC Language teaching. The textbook adopted by the teachers is "BASIC in elementary school," published by the Education Bureau of Beijing. Students have their 45-minute computer course taught in a special classroom called the computer room. Only one teacher is in the class. First, the teacher introduces some aspect of BASIC language knowledge and operation skills, then students operate with the new concepts under the teacher's guidance. Thirty computers are available; generally speaking, one computer is used by each two students at the same time. One is at the keyboard the first half of the class, the other the second half of the class. The students who operate independently on one computer seem quite good in computer learning in the class. Most of them join a computer extracurricular group in which they learn new knowledge beyond the classroom instruction, such as Logo Language, application of simple software and other more-extensive knowledge. They will soon attend a programming contest in the name of school.

Since the second school term of 1990, the school has replaced all its ancient computers with all new CEC-1 (Chinese educational computer made in China, which is compatible with Apple-II). The teachers have now set out to prepare to teach the Logo language and to carry out CAI.

277
Observations associated with higher-level cognitive activity and comments

The ITEC observations were carried out in BASIC-language teaching classes. The informational sessions were comprised of skills related to file acquisition and retrieval, application of BASIC commands, and command sequences applied to resolve a specific task. In the class, after the teacher's explanation, students operated the computers to practise each command respectively, then created a simple program, finally ran it, and got a result.

During BASIC Language teaching, both the teacher and we, the researchers, are convinced that there are many higher-level cognitive processes represented. For instance, while learning the "Let" command such as in "Let x=x+1", the children must compare it with the use of the equality symbol as learned in mathematics.

In general, we think that the behaviours listed in Form K are shown in BASIC language learning activities. But we could not represent them distinctively on the videotape record. For example, one child printed a complex figure on screen by means of the cycle command. It is certain that many higher-level cognitive behaviours were involved in this process, but we could not record them in respective ways such as those listed on Form K.

Suggestion

In the BASIC teaching class, computer is only used as a tool; but we could not compare this use to another type of computer application. The frequency of computer use and teacher and students' interaction have a positive effect on the higher-level use of the computer. The students using a computer together are not as good as those using a computer independently. Probably the reason lies in two parts, first, higher frequency of computer use, and second, no disturbance. Higher-level use of the computer is not, however, equal to higher-level cognitive behaviour. Because of having no control group, we can not say which aspect of computer use might have had a positive impact on children' higher-level cognitive functioning.

Comments on Phase 1

We think the plan of Phase 1 was not strict enough. Having no control group, pre-test and post-tests, we are not able to define what condition has a positive effect on higher-level cognitive functioning, thus no definite conclusion can be reached.

Recommendation on Phase 2

We hope the plan of ITEC Phase 2 will be more concrete than that of Phase 1. Experimental method used should be more scientific. Some psychological tests should be ready and the treatment of the videotaped record should be standardized. Finally, we are looking forward to have a good start on Phase 2.
Reflections on Phase 1 of the ITEC Project

4.7.3. The ITEC Project: Some Comments and Reflections on the Execution of its First Phase in Costa Rica

By R. Murillo, C. Fonseca, A. Brenes, Costa Rica

The Costa Rican program and the nature of its participation with the ITEC project

(a) The Costa Rican Computers in Education Program

The Omar Dengo Foundation (ODF) is a private institution created with the intention of supporting the Costa Rican Ministry of Public Education and contributing to the improvement of Costa Rican education through the introduction of instructional technology. Both the Omar Dengo Foundation and the Ministry of Public Education created the National Computers in Education Program which has been in effect since 1988.

At present, the Program has 165 computing labs (3300 computers) located in different areas of the country. Almost all the labs have 19 IBM computers PS/2/25, and a PS/2/50 as host server and a printer. The computers work individually and in a local network.

The Program uses Logo Writer, which was chosen as an educational tool for the Program on account of its potential to develop critical thinking, problem solving and creativity. Teachers are provided with training and permanent support (advice and follow-up) by the Computers in Education Program through its tutors. In most school situations, the Principal also gets training and administrative support to run the lab. Teachers selected to participate in the Program, work part-time as homeroom teachers in charge of a grade, and overtime as lab attendants. These teachers are trained in Logo through successive Logo courses (modules). When the children attend the computing lab twice a week, their homeroom teacher accompanies them and defines the educational projects, along with the lab attendant.

(b) Motivation for joining the project

The ITEC project was a challenge for this Program, since its research efforts were just starting and the Department did not have much people nor resources. Because the ODF is devoted to the introduction of computers in education, this research project was strongly related with its activity and, at the same time, it seemed to be an experience that would provide the researchers the opportunity to compare what they were doing with what is being done in other countries. That is, the project not only takes into consideration computer, teacher or school variables, but also cultural variables. All variables are strongly influenced by culture. As the ODF project is a national project unique in Latin America, the cultural aspect could bring important information for all the participants. Results could also be of interest to other countries considering similar projects. Comparative analysis with other ITEC teams could also provide new research approaches and methodologies. Present results are starting to throw some light on aspects of children’s development.

The ODF work is not just directed to the introduction of the computer alone, but also to create a methodology which will enrich the child’s learning. Doing research responds to an interest in determining how this Program is working, which are its results and under which conditions computers in education should be used. That is, the main objective is directed to determine variables, which is strongly related to ITEC’s general questions.

Great importance is given to the context of learning, the Vygotskian emphasis on learning in social context is closely related to the pedagogic interest. The Vygotskian theory also seemed interesting since it permits a “multidimensional approach”. This approach takes into consideration that the study of the impact of computers in education “cannot be considered in isolation” (Revised ITEC Project Document, p.2). This means dealing with a number of variables, all of them relevant to the results.

(c) Description of the community, school, teacher and class chosen for the ITEC Project

The researchers worked with two different schools, to prevent one observation from leading into an unidirectional point of view. As the Program involves a great number of schools, it was decided to choose two of them, in order to make preliminary comparisons. The Republica de Panama School (Panama School) and the Jorge Debravo School were chosen.

The Jorge Debravo School can be considered an average Costa Rican public school. The Ministry of Education defines the educational policies to be implemented. The school has approximately 1200 students and 34 teachers. The building has 20 classrooms, a library, a computing laboratory, the principal’s offices and the cafeteria, where children have a free snack every day. It also has some space for children to play and, in the future, to enlarge the school building. The school is located on the south-west part of San Jose, the capital city of Costa Rica. This region is undergoing intense growth due to the housing projects the Government has established in the area in the last twelve years.

The Panama School is also a Costa Rican public school. Being 100 years old, and because of the quality of its teachers, the level of this school is considered higher than the average level of Costa Rican public
Reflections on Phase 1 of the ITEC Project

The school has approximately 1400 students, 43 teachers and 39 grades (from kindergarten to sixth grade). The school is located in the southeast part of San Jose, the capital city of Costa Rica. This region could be characterized as a middle class. Many of the children's parents are professionals: teachers, lawyers, nurses, etc. Even though the social class here is higher than the one of the Jorge Debravo School parents', few students and teachers have a computer at home: approximately only 2 teachers and 30 students. Two or three years ago, some slums have sprung up near the school. For this reason, the school's population has changed somewhat and around 15% of the children belong to low and very low classes.

(d) Description of the computer-use lessons

For both schools, the computer lessons normally follow the desirable model currently established by the Computers in Education Program. Children go to the computing lab once a week to work in pairs with each computer for an hour and twenty minutes. First they work on projects they elaborate themselves with concrete materials. That is, they choose a subject and do some research on it. Then they elaborate the project with different materials. This is followed by actual work on the computer. In general, the projects are curriculum-based, but the children are free to choose. This does not mean that this is the only possible model (for example, it does not exclude working directly on the computer). Within this model, the teacher's role is essential. It requires a special attitude towards education and children. Following Piaget's constructivism (as stated by Papert), the teacher must permit the children to build their own knowledge in an environment of freedom and intellectual curiosity. The role of the computer is also essential since it enriches the learning environment in a revolutionary way. As Lea Fagundes, Brazilian psychologist and teacher, told the tutors: "We are in the Technological Revolution: ideology, values, morality are changing". Computers are not just another tool for learning, they have qualitative differences with what we have been using for education. As Papert says, the computer's essence is its universality, its power of simulation and its capacity to assume thousands of functions.

Comments on the objectives

After studying the ITEC conceptual framework and working document, the following were the most important research topics identified by the ODF research team:

(a) Kind of impact of computer use on children's high-level thinking;
(b) Conditions under which this impact is likely to happen;
   - Background conditions (teacher, student, school)
   - Cultural and social interaction conditions
   - Computer-use characteristics;
(c) Degree of generalization of transcultural findings regarding the high-level cognitive processes which can be identified in the children;
   - Doing previous research on their projects, and showing autonomy for choosing the best approach.
   - Coping with the anxiety of not knowing what to do and trying to find some solutions.
   - Showing awe and satisfaction with the achievements in the task.
   - Creating teams spontaneously and cooperating with the classmates in the solution of problems.
   - Showing signs of understanding of the processes involved, via nodding or similar gestures.
   - Giving evidences of dividing processes in parts in order to solve a problem.
   - Starting again when loosing their work, due to technical problems, thus showing a good level of tolerance to frustration.
   - Memorizing most of the information or executed steps, and use that in case of accidental lost of the work.
   - Becoming teachers to others and thus relearning from what they teach.
   - Considering the work of others as an external model which provides ideas.
   - Experimenting with alternative ways to do the same job.
   - Using different resources to plan and execute the work: writing, thinking aloud or talking about what is being done.
   - Evaluating objectively their own work.

Of course, these items are profoundly related with the way chosen to observe the children. In some cases, when the team talked with the children and participated in their work, high-level thinking
behaviours could be observed as a result of the interaction between the children and the observer. This suggests that such behaviours are associated with the kind of relationship the teacher establishes with the children. When a teacher is willing to provide all the answers and does not make the child feel capable of solving his own problems, or when he does not give the children the opportunity to solve their problems by talking among them, then less of these desired behaviours will be likely to evolve.

This document includes comments on how some of these objectives were covered in the Costa Rican experience with the first Phase of the ITEC project. In particular, there are some reflections on the results of the use of the specific instruments designed by ITEC, with two school groups of children from different social backgrounds. All this will be related to the general experience of the Computers in Education Program.

Comments on the methodology

The Phase concluded (the first of the ITEC project) was exploratory, looking for identification of behaviours associated to high-level thinking.

There was satisfaction in the team with the ITEC organization since we got all the forms and instructions for starting the observations. Nevertheless, since the Costa Rican team did not participate in the planning phase, familiarization with the project’s methodology and the observations required demanded time and effort.

(a) On the observation of subjects

Observing requires observers to know the theoretical categories of what is being observed. Since the team was not familiar with Vygotsky's works, the starting point was to get some bibliography (not a very easy task in Costa Rica). Finding adequate documentation on Vygotsky's theory was not an easy task at first. When documents and research were finally made available, the difficulties became the very nature of the task itself. How could this kind of specialized thinking be observed?

(b) On the use of forms

The forms sent represented a good way to standardize the information. However there were difficulties with some items which led to what the team evaluated as superficial or not relevant answers. There was hesitation in how to fill them out: write what the teacher and the principal actually said, or give our interpretation of it. The decision was clear: just write down what was said by the subjects.

(c) On the use of videos

Even if these are excellent instruments for showing the environment, the situation and the children, it was hard to figure out how to recognize on the videotapes what the team was looking for: high-level thinking behaviours. Of course, some explanations can be offered:

- Not having enough experience in videos, both in filming and in editing
- High-level thinking behaviours could generally be detected after some time of observation, that is, we had to follow the process to be able to interpret a behaviour as indicator of high-level thinking happening, sometimes for a long time.
- Since groups were too big (35 children), observation was difficult because we could just focus on two or three couples of children; for this reason we decided to concentrate in a few pairs of children.
- A serious limitation was frequently that, due to limited resources, observation was conducted by the same person recording.

Comments on the results

(a) General considerations

At the beginning it was difficult to find the behaviours stated in the research program as tentative indicators of high-level thinking, being as this was a new methodology for the team. It was found out that in order to identify those behaviours, observation of pairs of children at the same time was needed, then to follow the evolution of what they did, and hopefully detect some of these "high-level" behaviours.

According to a teacher's opinion, only some children showed high-level thinking behaviour, especially those children traditionally considered as "good students". They certainly showed more independence, more curiosity and a longer concentration span, but we as researchers did not think those children were the only ones that showed that behaviour.

One of the concerns of ITEC project is "the absence of commonality that makes it difficult to generalize across findings" (Roblyer et al., ITEC Document, p 8). We are not sure, as a team, if it is possible to reach this "commonality".
Reflections on Phase 1 of the ITEC Project

Using the same forms does not necessarily mean that everybody is observing the same things. This seems obvious when analyzing the observations made by teachers or principals. Some differences concerning this must be observed. In the case of Costa Rica, teachers and principals were not the actual researchers and their comments on high-level thinking were quite superficial. But the case of some other countries was different. In several cases teachers are involved as researchers and had more experience and involvement in educational computing projects. This situation made their answers deeper.

(b) The students

The children studied are from low and middle-low class and therefore they don't have a computer at home. This could be a strong variable for the high motivation they show towards computer use.

- Student interaction

The pedagogical intention of the Computers in Education Program is to stimulate cooperation between children. That is why group work is encouraged. Nevertheless, as Coll (1984) says, the decisive point is the quality of the interaction between peers, not the quantity. It is not enough to seat the children side by side; many authors have described different patterns of interaction, especially three: individualist, competitive and cooperative.

We observed those three types of peer interaction, in the following form:

- Competitive interaction

In this interaction the objectives of the participants are very close but in an exclusive way: that is, a member of the group can reach the objectives if and only if the others can not. This pattern of interaction was found mainly in two situations (which were not always competitive):

- When one of the children was a typical "good student" and the other one was an average or low student. The good-student would not let the other one touch the keyboard (sometimes even by taking the other one's hand); he would also show little patience and generally talked about the work as if it was only his. When one of the children seemed to be very shy generally the other one was the active one. In occasions the shy one had much more ideas, but the other child, being more talkative, seemed the more active in work. b) Individualist In the individualist pattern, the objectives of the child do not have any relationship with the objectives of the others. We had some observations of individualist children, especially in the Jorge Debravo School. Two cases:
  - Child 1: He just said he did not like to work with others. When he did, he assumed a competitive position, he did not allow the other child to work and talked about the work as if it were just his.
  - Child 2: He was described by the teachers as a child with discipline and emotional problems. The lab was one of the environments where he accepted to work. He did not talk to anybody and in the lab he was silent and alone. He failed the grade.

- The cooperative pattern In this pattern the participant's objectives are so related that the objectives of one cannot be accomplished without achieving the others. In this category, observations yielded many cases:
  - One "good student" helping an average student: the exceptionally good student taught the other one how to do things and was patient with him.
  - Two very good students or two average students: they both worked together for the accomplishment of their goals. We also found two cases of "no objectives" or better say "weak objectives":
    - Two girls that felt that everything they did was bad, they felt frustrated since nothing of what they had been trying to do had the result they had been waiting for (Panama School).
    - Two boys and a girl that passed all the lessons laughing, talking and did not work (Panama School).

(c) The teachers

It was difficult to make them take part of the research. This had an advantage: as they just continued their everyday work we had the opportunity of observing them working a they commonly do. But on the other hand, they did not show much interest in the study.

- Teacher-teacher interaction. We already stated that in the Costa Rican Program the homeroom teacher works along with the lab attendant in the computing lab. In general, homeroom teachers are not trained and have very little computing experience. Some of them are willing to learn and encourage children to work in the lab. Others are indifferent or just do not like to go to the lab and do not see the importance of it. Both homeroom teachers of the studied schools showed a positive attitude toward our research. The Jorge Debravo School teacher was a lab attendant herself (for other groups) and the Panama School teacher became very enthusiastic when her daughter started to teach her Logo. This made the development of the project easier.
Nevertheless, in the Jorge Debravo School there were some personal problems between the teachers that somehow interfered with the children's work and with the whole development of the class. The problems were never evident for the students, but they were for the team. At the end of the experience the relationship was better and the class ambience too.

In the Panama School the team noticed that even if the homeroom teacher was interested, she did not make much curricular integration. She tried to help the children in Logo, but did not keep on stimulating children to do research. In both schools the homeroom teachers had a role too much oriented towards keeping good discipline. For the computer attendants, as already stated, both of them were trained, but just as Logo's beginners. They tried to propitiate an environment different of what has been stimulated in homeroom classes. Nevertheless, both of them showed some authoritarian patterns of interaction with the children, which are not encouraged by the Computers in Education Program.

### Teacher-student interaction
As was already mentioned, there were two common kinds of interaction: the students frequently asking for advice or reinforcement from the teachers, and the teachers trying to impose discipline in the group. It was clear that when the environment was permissive enough, children tended to think more on their own, they were not so dependant. This is an important point to consider in future research.

### Some general conclusions

**(a) General indicators of high-level thinking**

Taking into consideration all the points discussed in the previous pages, it can now be said that after reviewing the data the following behaviours which might be associated to high-level thinking may not appear so easily.

This is specially true from a Vygotskian point of view, where both the teacher-student interaction and the student-student interaction are strong variables on the computer impact on children's cognitive development.

In fact, it was noticed that at the beginning the teachers did not stimulate the children's independence very much. They tended to give them the answers not stimulating the children to find the answers by themselves. Also, the teachers tended to reproduce the environment of the homeroom class, and in some occasions did not allow the children to stand up and ask others about a problem they were confronting.

Our main objective as researchers is to prove that the use of computers is having a positive effect on the children's cognitive development. However, human thinking, as a scientific category, is difficult to operationalize, that is, to define in terms of measurement. That is why we think it might be better to work with a comprehensive list of behaviours that supposedly show that high-level thinking processes are occurring.

**(b) Characteristics of computer use apparently more likely to propitiate a higher-level cognitive functioning**

Observations made showed that high-level cognitive functioning appeared in different circumstances: At first it was expected that high-level thinking processes would show when children interacted with teachers, "Since teachers are trained to stimulate children's thinking." Nevertheless it was not always so, since as we already mentioned, teachers tended in some occasions to give the answers away. When children were alone, high-level thinking behaviour appeared but the children experienced certain limitations due to the level of command of their Logo programming, the age of the student and the complexity of the questions being posed. In that moment, the role of the teacher could help the children to go beyond the limit. Sometimes it did, when teachers sat with the student and talked with him, helping the student to find the solution. But many times it was not so, because the teacher was too busy or just because she herself did not know a possible answer. High-level thinking behaviours also appeared when children were working alone or in pairs at the computer. The continuous feedback interaction with the computer allowed the children to respond and correct immediately what they had done or just create something new based on what they had already done. Awe was always present, showing that the computer itself is a source of continuous stimulation for the child. Interaction with computers tends to generate by itself high-level functioning behaviours and situations. This, of course, would also depend on the type of hardware and software used.

As explained, the Costa Rican Computers in Education Program chose Logo as an educational environment precisely because of its specific pedagogical interaction. In other words, the Program's point of departure implied some assumptions on the teacher-student interaction that would bring about high-level thinking. For this reason, training components have always stressed this element.

**(c) Social interaction surrounding computer use**

The social environment is essential for the development of high-level cognitive functioning. In the Program, the very characteristics of computer use imply close social interaction, not only in the specific context of teacher-student interaction in the lab, but also in a more general model of educational interaction.
Reflections on Phase 1 of the ITEC Project

This special model refers to a non-repressive and non-authoritarian environment that is supposed to be generated by the teacher, which stimulates the children’s learning. The research team agrees with Papert when he states that children can produce and learn more within this ambience; they tend to become epistemologists.

In our observations, we found that the more freedom the children had, the more they found different ways of solving problems, discussed them with others, shared and thought about what they were doing. When the teachers are worried about discipline, or when they did not give the children an opportunity to think about what they had done, dependency tended to be reinforced in those who try to get the answer from the teacher.

The instructional integration of the computer use

Within the Costa Rican Computers in Education Program there is close integration or curricular topics and computer use. This allows the children to bring into their computer work aspects from different fields of their knowledge and interest. This also allows the children to be able to establish relationships among different areas and to learn how to face a problem from different points of view. For every job assigned the child has to do research, read, work with concrete materials, write, use the computer, produce graphics and texts.

This approach makes it possible for the children to integrate affect and cognitive elements within their work, since they can be able to develop their own interests and use their emotions to stimulate cognition and learning. Of course, this contrasts with popular assumptions that computer isolates people. This might be an additional interesting field of further research.

For example, at the Jorge Debravo School a pair of students (a boy and a girl) worked on one of Costa Rica’s National Parks. This park has the special characteristic of being a turtle refuge. The children went to the National Park office, made research about the National Park system and the turtle protection program. Then, they prepared the project with concrete materials and finally, wrote a text and made a picture with Logo on the computer.

It is also essential to consider that within the Program the computer is used by pairs of students. This means that within this context computer use does not favour the children’s isolation, as many affirm. Instead, this use is based on a dialogical concept of knowledge in which children construct knowledge together. In the case mentioned, the pair was composed by a boy and a girl, which was special, because pairs generally were of the same sex.

An overall reflection on Phase 1

(a) On Research Methodology

The videotaping experience is indeed a strong instrument in order to observe and carry out longitudinal studies. The question is which other methods should be combined with it, in order to observe the appearance of high-level thinking behaviours.

In the case of the Costa Rica project and of other Logo based ITEC experiences, a possible complementary research method could be working with a sample of children’s computers projects chosen by random selection or by extracting exceptional cases. These children’s projects could than be analyzed and their programming procedures could be studied to understand and record the thinking processes behind them.

(b) On Computer-Use Methodology

Our experiences and observations tend to confirm that high-level thinking associated with computer use is determined by teachers’ methodology and pedagogical approach rather than on computer use itself. Even if the methodology used by a project or program is based on certain epistemological assumptions, the actual methodology used by teachers in the classroom or computer lab is determined both by their interpretation of it and by the personal attitudes they associate with it. For this reason, success in the use of a specific methodology is determined by the type of training provided and the regular support and follow up granted.

This has consistently been observed within the Costa Rican Computers in Education Program. However, it must be stated that successful implementation of the methodology is the result of a long process in the achievement of competency in computer use and pedagogical focus.

Dwyer et al. (1990) have documented this interesting process of teachers’ instructional beliefs when they are part of a process of learning the use of computers. As these researchers have documented, and our observations show, this is a highly irregular process in which teachers undergo periods of high competency and motivation followed by moments of frustration and difficulties to stimulate creativity and thinking processes in children.

Even if the desirable methodology involves teachers ability to provide freedom to students and to nurture creativity and thinking processes, this is not always easy to attain. Actually, the videotaping conducted within the ITEC project revealed quite traditional authoritarian behaviours in the teachers and lab attendants. For this reason, the Costa Rican Computers in Education Program has developed extensive
training programs on Logo programming and educational environment. The introduction of this pedagogical and epistemological strategy is a revolutionary step in Costa Rican education, and the results have always been expected to be long term. The overall acceptance and successful implementation of the model is in the process of taking place.

(c) Actual Computer Use by Children

As it has been observed by the Costa Rican team and by other ITEC researchers, type of hardware and software used determines the type or interaction. Immediate feedback always astonishes children, particularly when they realize that the orders they give the computer have result on the screen. This produces surprise and emotion which reinforces their pursuit of the task. This is consistent with Vygotski’s thinking that human beings are the only ones in nature that generate their own driving forces.

When using computers children tend to generate their own stimulus, to be surprised by their own productions. As Papert has said the computer becomes invisible and it is the child’s production that is the centre of attention. The computer becomes a mirror for the child, and for the teacher a mirror of the child’s thinking process. Hence the opportunity presented to the teacher to act as epistemologist. This is why it is so important for teachers to focus on processes rather than products.

References

4.7.4. Summary of the French ITEC Participation Phase 1  
By P. Gabriel, France

Problematics

At the moment, there is in France abundance of experiences that attest a real interest of the teachers for Information Technology (IT). However, the new educational situations created are facing us with some methodological and conceptual questions which show that in the field of assessment much work of thought and ripening has to be performed.

Also, these concerns have already found with the ITEC Project the components of a fruitful cooperation all the more since it goes beyond them. The project doesn’t only include the design of a contribution to a better understanding of some child-computer-school interactions but also the study of the effect of information technology on children’s metacognitive development and a contribution to the methodology of cross-cultural research.

The sample: the educative community

Two classes from two elementary state schools of Dijon, a 157,000 inhabitants city in the middle east of France, have been selected and involved in the first Phase 1.

The schools are what we call Application Schools (i.e. they depend on the principal of the district teachers’ training college) and the teachers are Application teachers (i.e., they have adapted training and schedules to be allowed extra time to work with applicant teachers). This context can be seen as not entirely profitable to the pupils; as a consequence, parents have the right to refuse that their child should be sent to one of these schools. Nevertheless, there are here no consequences deriving from this situation concerning the pupils themselves, the teaching contents and the reasons why these classes and teachers have access to computers. Moreover, these schools are broadly open to educational research.

A difference between these samples comes from the standpoint of the school principals: in the school "Petit Bernard", the principal considers computer-use with circumspection; on the contrary, in the other school "Chevreul", the principal encourages highly his colleagues the teachers to introduce and to develop computer-use activity.

Concerning the two teachers, Yves (M. Yves Seguin) and Jean-Pierre (M. Jean Pierre Chaix), they have nearly the same initial training and years of teaching experience. Their training with respect to computer use for instructional purpose differs: Yves, who is teacher in the school Petit Bernard made three times a two-week training period and Jean Pierre who is teacher in the school Chevreul, made, as for him, three times a four-week training period.

However, the teachers' experience with respect to computer use is very similar as the way they declare that they integrate computer use in their teaching: both follow ministerial directives regarding to the nature (i.e. the objectives to the IT policy are: to heighten pupils awareness' to a new dimension of the society environment and, secondly, to favour the renewal of the teaching methods; at primary level, emphasis lays on the cultural aspects of IT) and frequency of computer use (i.e. about 50 hours per year).

47 pupils have been involved in the study (21 in Yves' class and 26 in Jean-Pierre's one). 40% are girls, there are more boys than the average in Jean-Pierre's class. At the beginning of the school year the average age of the pupils was contained between 9 and 10 years.

According to data obtained from the teachers, we next give, in percentage, the features of the whole sample (together), Yves' pupils' features (Y) and the Jean-Pierre's pupils' features (J).

<table>
<thead>
<tr>
<th>Feature</th>
<th>(together)</th>
<th>(Y)</th>
<th>(J)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) family socio-economic level:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- above average:</td>
<td>28%</td>
<td>43%</td>
<td>15%</td>
</tr>
<tr>
<td>- average:</td>
<td>47</td>
<td>33</td>
<td>58</td>
</tr>
<tr>
<td>- below average:</td>
<td>25,5</td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>(b) school achievement level:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- above average:</td>
<td>49</td>
<td>57</td>
<td>42</td>
</tr>
<tr>
<td>- average:</td>
<td>21</td>
<td>14</td>
<td>27</td>
</tr>
<tr>
<td>- below average:</td>
<td>30</td>
<td>28,5</td>
<td>31</td>
</tr>
<tr>
<td>(c) apparent experience with computers:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- variety of experience:</td>
<td>30</td>
<td>43</td>
<td>19</td>
</tr>
<tr>
<td>- some:</td>
<td>45</td>
<td>57</td>
<td>35</td>
</tr>
<tr>
<td>- little or none:</td>
<td>25,5</td>
<td>0</td>
<td>46</td>
</tr>
</tbody>
</table>
4.7.4 Summary of the French ITEC Participation Phase 1

P. Gabriel, France

(d) apparent interest in computers:

- very interested: (together) 8.5 (Y) 5 (J) 11.5
- some interest: (together) 70 (Y) 81 (J) 61.5
- little or none: (together) 21 (Y) 14 (J) 27

(e) work habits:

- prefer to work independently: (together) 23 (Y) 24 (J) 23
- prefer to work with others: (together) 21 (Y) 19 (J) 23
- no particular preference: (together) 55 (Y) 57 (J) 54

The computer-use lessons

Six computer-use lessons, three in each school, have been observed and videotaped: Y1, Y2, Y3 (Yves' lessons), J1, J2 and J3 (Jean-Pierre's lessons).

(a) Instructional objectives of the lesson

There are three lessons about geometrical concepts, (i.e., the concepts of translation (Y1), regular polygon (J2), axial and central symmetry (Y3)), two lessons about technology in society (i.e., the discovery of robotics (J1) and of a word processor (Y2)) and beside these activities with Logo, there is a lesson about French language with a tutorial (J2).

Generally, the teachers combine some additional objectives to the proposal of activity and reflection on these themes:

1) some are linked to the use of a computer and of a programming language: discovering of computers rules of use (Y1), of function keys (Y2), of procedures (Y1, J3) and of the possibilities and constraints of the text editor (Y2);
2) some refer to cognitive skill: reflection over concepts (Y3), adoption of previous knowledge (Y3), acquisition or confirmation of "know-how" or notions (Y1, J1, J2, J3) and, also, use of an experimental research situation (J3);
3) a third type of objective is mainly associated to the relationship between child and the environment: acquisition of "savoir-être" (Y3) or encouragement to a mutual cooperation (J2);

(b) Organization of the lesson

Concerning the organization of the activities, the computer-use lessons are of two types. On the one hand there are Yves' lessons: the whole class makes the same thing at the same moment, that is, the teacher introduces the lesson up to the blackboard then he proposes a work objective with the computers to the class (Y1, Y2, Y3). On the other hand, there are Jean-Pierre's lessons: at the beginning of the lesson, the teacher organizes the class in different workshops (including one (or more) workshop(s) with computer(s) and introduces the activities; sometimes there is between these workshops a strict alternation (J1), in other words, the pupils take part in each of them to be involved alternately in the same activity, sometimes the alternation is open: depending on the teacher or sometimes on the pupils, those ones can have different activities (J2, J3)).

The lessons take place either in the children's regular classroom (J1, J2) or in a computer room outside the children's regular classroom (Y1, Y2, Y3) or in both places (J3). The arrangement of the rooms is described in the maps number one to six (see annex). In most cases, pupils are associated by groups of two or three with machines, which can be interfaced with input or output devices as a printer (Y1, J3), a little network (use for diffusion of the software or the recording of the pupils' production: J3), a robot (for example, a graph plotter) or some electrical supplies (J1, J3).

The teaching strategies according to G. Mills (1987) who places them by type of activity and roughly in the order of increasing control exercised by the learner in their choice of activity seem to be "instructional" (J2), "revelatory" (Y2), revelatory and "exploratory" (Y1, Y3, J1, J3), "utility" (J3). If we add that the pupils were apparently quite familiar with the computer activity except once (Y2), it seems that everything happens as if, a teacher uses a large sample of strategy, as M. Chaix does, or, on the contrary, adjusts a favourite one as M. Seguin.

(c) Development of the computer-use

The children appear to have no difficulties using the computers and software, even if the machines are obsolete (i.e. without help facilities and very often they are not enough reliable, with poor quality screen). There was a good general comfort of use, for some of these types of activity and when the pupils used the computer with one other child. When the pupils used the computer with a group of two others, they can put themselves out and have difficulties to open a notebook or take notes.

Nevertheless, the software that was used in all the computer-use lessons related closely to the overall instructional objectives set by the teachers; and the computer activities made, everything equal elsewhere, a strong contribution to the attainment of these objectives (note: we excepted for that concern J1: the lesson has
been disturbed by the visit of an applicant teachers group and it was after a holiday period and a lot of pupils had forgotten their previous knowledge about Logo language). In some lessons (Y1, Y3, J1, J3) the way they are managed (i.e. time allowed, objectives allocated), the pupils’ familiarity with the programming language is very important and makes difference between pupils.

During these lessons, at the same time, approximately two-thirds of the class had involvement (Y1, Y3) or more than two-thirds (Y2, J1, J2, J3) and for about one hour thirty minutes of activity with the computer, except J2 (20 minutes), pupils are half of the time engaged in this involvement, partly because the teacher often consults the whole class. Most of the students showed strong interest in those activities (Y1, Y3, J1, J2, J3).

The exchanges between pupils are made of: 1) talks not directly turned towards the lesson and its activities; 2) arguments with others concerning the rule of each one; 3) discussions concerning the activity itself. In the course of the first lessons, at the beginning of the computer use, when the group cooperation is unsuccessful or when technical problems occurred, especially in groups of three, children displayed a temperate aggressiveness towards others and a inter-group competition creeps into the class (Y1, J1, J3) while pupils-pupils interaction associated with the computer-use can mainly be described in terms of cooperation (i.e., they determine each one’s role, control over their peer's actions, coordinate each other, bring and compare their own understanding of the problem—observed in all lessons and sessions).

The teacher-pupils interaction associated with the computer work is of three types. In the first place, the teacher appears as a man of resource. The pupils ask him to give information concerning the activity: it can be some help, a point of view about the actual realization or a request of validation. In the second place, the teacher initiates the relation going from one group to another, point problems, makes suggestions or works with a group: he livens the activity up. In the third place, there are the more usual interactions with the whole class concerning the stages in the activity when, during the lesson, the teacher requires the attention of the pupils to sum up the situation or, at the end of the lesson, the teacher beckons the pupils to come nearer for a collective explanation. Sometimes the teacher-pupils interaction is very limited: at the beginning of the activity, the teacher introduces succinctly the exercise to the pupils (J2).

Higher-level cognitive activity

Generally the teachers feel that some of the pupils are displaying behaviours that could be examples of "higher-level thinking" (Y1, Y2, Y3, J1, J2, J3). Besides the examples we proposed, the teachers who agree with them, gave other examples of such behaviours because they have their own opinion concerning "high-level thinking".

For Yves, high-level thinking is the surpassing of the child by himself in relation with his/her actual realization, to encroach upon what it is possible to do. The following sentences are examples of the behaviours associated:

a) the notes taking without instructions from the teacher;
b) the creation of a program without taking notes;
c) the testing by trial and error;
d) the planning of acts (i.e. notes or diagrams preceding the programmation);
e) the research of an optimum solution to a program;
f) the saving of the results (i.e. notes following a successful realization).

For Jean-Pierre two concepts characterize "high-level thinking": "goal achievement" and "reflective thinking". From this angle the behaviours associated are:

a) the more important occurrence of correct answers;
b) the discussion of responsibly alternatives with others;
c) the use of previous knowledge and its adaptation to the particular case.

In the next section, the teachers’ observations of these behaviours are used as dependent variables when we shall try to answer to ITEC’s general research question.

ITEC’s general research questions

The amount of children displaying the behaviours associated with high-level thinking, on average, for three observations with each teacher, the volume of children displaying these behaviours, per lesson, indicates that one child over two had such behaviours.

For Yves, the amount of children displaying these behaviours is practically constant, slightly bigger from one lesson to the next. Are these three lessons similar from the high-level thinking point of view? Does the impact of this type of lesson increase with the practice? or does Yves become a better observant?
4.7.4 Summary of the French ITEC Participation Phase 1  

P. Gabriel, France

Concerning Jean-Pierre’s observations the point is different. A lesson (J2 - i.e. tutorial mode) is associated with a large amount of children displaying behaviours that could be examples of high-level thinking. On the other hand, for the two other lessons (J1, J3), the teacher observed in each of them, only seven children over twenty-six displaying these behaviours. Furthermore, with one exception it were not the same pupils who were concerned. How can we explain the difference between Yves’ and Jean-Pierre’s observations of behaviours associated with high-level thinking when these teachers both integrate the computer use in the same "revelatory and exploratory" mode? Are some characteristics of the children responsible for these results? Or, after all, isn't it the teacher’s definition of high-level thinking which makes the question?

Overall reflection on Phase 1

As we can see, for the moment, only a few results and a lot of questions can be mentioned. The international cooperation we are engaged in because of the multiplication of the observations may give some components to a reply.

In fact, concerning the French observations, some significant correlations are observed between, on the one hand, the sum of the behaviours associated by the teachers with high-level thinking, during the observed lessons and, on the other hand, the school achievement level ("ACHIÉsup & ACHIÉmoy" versus low achievement pupils), the apparent experience with computer ("EXP.ORD.V & EXP.ORD.M" versus without computer experience) and the pupils’ work habits ("HAB.T.A" - i.e. other & "HAB.T.S" - i.e. alone -versus no preference), all information also given by the teachers (refer to Table 1). Are such ratings appropriate? or does metacognitive development come down to problems that traditionally dominate school curricula?

Table 1 - Sum of high-level thinking behaviours displayed by the children with Teacher Number 1.

<table>
<thead>
<tr>
<th>Dependent variable is: &quot;Sum of observed high-level activities&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2 = 58,5%</td>
</tr>
<tr>
<td>s = 0,6582 with (47 - 9) = 38 degrees of freedom</td>
</tr>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Constant</td>
</tr>
<tr>
<td>&quot;EXP.ORD.V&quot;</td>
</tr>
<tr>
<td>&quot;EXP.OM&quot;</td>
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<tr>
<td>&quot;INT.O.G&quot;</td>
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<td>&quot;HAB.T.S&quot;</td>
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<tr>
<td>&quot;HAB.T.A&quot;</td>
</tr>
<tr>
<td>&quot;ACHIÉsup.&quot;</td>
</tr>
<tr>
<td>&quot;ACHIÉmoy.&quot;</td>
</tr>
</tbody>
</table>

Source | Sum of Squares | df | Mean Square | F-ratio |
| Regression | 23,1563 | 8 | 2,895 | 6,68 |
| Residual | 16,4607 | 38 | 0,433177 |

Recommendations for Phase 2 of ITEC

We completely agree with the idea of a Phase 2 being an improved round of what we did in Phase 1. In this spirit, we suggest the integrating of a collection of data based on a new assessment by the pupils themselves of their own behaviours associated with high-level thinking and, on the other hand, of the computer use lessons. Moreover it may be very interesting with regard to our theoretical framework to overlook what children can do with the assistance of others in a closer way.

Armed with such information we should be able to form a far more balanced picture of the child’s metacognitive capabilities and of the instructional integration of computers use impact, in a cross-cultural perspective.

References


289
Reflections on Phase 1 of the ITEC Project

4.7.5. Summary Report of ITEC Participation, Phase 1 - Hungary
by M. Csákó and G. M. Habermann, Hungary

Motivation

A research group headed by M. Csako has carried out research work on topics related to computer use in education since 1985. Results were published mainly in Hungarian, but some contributions to international conferences are accessible to English reading public as well.

Projects were focused on sociological aspects of computerization and teachers' attitudes. Both the analysis of the development of computer use in Hungarian schools and the cross-national comparisons made within the framework of the first projects led the team 1) to underline teachers' fundamental role in computer use in education; and 2) to reconsider the basic assumption that the integration of computer use into the teaching/learning process offers an improved and not simply a new version of education.

Consequently, further research work has been directed in 1988 on one hand to study changes carried out and planned in teacher training in order to cope with the new technology and on the other hand to study the impact of computer use on children in classroom setting.

The latter led naturally to an active participation in the preparatory work and the Phase 1 of the ITEC project.

Community, school, teacher, and class

Hungarian primary schools have been only a secondary target in the national plans for computerization in schools. Regular computer use in classroom teaching is still sporadic. There is a significant minority of teachers deeply involved in computer use but their main interest is to teach programming or hardware skills, not to integrate computers in the regular classroom. Lower age groups have normally the least access to computers in primary schools.

As the integration of computer use into the teaching process depends largely on the individual teachers initiative and her/his principal's openness, the hypothesis of a random distribution of regular use of computers in classrooms has very little probability.

In these circumstances we selected two primary schools for observation in Phase 1, one in Budapest ('Hikade' school) and another in a small village in the western part of Hungary (Abda). Unfortunately the teacher involved in computer use in the Abda school has moved to a nearby city and no one of his colleagues could continue the programme he started.

So the only school we observed is situated in the XIXth (an outer) district of Budapest with a higher than average degree of social segregation. Officially incorporated into the capital in the 50's, the territory has seen several waves of immigration. In the mid-war period and again in 60's, low level white collar workers have been settled there in separate blocks while blue collar skilled and semi-skilled workers remain the largest social strata. School districts follow the district's segregational pattern. Ageing and migration have changed somehow the social composition of primary schools by now.

We could not follow sociological criteria in selecting the school for observation because of the rarity of regular computer use in classrooms. However we have been lucky enough to find this school serving mainly a working class and lower middle class environment (more than 70% of the fathers are blue-collar workers) which can be considered as modal in a large city and somewhat above the average on the national scale.

Physically the school has better conditions than most Hungarian primary schools have. It has been moved to new buildings in the 70's when several new multi-storey housing blocks have been built nearby and the school district enlarged. Nevertheless disadvantages include the very small space of work and staying for a large number of pupils (1,246 children in three small two storey buildings in an air-polluted, noisy, and rather badly cleaned outside environment of the urban housing area).

Practically all children are Hungarian citizens with Hungarian native tongue, with a small minority of Hungarian Gypsies (mostly also of Hungarian mother tongue, and exclusively using fluent Hungarian as medium of communication). Hard familial economic conditions and weak cultural background result in relatively low input levels of intellectual abilities and frequent motivational and identification problems. Interpersonal conflicts at home may however, as we observed, reach a threshold where they might be converted into a motivational advantage: some children may see a way of escape from familial circumstances in staying in school.

The school's educational quality is higher than one could expect after its social status. The principal is an ambitious teacher who follows progressive educational ideas. Her competent and dedicated leadership
4.7.5 Summary Report of ITEC Participation, Phase 1 - Hungary

M. Csákó

G. M. Habermann, Hungary

encouraged teachers to take the initiative of experimenting with new tools and ideas and has opened the way to integration of computer use in classrooms beginning with the first grade.

Teachers involved in computer use work together with Mr. Károly Farkas, senior lecturer of the computer department of the Budapest Teacher Training College (BTTC), who has developed a special course and methodology to introduce informatics in the first grades of the primary school\(^9\). Besides this special program computers are used in teaching reading/writing as well.

The fourth grade class that we selected for observation has nothing exceptional within the school and its environment, but it offers a subject called 'Informatics'. Out of 23 pupils, 9 are girls and 14 boys. Ages varied between 9 and 10 years in Autumn 1989 and 9 pupils reached the age of 10 by January 31, 1990.

In Hungarian elementary schools, the usual pattern in the first four grades is to have one teacher for each class, although 3rd and 4th grades usually have plus two teachers, one for Environmental studies and one for Second language.

Mrs. Katalin Fekete-Kiss, the main teacher of the observed class, graduated from the BTTC two years ago where she took part later in an in-service training course in LOGO and now teaches Informatics, following the Farkas Method.

Description of the computer-use lessons

Within the given class Informatics is a compulsory and very popular course for all children. By the intention of curricular planners Informatics is meant to be a holistic and very general introduction into the basics of information processing and computation. Emphatically it is not a course to familiarize children with one particular application of computers or specific hardware or software. It is an open question however if the activities actually observed achieve the level of intended generality and/or transferability.

Fourth graders' activities in Informatics are arranged around a conception of using the LOGO language for developing problem solving skills and the children's cognitive abilities, aptitudes and skills in general. The pedagogical programme implemented—that of K. Farkas—shares much of Seymour Papert's philosophy. It emphasizes the widest range of potential applications and focuses on understanding the commands, semantics, and overall capabilities of LOGO through a psychologically well-founded approach by having children execute LOGO commands in gross bodily motion and free sessions of drawing before trying them out in a microcomputer environment.

Computers are used in different ways and for different purposes in Mrs. Fekete-Kiss' class. Normally they assist rather the teaching/learning processes than organize them. They serve children to check their knowledge in different fields (maths, geometry, LOGO), to try out their ideas and solutions to problems, to create images and illustrations, to exercise their LOGO-skills etc.

Observations associated with higher-level cognitive activity and comments

Children's activities observed during Informatics sessions comprised acquisition, retrieval, application of LOGO commands and command sequences required and aided by a set of different task and action contexts. They also engaged in evaluating command use, programming, wider-scale utilization and accessory performances of themselves and their classmates, and in freely interacting in LOGO-based activities involving spontaneous discussion. Several inventive practices were observed. Examples are the competitions in guiding a pupil by means of LOGO commands to a distant location determined by children or teacher, the drawing of more complex plane figures by producing constituents of varying size via parametrized LOGO programs, and the computer realization of a picture based on natural language descriptions in a Hungarian lyric poem.

In a pre-scientific perspective it seems entirely clear that overt behaviour observed—including those documented on videotape—could not be performed without relying on cognitive processes which fall under the ITEC working definition in the set of higher-level cognitive processes. Both observers and teachers are convinced that there are 'acts' in the frequency of the order of hundreds on each 15-minute videotape which presuppose the latent execution of processes labelled as 'recognizing a relationship', 'comparing similarities and differences', 'synthesizing information', and the like. However, the multitude of types and tokens of such behaviours appeared to show inadequacy of a "localization" request underlying an instrument like Form K.

In one of the work phases children construct an outline 'castle' drawing using several plane figures\(^6\). It seems to be clear that solving this task required command over a vastly complex system of sub-processes and operations (interpreted in a radical cognitive science sense, i.e. as minimal or atomic processes and operations lending themselves to explicit modelling and simulation). If a child succeeded in doing not more than 10-20% of the elements of this task, she/he must have repeatedly related (sub)problems to previous (sub)problems, recognized relationships, analyzed a (sub)problem, synthesized information, and the like.

At the same time it is not certain if certain processes and operations in any of the children actually conformed to rules of LOGO (or that of elementary geometry) or not. Some salient phases of observed
Reflections on Phase 1 of the ITEC Project

activities are splendidly structured (either by the teacher or by a pupil for another) but overall, the activities follow the free exploratory attitude advocated by Papert and others. Relevant international literature testifies that although children may like playing with LOGO and maintain constructive activity for prolonged sessions, their understanding of semantics of commands and the language in general may frequently be deficient. This is neither proved nor disapproved by our observations precisely for the same reason why higher-order cognitive processes are not in strict sense identified.

Suggestions

The videotapes—or any system of (written) protocols of behavioural observation—may provide quantifiable evidence for confirmation of the realization of an educational programme. It enables the researcher to compute frequencies of categories of overt occurrences (events). Categories may be defined with a high degree of sophistication, along several dimensions for one and the same flow of occurrences. Observation data of this kind remain, however, not more than raw anecdotal material for studying cognitive processes. It may suffice to orient the planning of research actually probing into cognitive processes of children, but it is not sufficient to confirming the presence (actual execution) or structure of any such process.

If this is true the dilemma will be whether to complement the present data by experimental (or at least quasi-experimental) findings proving specific cognitive processes—and only by them, cognitive abilities or "levels of development"—or constrain ourselves in naturalistic observation which would actually prevent the study of cognitive processes and abilities.

It follows that in view of Phase 1 data no strictly scientific answer can be given to the question concerning the conditions under which computer use had a positive impact on higher-level cognitive functioning. The two main causes are:

- the insufficiency of anecdotal evidence to prove cognitive functioning
- and the small range of values along any of the predictors defined (computer use, social interaction, instructional integration).

The sessions observed in the target school in Hungary contained several different settings for computer use: they also included varying social and interpersonal contexts in which children indulged into computer-aided task realization. The range of different settings and contexts is however not wide enough. In one school and one classroom, under the direction of one teacher it was not possible to contrast dissimilar settings and contexts.

Even if such a comparison had been possible it would not have been reliable to draw conclusions without an opportunity to assess children individually. Observations and video recordings do not offer a possibility to know the individual and average cognitive performances of children participating in context A versus those in context B (or setting A vs. setting B). What we have is anecdotal evidence concerning behaviours of one or some children in any of the contexts or settings.

Compared with what has been found in international literature about using LOGO at a comparable age cohort it is clear anecdotally that most of the children in the target class have a good command of the LOGO language. They seem to have mastered the system of turns and moves constituting the basic layer of the language; have appropriate knowledge of basic geometry (figures, angles, rotation in the plane); are mostly able to replace egocentric perspective by a 'turtle' perspective. At least half of the children seem to be able to use the capacities of LOGO in solving novel tasks creatively. All this appears to point at the possibility to teach LOGO to fourth graders in average Hungarian elementary schools. It does not tell however anything specific about higher order cognitive processing as a function of environmental determinants.

Comments on Phase 1

- Although political and institutional changes in Hungary made following and funding long term projects difficult, our team became even more interested in carrying on the ITEC Project.
- Phase 1 should serve the development of our tools but only the video recording, the less pertinent of them, has been tried out. We think some psychological tests should have been tried out in parallel, in view of selecting them for cross-national analysis.
- The tools we received from the Steering Committee are certainly the result of a prolonged preparatory work. However it might be useful to discuss them with all the participants in order to achieve an interpretation shared by everyone. We hope the working session in Victoria, B.C., attained this goal, but omitting discussions before acting can cause loss of time.
Recommendations

- International coordination and co-operation should be improved within the ITEC team. We encourage contacts among national teams, while regular contacts between the central organizers and the national groups are the most important.

- Standardized pre-tests and post-tests may be needed possibly under "laboratory conditions" in part or whole because classroom conditions make the assessment of higher level cognitive abilities impossible. For cross-national comparison we may propose verbal or non-verbal pencil-paper tests. (See G.M. Habermann's "Brief methodological comments", Section 3.4.1)

- In order to be able to assess any impact of computer use on children's cognitive development, we recommend to use one or two control groups (parallel classes), at least in the national projects.

- Video recording seems to offer rather general impression than any possibility of exact assessment of higher level cognitive activity. Direct observation on the spot should remain the main form of observation and an observation standard concerning time sampling and specimen vs. frequency of occurrence must be developed for international use by the ITEC team.

- Observations on higher level cognitive activity in classroom setting could be best standardized for cross-national comparison by organizing two international groups of the ITEC participants and giving them opportunity to carry out and discuss observations together. They should be then charged with training the national observers.

Notes

1. Csákó M., Altalános iskolai pedagógusok viszonya a számítástechnikához a kapcsolat kezdetén (The attitude of primary school teachers to computers in the period of their first contacts with them). Project report, Budapest, 1985; --


Teachers' attitude to computers at the quasi-zero degree of computerization. Contribution to the European Conference on Computers in Education, Lausanne, 1988; --


3. In 1990 the street and the school has been renamed "Arpad" after the chief of the Hungarian tribes when they settled in Europe. The earlier designation commemorated an 1919 Communist leader.

4. Relation between social segregation and education in a neighbouring district has been explored by an in depth sociological project in the late 70's. See Csányi G. and Bánk J., Szelkció az általános iskolában (Social selection in primary schools), Magvető, Budapest, 1983.

5. A guide book for teachers has been published: Farkas K. and Körös M., Jásszd el a teknőcot! Informatikaoktatás 1-2. osztály. (Act out the turtle! Teaching informatics in classes 1 and 2), Pest Megeyi Pedagógiai Intézet, Budapest, 1989. The authors' method is to integrate children's computer use and acting out (imitating) the turtle's moves—in other words the corresponding LOGO-commands—with their own steps and turns in the real space of the classroom.

6. A similar experience has been analyzed in De Corte E. et al., Acquiring programming skills in LOGO: an exploratory study with sixth graders. Paper to the IACE Annual Conference, New Orleans, 1988.


Motivation for joining the project

In Japan, the introduction of computers into schools was launched in 1985 nationwide. Many governmental committees and councils were established and reported the recommendations on political strategies of educational computing. The Chief Researcher participated in almost all committees and Task Forces on introducing computers into Japanese Schools. As one of the researches, I conducted the national survey of psychological impacts of computers on child development by the requests of the Ministry of Education, Science and Culture. We gained the interesting results on child behaviours using computers. Therefore, we would like to compare our results with those of other countries.

Description of the community, school, teacher, and class

The community surrounding Shiura Second Primary School is situated in the eastern part of Tokyo Metropolitan District and surrounded by mixed residential and industrial area. Economical and cultural conditions of families are average. The School has 14 classes. The first and third grades have three classes, and the other four grades have two classes each. The number of children in each class is on an average 30 to 35. The school has experimented to use computers for the past four years in various ways from CAI, CMI to informatics Education. All teachers including Fine Art, Home Economics, Health Education and special education use computers for teaching, and school or classroom administration and management. The two teachers participating in Phase I of the ITEC Project are male and have good computer-operating skills. They are coordinators of other teachers on the promotion of educational computing in schools. Their classes are respectively 4th and 5th grade. The age of children are from 9-10 and 10-11 years.

Description of the computer-use lessons

Three lessons were videotaped. All lessons are taught in the computer classroom which has 14 16-bit computers for children and 2 computers for the teacher and their local area network. Children use computers in groups. Usually two children use one computer, but sometimes three use one. While children are studying by computers, the teacher goes around everywhere in the classroom and individual guides children. Sometimes children and the teacher talks with head-phones.

The first lesson was a fourth grade arithmetic class, where children studied the calculation of subtraction of fractions. The task presented to children by computers, for example, was that an amount of liquid was in a container A, 4/10 was transferred to another container B, and 1/10 was spilt out from the container B, then how much is left in the container B. After finishing the tasks of fraction, children can select other kinds of tasks such as calculation of area overlapping in two rectangles.

The second lesson was a fifth-grade Logo Writer class. Children made sounds and composed music, changed turtles to other attractive patterns, let them move around, painted the background, enlarged the patterns an accomplished the animation. The third lesson was a fourth-grade arithmetic class, where children studied tasks of calculus by commercial CAI courseware.

A summary of observations with respect to observed behaviours assumed to be associated with higher-level cognitive activity

Children studied very hard. Sometimes two children competed to use computers in a group, but frequently children discussed to solve problems with each other, while describing ideas in their notes and a display. As the teacher walked and looked around everywhere in the classroom, children were able to ask questions to him any time they wanted. Especially in the animation class, children described ideas in their notes, or seemed to make attractive patterns on display while imaging the final scenes.

Suggestion for a response to ITEC's general research question

Although children were motivated to solve questions even if the tasks were given by the computer in the CAI situations, the better conditions seemed to be more flexible task situations such as making animation by Logo Writer. These children are able to imagine the final state and create attractive patterns by themselves in the group discussion situations. Group problem solving seemed to be more beneficial to the higher level of cognitive activity than the independent problem solving.

However, there are some difficulties that one child without operating the computer sometimes might be tired and become less motivated. In order to enhance children's motivation, make them more active, and
stimulate their higher-level of cognitive activity, the integrated instructional methods which use blackboard
descriptions, textbooks, note-books, group discussions, and computers seem to be more effective.

An overall reflection on Phase 1.

The study of Phase 1 in ITEC project was very useful for understanding children's behaviours of
problem solving in computer use situations. Children in videotapes showed highly motivated and enthusiastic
behaviours on study which were never seen in traditional classroom teaching situations. We were able to
know the effectiveness of computers in education.

However, there were some difficulties for conducting the Phase 1 Study.

First, it was quite difficult to know the conditions of children's families, because of privacy problems
and of the viewpoints of educational equity.

Second, it was difficult to get suitable software or courseware for enhancing children's higher-level
cognitive activity, because children differed one from the others in cultural backgrounds, study abilities,
experiences in computer use, interests in special subjects, and so on.

Third, it was very difficult to videotape children's behaviours. Especially, we were unable to videotape
both children's study behaviours and scenes in displays simultaneously. When we shot children's study
behaviours while they were enthusiastic to discuss and solve problems, we should miss the scenes which
made children induce active behaviours. Therefore, it was impossible to understand the exact
relationship between stimuli in computers and children's behaviours, and guess the effectiveness of
computers.

Fourth, it was, moreover, quite difficult to guess children's higher-level cognitive activity by the
observation from outside. When children gaze the computer display with concentration, they may
imagine the final goal situations or select a sequence of better alternative actions. Although these sorts
of difficulties were in the proceeding of the study, the Phase 1 study was very useful for seeking better
methodology in the future investigations.

Recommendations for Phase 2

Several improvements in the study procedure might be undertaken.

First, we should use the wiper for videotaping both the computer display and children's behaviours
simultaneously.

Second, we would be able to make protocols on children's cognitive activity by showing videotapes to
children themselves and by asking the children to interprete their own cognitive activity in their mind
through watching their own problem solving behaviours in videotapes. Then we could draw flow-charts
of higher-level cognitive activity in children and infer the effective functioning of computers on child
cognition in the model of cognitive processes derived from accumulated flow-charts.

Third, in these cases, we are able to compare the data between excellent students and poorer students in
the problem solution in the conditions of computer use or between children who have more experience
and less experience on computer use.

Fourth, we are also able to compare the data among different use of computers in classrooms such as
CAI, measurement of natural or social phenomena, word processing, use of application software like
graphics, drawing, music composition, spreadsheet, data base, communication, and programming.

Fifth, we are, moreover, able to compare children's cognitive products shown by the problem solving
tasks between computer experience and computer inexperience which will be investigated by
questionnaires. There would be many ways to conduct the Phase 2 Project, referring to the observations
in the Phase 1 study.
**Motivation for Joining the Project**

In Mexico, although there is a lot of interest in applying computers to education, the economic situation is such that only the private schools, generally associated with foreign communities, where the children of these foreign communities and other well to do groups can attend, because of the high tuitions, are presently benefiting from the use of new information technologies. The Mexican Government has initiated a program to introduce computers in secondary and recently primary public schools but there is only one computer per school available in some schools that have been provided with a computer; many still have none. There is thus great interest in Mexico in knowing what factors in the use of computers in education are effective in positively changing the manner of reasoning of students, given that in the past the educational system has concentrated in memorising facts and students and even teachers have played a very passive role in the educational process leaving almost everything to the Central Government Authorities. The ITEC project could be very helpful in detecting in a multi-cultural environment factors that are really important. These factors may or may not require a computer for every two students, sophisticated new technologies such as multimedia, teachers very familiar with computers and other solutions that tend to be expensive for developing countries such as Mexico. Since the solution that Mexico will apply is unlikely to be the one applied by the rich nations, a multitude of approaches in countries very different from Mexico is the ingredient that may provide the information we are seeking.

**Schools, Communities, Teachers, Class and Computer-Use in Class**

Mexico is a country rich in contrast. Schools go from the very sophisticated that have very well trained staff and are well equipped with the latest technologies to the one-room primary school with one teacher instructing all the children from first to sixth grades lacking a library, Xerox copier, and telephone. The training of the teacher may not be much above that of the students. For this reason we wanted to include a variety of schools in Phase I of the ITEC Project. We wound up with two private schools and two public schools.

The private schools are both well-to-do. One is associated with the English-speaking community and has a good connection with IBM of Mexico since one of the children of the President of the company studies there. The school has received a donation of many of its computers from IBM Mexico and has three full-time university graduates in charge of these computers. Their teaching methodology is that each teacher takes the students to a computer laboratory and uses the computer as a complement to other class activities. The people in charge of the laboratory are constantly looking for software that may help the teachers illustrate or provide exercises for their courses and discuss with them the possibilities and train them in the use of the software and any other requirements they may have. Most of the software used is in English, mostly because of the acute lack of educational software in Spanish. However its use is acceptable because it is a bilingual school that teaches both a Spanish and an English program of studies. The teachers are relatively well off, are bilingual and have generally travelled outside the country therefore they are aware first hand of other cultures including the one that created the software they use.

The second private school is associated with the Spanish (from Spain) community in Mexico and is also a well-to-do group. They have acquired a network from a Company associated with the BBC of England that has translated most of the educational material to Spanish. They also have the teachers take their students to a computer laboratory although recently with a change in Computer Coordinator things are changing and the computer laboratory staff is taking in their hands more and more of the teaching in the laboratory. This in the writer of this report's opinion is a step backwards. However it reveals one of the characteristics of Mexican education: the frequency of changes in personnel, in methodology, in availability of funding, etc. The teachers are also relatively well to do but may not be bilingual. The software they use, however, is in Spanish, generally. (There may be some exceptions in say graphical packages where the language barrier is less profound.)

The two public schools are very different from each other. The first school which finally dropped out of Phase I of the project because the two researchers associated with the project left the school in search of better salaries (the salary of a Mexican teacher is currently $160.00 U.S. per month.) is one of the public schools in Mexico City with a good reputation for being very forward in its teaching methods and in extra activities. It has acquired a PC computer with funds obtained through the Parent's Association as well as an experimental Radio Station in spite of the fact that it has no telephone, no copying machine and no formal library. The reason for its good reputation is a trio of people working in the school. The Director has a Master's Degree which is something out of the ordinary in Mexico. It also has a couple of people with university degrees in Communications that have been instrumental in moving things much more than in similar schools. The student population belongs to the low-middle class (children of factory and agricultural workers for the most
part) and the school is one of those in the Government’s Program that has one computer for the whole school (the computer is different from the PC acquired with Parent Association’s Funds) The software available is adapted from software developed for higher grades (secondary school) and the computer is an 8-bit machine with a 5.25” drive and a 20” colour monitor. Programs are designed in such a way that the whole class can see the letters and since there is only one computer there is essentially no interaction between the computer and the students, since the teacher is the one that handles the machine. The teacher is lower-middle class, monolingual and earns the salary mentioned above.

The second public school is a very special situation since it is a group of hearing-impaired children that belongs to the Directorate of Special Education of the Ministry of Education of Mexico and they have been outstanding pioneers in the country in the use of computers for teaching hearing-impaired children. They handle groups from first grade primary to third grade secondary. This group of teachers has no computers of their own and use a room with computers provided by the National University of Mexico. The teachers have been doing this work for about seven years largely on their own, apparently because of the benefits that they can see that the children obtain by using the computer. One of the sayings in this community is that the computer is very appropriate for these children because like them it is deaf (in the sense that communication is not through voice but rather through keyboard and visual screen.) The children attending this school are also low-middle class with a few exceptions. They work in groups of ten children with special education teachers that are generally more extensively trained than ordinary school teachers, but receive the same salary as other teachers.

The lessons involved in the observations of Phase I for the case of Mexico involved a variety of situations. In one of the observations of the ordinary public school the lesson involved Spanish Grammar and the computer was used mostly to announce the topics that were being covered. Any indications of higher-level thinking was really elicited by the teacher’s questions and the computer was only a prop. In other lessons the students were drawing things with Logo and there was higher-level thinking because the students were faced with a problem, original as far as they were concerned, and the students were able to solve it.

Observations Associated with Higher-Level Cognitive Activity and Comments

We have found very difficult to be sure that what we film is evidence of higher-level cognitive activity. In some cases the evidence may be there but does not necessarily show on film and in other cases we may be confusing higher-level thinking activity with attitudes that could but not necessarily involve such activity. My personal opinion is that such instances are much better detected by the teacher conducting the class than by experts observing edited tapes in foreign languages. Thus for the data gathering I would rely on teachers’ comments and would leave the tapes for some verification but mostly for public relations efforts. The whole question of “higher-level thinking” seems to be full of difficulties. Although a paper was passed around with some tentative definitions, the Project never had an official definition and the guideline given were vague enough that any results can at most be tentative. This is probably a typical example of a research question that has to be dealt with intensive detailed observation of cases rather than with statistical techniques.

Suggestions for Response to ITEC’S General Research Questions

It has been mentioned in the Victoria meeting that the data suggest there are all sorts of conditions under which there is a positive impact on children’s higher-level cognitive functioning in the use of computers in the classroom. Thus the following suggestions are of a very personal nature not based exclusively on formal observation during the ITEC Project.

To me the important thing to get children involved in higher-order thinking is first of all get them interested, second to present them with some challenges difficult enough that they have to exert themselves but not excessively difficult that they get discouraged. All this can be done in infinitely varied ways and depends more on the creativity of the teacher than on amounts of equipment and software. Although some pieces of software may help a teacher to do the above activities more than others. One of the big items about computers is that it seems to get the children excited, possibly because it looks like a game. I feel much can be done with one computer in the classroom as long as the teacher has some imagination. Lacking an imaginative teacher I would resort to imaginative software such as educational adventures and some educational games, but having an imaginative teacher almost any software is just as good. The same thing goes for the equipment and the recent advances in multimedia. Lacking a good teacher I would prefer to show the children interesting videotapes. But with a creative and imaginative teacher the result can be obtained with pieces of coloured cardboard, or an encyclopedia or with field trips, and even by having the teacher narrate things and ask leading questions and starting a good discussion. The social interaction is generally created by the teacher and school rules and general environment and is little affected by the computer itself or the software (although again some pieces of software may be more leading to good interaction than others). Finally the teacher can integrate almost anything into the curriculum with enough imagination and long as the environment of the school allows it. Part of the problem is the rigidity with which the curriculum is handled which often does not leave any time for creativeness, given that the curriculum is too full and too much is spelled out in detail.

In short my opinion is that the teacher is the key to good computer use, and that creativeness and imagination are the key ingredients as long as the environment allows things to be tried out.
Reflections on Phase I and Recommendations for Phase II

It was very necessary to try to measure higher-level cognitive functioning in Phase I to convince oneself of the real difficulty in doing it and in coming to scientifically supported conclusions with respect to this matter. I come out more convinced than ever that the teaching and learning process is much too complicated to yield to simple models. One of the models in vogue among some people in the artificial intelligence community is that the central nervous system is organized in the learning process by forming the connections between a very large number of neurons in a model that may have billions and billions of connections. This is equivalent to a model with billions and billions of parameters, which we do not know how to handle at this time. The neural nets learn things by randomly connecting processors in large quantities by a process somewhat similar to “teaching” the machine in a relatively simple manner (such as telling it if the answer is right but providing little additional information.) If we are to believe in this school of thought every brain is constantly changing its connection as the brain learns. But vastly different connections may function just as well, hence there may not be a preferred way of teaching or a preferred way of learning and only long experience may provide guidelines as to what has worked and what has not.

Thus at this time I do not favour statistical models with a few parameters to adjust to decide what to do with respect to computer use in the classroom to generate high-level thinking in the students. This means we should assemble leisurely for planning what to do with respect to Phase II of the project which may have to change to detailed observations from a group that has previously agreed on what to look for and may have to extensively discuss personally among its various members before coming with any useful results. I doubt very much that the study will be of a statistical nature.
Reflections on Phase 1 of the ITEC Project

4.7.8 Summary Report of ITEC Participation, Phase 1, New Zealand

By Kwok-Wing Lai

Motivation for joining the project

Since the advent of microcomputer technology to classrooms in the early 1980s, increasingly more students have been using this new tool to support learning and thinking. Much research has been conducted investigating the effects of computer use on higher-level thinking skills, but at present it is unclear under what conditions the computer can be used most effectively. One of the main reasons for the inconclusive outcome is the difficulty in measuring higher-order thinking skills in the context of computer use. Recognizing these difficulties, the ITEC project aims at addressing the issue by adopting a sound theoretical framework and developing standardized instruments in a cross-cultural investigation to provide better measures of higher-order cognitive functioning. The opportunity for researchers and teachers from different cultures working together is a great learning experience and I believe this effort will contribute to a better understanding of computer use in classrooms.

Description of the community, school, teacher and class

The school in this Phase 1 study was located in the city of Dunedin, the fourth biggest city in New Zealand, with a population of 110,000. The school, Waikari Primary School, was in the suburb of Waikari, a middle-class area. This government-supported school had approximately 270 students and 12 teachers. There were six grade levels, from Junior 1 (age 5) to Standard 4 (aged 11). The class where observations were undertaken was a composite class of Standard 3 and Standard 4 (9 and 10 year old) and there were 35 students. These students were grouped according to ability. The vice-principal was the teacher of this class. He was an experienced teacher, with nearly 20 years of teaching experience. He was also an experienced computing teacher, having had graduate training in computer applications and having about 10 years experience in using computers in teaching. He was very active in the local computer sin education society and has conducted several literacy computer workshops for in-service teachers.

Description of the computer use lessons

Three computer-use lessons were videotaped. The first lesson was a database-oriented activity. Students were asked to set up a database using information they had collected on a field trip to various beaches. They used key words to categorize information and at a later stage came up with questions to retrieve information from the database. They worked on the database in small groups.

In the second and third lessons a computer program named "Transylvania" was used to support the development of group skills and problem-solving skills. The objective of the program is for the user to rescue a woman who is trapped inside a statue. To do this the students must work out the goal of the program, what tools they may need, how to get to where the statue is and how to avoid or get past the werewolf. Again, the students worked in small groups (2 or 3 students per group).

Summary of observations associated with higher-level cognitive activity

The teacher was interviewed after each observation, and was asked to report whether he had observed any higher-order thinking skills displayed in the lesson (Form I). The researcher was also asked to respond to two separate questionnaires (Forms J and K). In Form J he was asked whether he concurred with the teacher's observations (and why) and in Form K he was asked to respond to 10 indicators of higher-order thinking skills and indicate the extent of these skills being displayed in the computer classes. In general, in all three observations the researcher concurred with the teacher's observations that several higher-order thinking skills have been observed, at least for some students. Specifically, higher-order thinking skills of relating a problem to previous problems, formulating questions, trying alternative approaches, evaluating one's own actions, analyzing problems, recognizing relationships, and synthesizing information were displayed by some students while trying alternative approaches an observing central issues and problems were generally seen in the computer-use classes.

In the computer-use lessons there were two computer-related curriculum activities, namely , in a database-oriented activity and a group-solving activity. In the database activity the teacher commented that some students were able to use their personal experience to establish key words to categorize information for the database. Some came up with a plan to find out which keywords were most likely to provide the information they wanted. Based on the plan, they formulated questions and subsequently tested these questions. Some students were able to explain their plans to the teacher.

In the group problem solving activity, students also need to establish a plan in order to save the woman. Initially they used trial-and-error but as their confidence increased, they set up more of an organization
whereby if they picked up an object, e.g. the silver bullet, they would evaluate its use. Some students formulated hypotheses (e.g., "if this does not work we might have to go... on and on") and evaluated their decisions. Discussions following the computer-use lessons showed that students had recognized the importance of trying alternative solutions to problems.

Responses to the Research Question

It is obvious that the computer-based learning environment set up by the teacher was conducive to the development of higher-order cognitive skills. The computer use was carefully integrated into the lessons, where co-operative group learning was particularly emphasized. Throughout the three computer-use lessons, students were encouraged to practise group problem solving skills. In our opinion it is clear that with the aid of the computer a rich learning environment was created which encouraged the acquisition of higher-order thinking skills. For example, in the database lessons, the students were seen categorizing information, and subsequently retrieving information from their database by testing and evaluating hypotheses. In the two “Transylvania” lessons students were seen exercising planning skills.

There is no doubt that the learning environment under study was successful. But in the New Zealand case the role played by the teacher was crucial. The classroom teacher had a solid understanding of how and when to provide guidance and leadership; and his knowledge in problem solving and computer use was of great asset. Also there was an extra teacher in his class, which made it possible for him to look after individual groups.

In our opinion it is difficult if not impossible to single out a factor, or even a combination of factors to account for the successful outcomes of computer use in these three computer-use classes. Of course, explicit instruction on higher-order thinking skills, the opportunity to practise these skills, as well as small group discussions were certainly important factors. However, it was the total environment, the interplay of reciprocal influences of these factors that contributed to its success.

Overall reflection on Phase 1

There is no doubt that the ITEC project has provided a good learning experience for both the students and teachers as well as for the researchers. The participating children were excited to know that children from other countries were also working on the same project. It was also exciting to have the opportunity for researchers from different cultures to work together on the same issue.

Recommendations for Phase 2

There are a few recommendations for the Phase 2 study:

1. Standardization of procedures and instruments is important if reliable results are to be obtained. Researchers should understand the procedures and the operational definitions used in the study. For example, it is important for the researchers to have a consensus of what higher-order thinking skills mean before they proceed to conduct the observations.

2. Although higher-order thinking skills could be observed in a computer-use lesson, it is likely that skills acquired during these lessons will be displayed in a non-computing environment. If computer use is effective, we should expect some sort of transfer. Therefore it may be more productive to observe both computing and non-computing lessons. We may wish to take a whole curriculum unit, rather than a computer-use segment (or a lesson) as the unit of analysis in future investigations.

3. A more formal procedure should be used to measure higher-order thinking skills in the Phase 2 study. If observations are to be used, clearly defined variables should be observed. Some sort of verbalization analysis should also be conducted (e.g. interview, protocol analysis) to solicit information on cognitive gains.

4. Videotaping is a useful means of collecting information, especially in a small-group setting. However, certain technical problems (e.g., sound) should be addressed. Also, transcripts written in English (or translation) should be provided for analysis.

5. It is also recommended that the participating teachers should have a more active participation in the future project. A communications network should be set up for the teachers so that they can share their experiences and concerns with their counterparts. This may also give the participants a sense of control.
Considerations of the Background of the ITEC Project Organisation in Romania

As for their organisation, those groups have used a series of both common and different elements. The psycho-pedagogical aspect was coordinated by a research group from the institute of Educational Sciences (a group leaded by E. Noveanu).

(a) Common Elements

Both School No.17 and School No.56 are:

- general schools with 8 forms (children from 6 to 14 years age);
- large schools;
- placed in a town (approximately in the central area);
- close to big an well-known secondary schools with a certain orientation towards sciences;
- average and above-average social contexts;
- old, over-passed endowment with educational means (as it actually is in the whole country);
- level of computer endowment: six HC, with external memory on cassette;
- computer-use activities welcomed both by the masters and by the teachers themselves;
- parents thought that using the computer was a certain advantage for their children;
- the research leaders did not belong, either to the school, nor to the teaching stuff;
- a special lab for informatics already existed;
- the psycho-pedagogical coordination was the same;
- the children’s high interest;
- small number of computers implied working in groups (4-6 pupils per computer);
- both video recording and editing were realised by the same team.

(b) Differentiating elements

School no.17:

- less crowded;
- systematically organized computer-use lessons since the pupil’s first form (meeting);
- this initiative is greatly helped by near by institute for Computers and Informatics (ICI);
- the pupils chosen for the experiment were 10-11 years old (in the fourth form);
- the computer-use activities were taught by one of the members in the ICI research team (who also had certain experience in teaching, as she had been a school teacher herself for three years);
- the experiment consisted in practising programming knowledges applied in different school subjects;
- the whole class was simultaneously involved in the same computer-use lesson;
- computer-use lessons aimed at creative activities and correlated knowledges from different fields (informatics and other disciplines).

School no.56:

- more crowded (children organized on three shifts, from 7 a.m. to 8 p.m.);
- systematically organized computer-use lessons since the pupil’s second form;
- local initiative of the school teachers;
- the pupils chosen for the experiment were 9-10 years old (in the third form);
- the computer-use lessons were taught by the usual teacher of the class herself (the Romanian system of education imposes only one teacher for a class since the first up to the fourth form);
Reflections on Phase 1 of the ITEC Project

- the experiment consisted in integrating, within the usual lessons, programs and practising skills, educational games etc.;
- the class was divided into two groups, that were taught the same lesson, but not at the same time;
- computer-use lessons aimed at logical and anticipative thinking.

General Psycho-Pedagogical and Methodological Remarks

From the development of the investigation conducted in the two schools above-mentioned, we may draw the following conclusions:

(a) The experimental data confirm the hypothesis that the computer's use produces an impact on the cognitive capacities of the pupils (for further details, see reports A and B);

(b) At the same time, the collected data, through their structure, enable us to compare them to the data gathered by other research teams (each and every group representing a particular type), and draw conclusions at the general level of the ITEC investigation.

(c) As a result of the research, there appears to that a more detailed investigation, both in the theoretical field of the approached matters and the methodological domains, is needed.

It is on these matters that we are going to briefly insist on adding our propositions to this phase of the project.

The theoretical stand of the ITEC project, formulated in the initial documents or in the resulting from the analysis of the suggested methodologies on the one hand, and the experience gained in practice, during the phases that have already been implemented, on the other hand, allow us to reveal a series of aspects on different hierarchical levels, that demand a more thorough insight into the matter, especially from the psycho-pedagogical point of view.

(a) The orientation of the investigation

We think that, at the present, the orientation of this investigation is too ample; it goes without saying that its main characteristic is investigation, but the elements that make part of the mechanism are too numerous. It is as if examining different grain deposits to see what kind of other grain one may find in there. It might prove efficient even in this way, but in our opinion this is not the most straightforward way of effective procedure. If we intend to analyze the way in which a certain theoretical position is turned into practice for a certain age envisaged (9 years, perhaps) for example the concept of "group cognition" as an intermediary experience between the child's figurative understanding and conceptually based operative understanding, then we shall come to the conclusion that we must organize an interaction to make children work in groups to facilitate the breakdown of individual understanding. If we introduce the computer in the scheme of the experiment (software), as an interaction element with the pupil, we can verify if this scheme may favour or not the elements we had in mind to check.

It is here that we must specify that in this experimental scheme of the interaction among pupils and computer the most important element to be studied is the group's structure: in the case of authoritative leaders, in most of the cases, the process of learning is hindered and the results are not the expected ones for the rest of the group.

(b) Cognitive development

We agree with Roblyer, Castine, and King (1988) that there seem to be differences in the effects of computer applications among content areas and these differences may be due to the type of application interaction with the type of skill within the content area.

Adhering to such a position means to design our own experimental scheme, in which we do not compare elements which are different (or do not "put them in the same pot").

We believe that this is the field to be given priority when trying to make clear the concepts and methodology. It is imperative that a model of the areas under investigation be settled and a set of instruments, to reveal the coming into being of cognitive capacities (metacognitive, affective, violative) be devised, bearing in mind what we want to investigate; it is only the information obtained with the help of an unitary instrument (internally coherent) that may represent in a starting point in such a delicate research as the ITEC Project envisages.

(c) Methodological problems of investigation

Taking into consideration the experience we have gained so far, we think it necessary to stop and ponder over not only the results (which should be put together into a comprehensive synthesis study for the meeting due in May 1991), but also on the research itself. We believe that a group made up of 3-5 experts (psychopedagogues) should be constituted to analyze the information gathered during the research, and devise the ways of developing continuing and deepening the research, recommending the necessary types of instruments, the adequate experimental schemes etc. This group of experts would work independently from the group that
Our general background and motivation for joining the Project

The first steps in introducing the technologies based on computers in Romanian educational system started in 1984/85, once the national production of personal computers began.

There are more directions:

a) enlarging the curriculum by introducing in mathematics some elementary notions about informatics and BASIC programming;

b) specific subjects for high schools orientated towards informatics;

c) research - encouraged and financially supported especially by the Minister of Electronics and Electrotechnology within the institutes of research (The Institute for Computers - ITC); the Central Institute for Informatics - ICI); this aspect is aimed first and foremost to realise adequate educational software but also to experiment with computer use with the pupils (organizing special courses and even camps);

d) organisations for children and youth that aim to familiarize the young generation with computer-use based on techniques during special courses, camps and national programming contests for pupils. Although this has so far involved a respectable number of children and thus prepared for introduction of this type of activity in the national educational system, it also has a few shortcomings: it has no pedagogical principle on which to organize; and it took into account only a single aspect of this activity: the algorithmic structure of thinking, while learning programming;

e) some isolated achievements within the educational system itself: some enthusiastic teachers tried both to integrate the computer in their usual courses and to organize additional computer-use activities, apart from their usual lessons.

The research teams from the Central Institute for Informatics and the Institute of Computers have made studies about educational technologies since 1984. The research was directed at experimenting with:

- using computer in school as a part of the usual educational process;
- using computer in school by learning BASIC;
- using computer in school, by LOGO methodology.

As the educational system was mostly organized as a rigid, authoritative, non-permissive structure, since 1988 research has included studies focussed upon possible modifications in the educational system by means of the technologies based on computers (e.g., to integrate computers in school using educational games-type programs, or to promote creative activities based on computers).

After the revolution (December 1989), the researchers had the possibility to "enlist" in the International Project ITEC and thus - the opportunity to start a substantial study upon generalising technologies based on computers in school; as most of the national resources in this domains were involved in this project, the collaboration with other countries offered the possibility to reintegrate the country in the European and World circuit.

In 1990, The National Institute for Educational Sciences (ISE) and The Centre for improving the Teaching Stuff's Activity in Informatics (CPPDIC) were founded as institutes subordinated to the Ministry of Education; they had undertaken and nationally coordinated the research in this domain.

Summary Report of ITEC Participation - School No.56

(a) Community, school, teacher and class

Romanian primary school has been only a secondary target of the plans that the Ministry of Education has for computerizing the schools. Regular computer use in classroom teaching is sporadic. There is a minority of teachers involved in computer use but their main interest is to teach programming not to integrate computers in regular lessons.

Lower age groups have usually had less access to computers in primary school.

Under these circumstances two schools in Bucharest were chosen to participate in ITEC Phase 1; they represent the main tendencies of computer use in primary school:

- School no.56, where computer use is based on logical collective games and LOGO methodology;
- School no.17, where computer use is based on the BASIC language (also see Mrs. Anca Costin - Summary Report).
Reflections on Phase 1 of the ITEC Project

School no.17, where computer use is based on the BASIC language (also see Mrs. Anca Costin - Summary Report).

School No.56 was chosen first of all because of some young and enthusiastic teachers, willingly participating in such an experiment. On the other hand, both the headmaster of the school and the Ministry of Education fully approved of the idea.

Last, but not least, the school had a better (although not excellent) computer endowment as compared to other schools: six HC-85 (Sinclair Spectrum compatible computers, 48Kb free memory and external memory on cassette) and a CP/M compatible computer with a printer.

The school is a rather big one (over 2500 pupils; 100 teachers); it is placed in a heterogeneous zone - where the new part of the town (built in the 1970-1980) intermingles with the old section - with a totally different architecture. In the same neighbourhood within a small distance there is an important secondary school (Mathematical Physics orientated), as well as the Faculty of Construction, an Institute for Constructions Projects, and a candy factory. The cultural background, mostly directed on the technical line, has undoubtedly influenced the level of children's learning in this school.

The pupil’s parents are 60% graduates of different faculties; as for the others they are workers and office workers, most of them in Bucharest. The school has a new architecture - it has been built in 1965. Its project plan at that time supposed that there would be a swimming pool in the school yard and many sport grounds; but within the last years, the economical crisis caused their degradation and the impossibility of using them anymore. The school has many classrooms, including workrooms (for electrotechnics, locksmith training, embroidering and sewing) and labs (for biology, physics, chemistry and informatics), a sport hall and a surgery.

A striking characteristic of the school is the huge number of pupils crowded in because of the demographic expansion of the 70s, unrelieved with more school building.

Therefore this situation: 40 pupils in one class. The educational process is organized following three shifts (from 7 a.m. to 8 p.m.). Under these circumstances, one must admit that experimenting with computer use is a rather difficult task. Most of the pupils in school are Romanian citizens plus a few of them are Romanian gypsies.

The cultural background and the educational process are above the national average, but not of a special type. The headmaster is an ambitious teacher, who more or less successfully manages in maintaining an equilibrium between the different tendencies in school.

The teacher involved in ITEC, Mrs. Tatiana Ionescu, has not attended any special courses on informatics but she is mostly familiar with computer use and also has a computer at home. She has been chosen for this experiment because she responded most willingly to the opportunity to integrate computers into her lessons.

The 3rd form selected for this experiment has no special characteristics as compared to the others in school; there are 39 pupils; 22 boys and 17 girls. Their ages are between 9-10 years in 1989/90. The pupils were familiar with computer use as they had already attended a few computer-use courses in school.

The general model of the Romanian primary school is to have only one teacher from the 1st to the 4th form.

As six computers were insufficient for 39 pupils, the class was divided into two groups of 19 and 20 pupils and the teacher repeated with each group the same lesson.

As it is obvious, when watching the first recording on the videotape (the usual, ordinary lesson with no computer use) in the Romanian contemporary educational system the informative aspects overwhelm the formative ones; pupils can only seldom have their own initiative in the teacher-student relation as the general atmosphere is rigid.

The student-student relation is mostly infrequent in their attempts of solving together some problems; learning in group is also an almost inexistant fact.

(b) Description of the computer use lessons

As already shown above, the computer-use lessons aimed at creating a stimulating climate for the pupil’s learning potential; in a permissive, non-authoritative atmosphere, children ought to be curious, spontaneous, and to have their own initiative.

Therefore, computer use activities were based on the following software:

1. An adequate "drill and practice" software for different specific subjects of the 3rd form. One may say that these programs were the classic type of computer-aid instruction: the traditional patterns of learning are completed with the new element, the computer. It became obvious that using this software helps the pupil to make progress in learning, and encourages him when he needs it; these programs usually
appreciate the students' results with qualificatives, instead of marks. Special attention was focused upon integrating computer use in lessons (as a consequence of the whole team's deliberation, within the teacher has an essential part). Computer use in such lessons took 15-30 minutes. The software was oriented towards the most difficult problems included in the curriculum (the so-called "hot spots") and also towards the problems for which computer use is helpful and implies more efficiency and less wasted time.

Therefore, the first step was to identify the above mentioned "hot spots" in the 3rd-year curriculum. The educational software used also aimed to "arm" the children with correct skills and basic principles for computer use such as: learning the use of some essential keys; moving a cursor (or another object) on the screen; using menus (option choosing); using certain programs including simplified ones of spreadsheet type; basic principles of dealing with a database-type collection (searching, choosing, etc.).

Some of the programmes in this experiment are:

- "The Romanian Language" (to practise hyphen-use), "Words" (to practice difficult spelling), "The Noun" (recognizing the nouns in a given list of words) - which has also been the model on the demonstrative video tape (2nd computer use recording on the tape), "The Verb" (recognizing the verbs); "Tablead" (practising the skill of mathematical operations and the problem of solving in a table shaped form), etc.;

2. Using some logical game-type programs (competition), both for practising different skills and for developing logical, anticipative, creative thinking. The teacher's indications in this respect were very important. The element of competition meant a considerable increase of the pupil's concentration upon and their interest in that certain matter. Some of these programs are:

- "The Cave" (the ability of orientating in a labyrinth shaped on several levels) - was chosen for the first computer-using record on the video tape), "Geowords" (recognising notions and concepts used in Geography), "Animals" (skills of classifying and systematizing animals on different criteria), "Rabbit", "Reversi", "The Tower of Hanoi", "The Blue Road", "Logical" (the word "cal" in Romanian means both "horse" and "knight") - (skills of developing one's own state when solving a problem), the latter was chosen for the third computer-use record on the videotape, "Painter", "Music" (to develop creative skills) etc.;

3. Familiarising the pupils with the specific LOGO-type of thinking and learning, and with the computer as an instrument for measurements and experiments. Therefore, there were also used a few procedures already introduced in the LOGO system, that enable measuring (distances and angles) and experiments (closing the triangle, calculating the sum of its angles, etc.). These activities were also organized as games.

Generally, a computer-based lesson supposes:
- a teacher's presentation of the problem and of the software used;
- a computer-use activity (children solve problems, individually or in group - each child using the computer for 10-20 minutes);
- (usually) some pupil's explanation upon the way he solved the problem.

Most of the pupils got integrated in computer-use activities, showing special interest for this kind of activities. They were in general more familiarized with using software that demands individual activity and less familiarized with "working" in groups. They was no major difficulties experienced in using computers or the software.

The educational software has mostly the same topics as the pupils' usual curriculum, but there were also some new elements (anticipative thinking; familiarisation with the forward-backward-left-right-up-down plan). According to the result of this software, there will be provided certain recommendations for developing the actual curriculum.

(c) Observations associated with higher-level cognitive activity and comments

Both the scientific researchers and the teacher are sure that each of the recordings of the videotapes contains frequently many elements that suppose executing some higher-level cognitive processes, such as "trying alternative approaches"; "evaluating one's actions", "formulating appropriate questions", "synthesizing information", etc. The great number of these processes makes more difficult integrating them within a given pattern (Form K).

During the first recording on the videotape of the computer-use lessons the pupils have to find a treasure in a labyrinth-cave shaped on a number of levels (the "Cave" program). This task needs that each given
Reflections on Phase 1 of the ITEC Project

command should execute properly and involved a great number of cognitive processes and operations such as:
evaluating the actions, alternative approaches, synthesizing information, analyzing problems, etc.

At the same time, we think that it is not absolutely sure whether certain processes and operations noticed
during the recording belong to the high-level cognitive function. For example using "The Cave" program in
the class determines most of the teams search thoroughly for the treasure hidden in the cave; but often, the
observer can’t be sure (watching the film) whether this behaviour is an organized exploration or one of the
"persisting" or "high-absorption task" type.

Another problem regards the way the recording itself was realised (with a simple camera): namely one
videotape that only allow observing one single pupil (team) at a time, during a longer interval. For instance,
one of the sequences shows a boy (thoroughly?) thinking in front of the computer and then taking a decision.
Lacking the whole problem-solving context of his whole activity, we can not be sure, once again, whether
he was analyzing and really thinking upon his would-be decision or if his behaviour was only a "stop" that
perfectly initiated a high-cognitive process. Therefore, we may conclude that the high-cognitive processes
have not been, strictly speaking, identified.

Nevertheless, numerous high-level cognitive functioning behaviours have been revealed; they belong to
the following types in Form K:
- evaluating ones' actions and formulating appropriate questions (in all the three
  recordings);
- trying alternative approaches and analyzing appropriate problems (first and third
  recordings);
- recognising relations and synthesizing information (first recording);
- observing central issues and problems and relating a problem to previous problems
  (second recording).

We have also realised a list with all the behaviours that could be high-level cognitive functioning
behaviours that have been observed and that fit (under the above-mentioned limitations) the types of Form K:
- discussion among peers;
- discuss alternatives with peers;
- explain one's own way of solving a problem;
- critical thinking about actions of others;
- share work in the group;
- ask questions;
- control one's own work;
- commenting, analyzing ones' own work;
- looking for alternatives, self evaluation;
- looking for help;
- evaluation and decision making after trial and error;
- high absorption in task;
- reflection;
- extrapolate previous understanding to new situation;
- "stop to think" and learn from reflection;
- persisting;
- alternative representation, also (language-"images"), creative analysis, insight into
  levels of complexity of a situation;
- developing a "cognitive map" to visualise/organise information;
- moving from one to another representational system.

(d) Suggestions

We can say that the video tape allow observing and researching different types of pupil's behaviour as
well their frequency of occurring during the computer-use activities.

Most of the pupils in the chosen class developed a basic skill of using the computer (basic commands,
program-using techniques, etc.); improved their problem-solving abilities by means of informatics techniques
(e.g., moving the knight on a carriage); developed new capacities relative to learning situations that had been
almost extinguished in other schools in Romania.

Still, the given data, through able to be used in studying the cognitive processes, have certain limits that
make it more difficult to structure them. Such limitations are:

1. Insufficient data (specially the ones regarding the individual behaviour). It is
   impossible to know either the individual performances or the average performance
   of the whole group. The videotape cannot possibly display the whole complexity of
   behaviours. One single video-camera can watch the whole context (dialogues, for
   example) of only one single pupil or team at a time - which is sometimes an irrelevant
difficult to organize. Only thus would clearly appear both the pupil-pupil and the team-team relation.

Therefore we consider it would have been more useful to combine the videotape with an audio one (perhaps realised independently). Thus, for "The Cave" program, we recorded on an audio tape the discussion of a team (of 3 pupils) arbitrarily chosen. The research team then analyzed this tape. Of course, the audio (individual) recording needs different techniques both for realising and for analyzing. We suggest to try and have each pupil’s voice recorded with a microphone locked on his coat.

2. Small possibilities of evaluating pupil’s progress in the observed class within (or compared with other groups that use otherwise or not at all the computer) a longer period of time (because we had little information regarding their skills at the beginning and at the end of this period).

Within the experiment in School No. 56, we also collected data regarding each pupil’s skills. For instance in one of the classes that aimed to shape anticipative thinking, we recorded on the tape a pupil’s individual results based upon the way of solving the given problem (for example, moving the knight on a table of 3 per 3 squares). Thus we recorded: (given problem; number of movements proposed by the pupil; real movements; time of solving).

Concluding with a consideration of the hardware, the small number of available computers did not allow the best participation for each pupil and there should have been external memory with floppy units available for a better organization of the computer-use lessons.

Thus it is difficult to give immediately after Phase I an answer about the conditions for a positive computer-use impact upon children’s cognitive functioning.

Summary report of ITEC Participation: School No. 17

(a) Community school, teacher and class

The MINICOMP project developed at ICI, had in view the elaboration of educational software and organized experiments in schools and kindergartens. Since 1986, the General School No. 17, in the neighbourhood nearby the institute, has served as the “research” centre for the MINICOMP project.

It is a eight-year-old public school, not far from the central part of the town, with an average social background, even more than a medium social level, with a high percentage of intellectuals among parents.

The school has been equipped with computers, SPECTRUM compatible, by ICI. The teaching staff were not used to working with computers and had no previous contact with them, so that the lessons in informatics had to be held by the members of the MINICOMP team. Nevertheless, we have been permanently assisted by the board of teachers and by the teachers themselves, who cooperated in the accomplishment of the experiment along with the parents.

They regarded this activity as an advantage for their children and not as compulsory supplementary work.

(b) Description of the computer-use lessons

In spring 1986 the MINICOMP team began to work with the pupils in the 1st form. The 40 pupils of the form were divided into five groups of eight children each, and they work daily as a group, for thirty minutes, on the computer.

The software for the lessons consisted of the educational program BAMBY, written for pre-school children and for pupils in the first form. The following year, preserving the same organisation, the children began to learn programming in BASIC. The lesson duration increased to one hour, weekly. Stress was laid on the graphical and musical "capabilities" of the computer. At the same time, an attempt at familiarising the children with the repetitive and alternative structures of the language was being made (FOR, IF).

In 1988, when the ITEC project came into being, these children were in the 4th form; they were 10 years old, an age which befitted the purpose of this project.

The lesson’s content:

For the ITEC project it was envisaged to turn into good account the knowledge acquired in programming by these children, by applying it in different subjects such as maths, music and drawing.

There has been no use of CAI; the children themselves made up their own programs to solve the problems put by other disciplines. At the same time, these lessons represented a reinforcement of the pupil’s knowledge in programming, in the following way:

- For music, they represented a revision of the knowledge, regarding the C-major scale and of the BEEP instruction in BASIC. The computer was used as an instrument, stimulating the children’s creativity.
Reflections on Phase 1 of the ITEC Project

- For music, they represented a revision of the knowledge, regarding the C-major scale and of the BEEP instruction in BASIC. The computer was used as an instrument, stimulating the children's creativity.
- For geometry, the children consolidated their knowledge about graphics on computer (instructions PLOT and DRAW) and made use of it in organizing the screen and determining the geometrical figure, horizontally and vertically;
- For drawing, their programming abilities enabled the children to show their creativity while drawing a poster (the theme was at choice), using graphical characters.

Lessons' Organisation:
The restricted number of computers at our disposal led to the making up of rather big groups of children (6 per group). The group activity made it possible for the children to cooperate in the joint solving of a problem, but some of the better children tried to impose their opinions and became leaders of the group. This became evident during the children's contests, when the less-prepared children easily accepted the propositions made by the "leaders" and the competition developed mostly among them.

These interdisciplinary lessons and lessons in applied informatics were conducted by the teacher of informatics (she is a member of the team, but is also experienced in education) and not by the permanent teacher of the form.

(c) Observations associated with higher-level cognitive activity

Although when organizing these lessons, stress was not put on a series of manifestations to be associated with high-level cognition (Form K was received by the researchers only afterward the video had been made), after analyzing the videotapes we made, we can point out such manifestations. The most important ones, in our opinion, are: the capacity to correlate and sense the resemblances and the discrepancies in comparison with other previous problems and to make use of previously acquired knowledge. This is to be explained through the characteristics of the lesson's content: making use of programming knowledge within other disciplines.

As it has already be stated, the way the form is organised favours cooperation within a certain group, and the capacity of compromise. But, at the same time, it also proves that some children have a tendency to give up personal initiative and easily accept the others' solutions.

The character of this activity determines the children to make a plan of their own, before starting to work: for a music class, they make up a melody on the staff, then they transpose it on the computer, through a program; for geometry, the children draw the robot on mathematical paper, make it, then they calculate its coordinates and make the program; and for the drawing, the poster is conceived on mathematical paper first and then is transposed on the computer. Even programming may be considered as a process of elaborating a plan to solve the problem, because it presupposes the decomposition of the problem into its little steps, up to the instruction level.

The making up of a melody or of a poster, finding out solutions for the robot's rescue lost on the Earth represent manifestations of creativity, of finding new ways, new alternatives.

Under competition conditions (the melody contest, for example), the children have to formulate critical opinions regarding the other colleagues' actions.

(d) Suggestions

The experiment held in School No.17 was based on the interaction among teacher-pupil-computer by means of programming, that is why our observations strictly refer to this type of activities:

1. The programming activity is open to ten-year children, and stimulates the superior cognitive process because:
   - it obliges them to draw a clear-cut line between a significant and the less or insignificant aspects of the matter;
   - presupposes a decomposition of a more complicated problem in a series of less complicated ones, and then the synthesis of these steps in a unique program (the algorithmic approach of the matter);
   - presupposes the recognition of a problem with repetitive character (cycles, loops); with alternative character (decisions, jumps); with conversational, interactive character (man-computer dialogue);
   - enables the making up of a new problem, similar to the previous one, but with a higher degree of complexity, which favours the establishment of a correlation with previous approaches;

2. By means of universal use of a programming language, to enable the student to:
4.7.9 National Report of ITEC Participation Phase I, Romania

3. A new programming language represents a means of developing creativity, manifested both in the way of conceiving a program and of choosing the informatical solution to a particular problem;

4. Organisation of computer activity may be achieved in groups or individually (if the hardware supply allows for it). We have underlined the advantages in a group activity (cooperation, compromise), but these groups should not be too large and the members of the team should be approximately at the same level, otherwise the leaders tend to take the leadership of the groups;

5. Computer use, through its interactive character and by means of quick or immediate results offered, constitutes a supplementary motivation in the educational process, mostly for the pupils who have a tendency towards giving up the finding of a solution and transfer the responsibility to their colleagues;

6. There have not been noticed manifestations of aggressiveness within the groups, but we may not be fully aware of it because the whole activity took place under the strict supervision of the teacher.

(e) Conclusions

Taking into account consideration the comprehensive list of high-level cognitive manifestations delivered after the workshop in Victoria (Canada) it seems that the first stage of ITEC in School No. 17 achieved its goal; to underline the cognitive functions in the use of computers by children. From the point of view of the experiment in School No. 17, in Bucharest, as it has already been pointed out, part of these manifestations are quite evident.

Our main drawbacks were the following:

- the restricted number of computers at our disposal, which do not allow for direct and complete use of computers by each pupil participating in the experiment;
- the fact that the main teacher did not participate directly in this activity, although he encouraged it;
- the fact that many of the main manifestations of the high-cognitive level functions we have noticed in children's activity are not fully rendered by videotapes.

Recommendations

Even if the methodology for the second stage is to be settled after the Conference in Varna, in May 1991, the general background of the experiments to be performed during the 1991-1992 school-year should be outlined as early as possible.

In order to choose the forms and the teachers to work with during a second stage of ITEC, we should know as early as possible before this stage:

- if the pupils, who participated in the first stage would participate in the second as well. (note: they are more than 10 years old now and study in the 5th form, which presupposes more than 1 teacher);
- if the programming activity, as a means of interaction between pupil-computer, is regarded as most appropriate for the study (as we have pointed out above, we think that programming demands the use of high-level cognitive functions of children.

We believe that, in case we can get the information on time, we could make possible for the teachers themselves (through previous training) to use the computer as an educational means.
Reflections on Phase 1 of the ITEC Project

4.7.10. Summary report on Phase 1 of the ITEC Participation: Russia

By the Russian National Committee for UNESCO Affairs

Motivation for joining the project

Participation in the ITEC project was motivated by several reasons. First, goals of this project are similar to the goals of our project "Developing Informatics in Primary School". Both projects are aimed at the identification of the factors which influence students' cognitive development during computer using. We hoped that we will be given additional information about our students by ITEC Project data. Second, we supposed that cross-cultural analysis within the ITEC Project will help us to overcome our cultural-specific stereotypes and to have a new view point of our own studies. Third (last but not least), participation in the project provided opportunities for exchanging ideas and experience with specialists from other countries. We can state now that our hopes were realized in the large extent.

Description of the community, school, teacher and class

Third-grade students from School 91 were involved in the Project. This school is one of the best Moscow schools. It is not a super-privileged school for the VIP's children but in some aspects it is an unusual one. First, it has the special status and attracts special attention as an experimental school of the (then) USSR Academy of Pedagogical Sciences. The most advanced educational techniques are used in this school and the best teachers are invited. Many of the teachers get additional salary at the Research Institute of General and Educational Psychology as teacher-researchers in the school permanently. Foreign guests visit the school very often. Second, the school is located in a very prestigious area—an old street in the centre of Moscow. All these conditions create the unique atmosphere of the school. Children as a rule are proud to be School 91 students, they feel their "exceptionality".

The majority of the students are middle-class children. There are no special entry criteria for students. Usually children live in the neighbourhood but some children live in another district of Moscow (their parents want them to attend School 91 and have managed to use their personal relations in order for their children to be admitted to the school).

During the 1989/1990 school year there were two third-grade classes in the school, approximately 40 students in each. The children were randomly distributed between a 3"A" and a 3"B" class. The 3"A" class was involved in the ITEC Project.

Natalia Tabachnikova was also involved in the Project. She is young but an experienced and competent teacher. She taught third-graders math and was the 3"A" supervisor.

Description of the computer lessons

The computer lessons took place in the computer lab, equipped with 16 MSX-2 computers (a local net of 15 students' computers and 1 teacher's computer), 2 floppy-disc drives and 1 printer.

The learning process was organized within the framework of the "Developing Informatics in Primary School" Project. The authors of this report were curriculum designers, investigators, teachers and assistants.

There was the following background for the "Developing Informatics in Primary School" Project. Until now LOGO was used as the leading approach to the computer use in the primary school. However experimental studies revealed rather low "cognitive efficiency" of LOGO. We have tried to identify the causes of this turtle-graphics low efficiency. Teaching third-graders (9-10 years old) LOGO was the first phase of the investigation.

The teaching process consisted of two stages. At the first stage children studied the basics of LOGO. Students were provided with the possibility of active experimenting with the material in the interaction with computers. Then (at the second stage) students were asked to design their own LOGO procedures for various pictures. These pictures were purposed by the teacher or invented by the children.

At the beginning of Stage 2 there were two introductory lessons. They were devoted to (a) the principles of programming (a simplified version of the structured programming basics) and (b) the demonstration of these principles by the teacher—working out the "HEAD OF THE CAT" procedure.

At Stage 2 the children were organized into groups of 2-4 persons. Each group had its own picture. We hoped that grouping would stimulate the co-operative work. This was partly realized. According to students' words they sat and worked out programmes during and out of school time. However at the computer lab we observed each child's aspiration to work at the individual computer. We could not provide such possibility for all students and the distribution of the computers was often accompanied by "little tragedies"—conflicts, offences and sometimes even tears. Evidently the cause is the very high "social status" of working at the
computer. So, every child wanted to use the rare chance to play with this mysterious exotic thing. First, it is interesting by itself. Second, it is possible to boast of working with the computer later. Unfortunately, the main thing is usually key pressing or screen watching, but not the meaning of these elementary actions.

Special attention was paid to the forming of the structured approach to programming (in its very primitive version). Advantages of task decomposition, identification of picture structural components, design and debugging of the separate procedures for every component were emphasized. Pictures were invented specially for demonstration of the benefit of the structured approach. These pictures consisted of many repeated elements.

**Observed Behaviours Assumed to be Associated with High-Level Cognitive Activity**

The videotape describes three lessons from the second phase of the turtle graphics learning. At these lessons students worked out their own LOGO-procedures. They solved the following problems:

- a) design of the LOGO-procedures (converting pictures into the LOGO-procedures, the children usually had completed this task before);
- b) acquisition and practical application of the user interface handling skills;
- c) typing (entering the procedures texts into the computer, loading the russification file, etc.)
- d) analysis of the results of the procedure’s execution, search for causes of unwanted results);
- e) planning the remediation or the modification of the procedures
- f) remembering the current procedure after the interval, restoration of the mental model of the procedure

The last three of the problems were assumed to be associated with high-level cognitive activity during computer-use lessons. Solving these problems was manifested in different aspects of debugging behaviour. Restoration of the procedural mental model was associated with the initial analyzing of texts (on the screen and in the notebook) and running the procedure. The search for causes of mistakes was associated with the exploratory behaviour which could be observed after identification of incorrect results of a procedure execution. Usually children were looking at the screen and speaking aloud (e.g., "Where have I been mistaken?"). Modification of the program’s mental model resulted in the modification of its text. It should be mentioned that all these indicators of high-level cognitive processes are not very sensitive and reliable. Any kind of high-level cognition can occur when the student is only sitting at the computer and looking at the screen.

Only part of the students manifested high-level thinking. Basic statements of the turtle graphics were successfully studied by all students but the whole circle of the design and debugging of LOGO procedures was only mastered by a part of the class. Evidently, differentiation of tasks on the basis of its their difficulty was not sufficient. This shortcoming was partly compensated by the teacher’s help. Sometimes the teacher set a new problem which was a rather simple part of the initial problem.

Three approaches to the problem solving were observed among those students who were assumed to display high-level cognitive processes. Only two students adhered to the consistent structured approach, recommended by the teacher. At the early stages of procedures development these students had some troubles: (a) their efforts did not result in such tangible effects as the efforts of 'spaghetti programming' proponents, (b) it is much more difficult to maintain and to restore a mental model of a procedure while applying structured approach, comparing with non-structured linear conversion of every picture element into an individual LOGO statement. However, at the later stages of procedures development these problems were less severe.

Two students changed their approach to a non-structured approach despite the teacher's requirements. They had the first pictures at the screen very soon after starting the work but by so doing they usually had the greatest problems. Most of them could not debug their procedures effectively.

Two girls were the most successful. They created procedures for three rather simple pictures. They tried also to develop procedures and decided to reduce their goal (to make a procedure for the monster's head instead of the whole monster).

So, we observed the strong tendency to reach screen effects immediately. This tendency interfered with the acquisition of the general principles of the algorithm design.

At the end of the school year we compared our students (from the 3"A" class) with the students from the control group (3"B" class) using a specially created set of the "non-computer" tasks. These tasks were created with the aim of selective measurement of the three components of the algorithm design skills: (a) determining the sequence of actions which leads to the goal, (b) coding this sequence of actions (writing it down in a formal language), and (c) selecting the best sequences of actions among several possible. Results had shown that there was only one significant difference between experimental and control classes—the difference in the coding efficiency.

311
Reflections on Phase 1 of the ITEC Project

Summing up, the results of our investigation can be considered as an evidence that there are high-level cognitive processes during LOGO learning and that this learning influences students' cognitive development in a specific way.

Conditions of a Computer-Use Positive Impact on Children's Higher-Level Cognitive Functioning

(a) Characteristics of computer use

Our observations lead directly to the three conclusions on the optimal conditions of the positive computer impact on high level cognitive skill development:

First, educational software must be equipped with a user interface of very high quality (easy-to-learn, easy-to-use). Concentration on technical aspects of interaction with computer distracts students' attention form the content of their work, leads to cognitive overload and so disorganizes high-level cognitive processes.

We observed high-level thinking only in students who had acquired skills of human-computer dialogue successfully. Probably the opposite, the dependence, takes place as well, i.e., that the higher the level of cognitive development, the more successful the user-interface skills acquisition. However, it does not contradict the notion that improving the user interface is an important factor of the "computer-aided cognitive development".

Second, the optimal combination of computer and non-computer learning activities is needed. Computer use lessons have their advantages and disadvantages. The advantages are well known: additional motivation, active use of students' knowledge, immediate feedback which provides the practical testing of the knowledge acquisition (the criteria is simple: "does it work or not?") and reduction of the routine auxiliary actions.

However, computer use can lead to negative consequences. We have found that in dialogue with the computer, students' thinking often 'narrows': concentration on the local tasks interferes with whole understanding of the problem. Immediate feedback seems to stimulate the tendency of immediate response. Then, the intensive low-level interaction with the computer occurs but the holistic approach to the problem disappears. Often we observed students who made countless "trial and error" attempts in situations where stopping and thinking were necessary. Of course, this kind of behaviour was accompanied by the great reduction of communication with other students.

Probably, in a more favourable situation (unlimited computer resources, better educational software etc.) it would be possible to create appropriate conditions for creative thinking, discussions, efficient and flexible analysis of the various aspects of the problem (including reflections on the general approach to the problem) at the computer lab. However, in many cases computer-use lessons must be optimally combined with the non-computer ones for maximizing the advantages of both type of lessons.

Third, the appropriate level of the task difficulty is also an important factor. We observed sometimes that too-difficult or too-easy tasks lead to the student's interest decreasing.

(b) Social interactions

It was mentioned previously that the social prestige of computer use is very high in the observed population. It was manifested in particular in each child's desire to have his/her own computer during the lesson. We can hypothesize that it influences the high-level cognitive skills positively. However, our observations do not confirm this hypothesis. Further investigation in this fields is necessary.

Observations of the "student-student" interactions during computer use had shown that these interactions increase the efficiency of the problem solving if the interacting students are of similar level of competence. In such conditions we observed: (a) discussion and mutual help; (b) distribution of functions between the students (e.g., one girl reads aloud the text of procedure written down in the notebook, another girl compares this text with the text on the screen); and (c) effective use of equipment (e.g., one screen is used for the text of the procedure, another for the appropriate picture). The grouping of students was changed slightly from lesson to lesson because students were sometimes ill. Some students worked in both the "same level" groups; these students were much more active and productive.

(c) Instructional integration of computer use

According to our experience instructional integration of computer use is highly desirable. In the case of our study LOGO learning was not closely related with the standard curriculum. The 'special status' of computer use lessons has created many problems.

In fact the above-mentioned requirements of the optimal coordination of computer use and non-computer lessons (see "a" above) can be formulated as a requirement of optimal instructional integration of computer-use lessons.
An overall reflection on Phase 1

The results of the ITEC Project Phase 1 are very important in several aspects.

First, they provide an impressive description of the varieties of the computer use (and not only computer use) in education. Learning these results helps us to overcome cultural stereotypes and to gain visibility.

Second, it is valuable to attempt to identify the dimensions of the computer-use varieties, to 'catch' and understand this reality.

Third, these results provide additional information about the observed students, about their learning and cognition.

Recommendations on Phase 2

In our opinion two problems have to be solved for the ITEC Project Phase 2 to be successful.

1. Measuring the information technologies' impact on the children’s cognitive processes.
   It would be useful for this aim to differentiate between 'manifestation' and 'development' of high-level cognitive processes. It would be useful also to specify the target high-level processes on the basis of the concrete analysis of the cognitive functioning under the conditions of educational computer use.

2. Standardization of the conditions between countries.
   This is a very difficult problem. Too-large differences make the comparison almost impossible. Too-strict standardization suppresses the factors under investigation. So, it is necessary to formulate requirements which can provide both the compatibility of the data from the different countries and the possibility for observation of the all pertinent phenomena.
Reflections on Phase 1 of the ITEC Project

4.7.11 Summary Report of ITEC Participation, USA, Phase 1

By A. Pilz, G. Pilz, P. Resta, USA

Motivation for Joining the Project

Internationally, many studies have been conducted in which the performance of students receiving computer-mediated instruction is compared to the performance of students in traditional instructional settings. As important as these studies are, there remain a host of unanswered questions related to the varied ways computers:

- are integrated into teaching-learning process;
- impact and transform the classroom environment over time;
- may be utilized to help develop "higher order" thinking skills in elementary school children.

Nor do we adequately understand the specific factors related to administrative leadership, school climate, training, and the barriers and incentives that are important to teachers in the use of computers in the classroom. In addition, the traditional evaluation paradigms and assessment procedures used in computer education research studies do not appear to adequately account for and encompass what is happening with children using tool and open-ended software programs in the classroom.

The primary interest of the U.S. research team in participation in the ITEC project was to work collaboratively with colleagues in other countries in helping to address and clarify these problems.

School and Community

Zuni Elementary School in Albuquerque New Mexico, (the largest city in the state with a population of 495,000), is located in a densely populated northeastern part of the city. The school is bounded by middle-class single-family dwellings on the north and the east and by small professional buildings and the city’s largest shopping centres on the west and south. The school population could be considered typical for those schools in Albuquerque that serve middle-class (mostly white) neighbourhoods but is not representative of the cultural diversity of the state which includes larger percentages of Hispanic and Native American (Indian) students.

Zuni serves the school-aged population of students who live within the school boundaries. In addition to in district students, Zuni serves:

1. Those students whose parents are part of the Uptown work force;
2. Those students whose parents will make a commitment to be actively involved with Zuni Magnet school;
3. Those students and parents who have an interest in a computer and communications school.

Due to the size of the facilities and uniqueness of the program, the magnet school enrolment at Zuni is limited.

Zuni’s mission statement includes the following statement regarding computer use:

Zuni School is committed to providing students with an education that will benefit them in the 21st century. Computers are a very essential part of that education. The very comprehensive computer program at Zuni Elementary School is designed to encourage the development of critical thinking skills, as well as confidence in the use of the computer as a tool. There is a computer in each classroom in addition to a networked computer lab used by all classes, from kindergarten through fifth.

When asked what kind of difference the computer lab had made, the staff made the following responses:

- Dramatic 12%
- Considerable 68%
- Moderate 15%
- Slight 6%

A recent evaluation of the school indicates that parents and staff are very satisfied with the overall program at the school (an unusual response from an American population that is generally unhappy with the state of public schooling). The evaluation states, “Both parents and staff expressed satisfaction with the
emphasis on computers. Parents said their children were enthusiastic about computers and students said they liked working with computer. When asked about "higher-order learning processes" the parents and staff responded in the following manner:

**Percent Satisfied:**

<table>
<thead>
<tr>
<th></th>
<th>Staff</th>
<th>Parents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative Learning</td>
<td>74</td>
<td>91</td>
</tr>
<tr>
<td>Critical thinking</td>
<td>8</td>
<td>86</td>
</tr>
<tr>
<td>Learning to learn</td>
<td>74</td>
<td>74</td>
</tr>
</tbody>
</table>

The teacher:

Sylvia Mills, the original teacher selected for the ITEC research, was selected as the Christa McAuliffe scholar for New Mexico (1990-1991). This honour (named after the American teacher-astronaut killed in the tragic Challenger accident) is bestowed upon one teacher in each state. It allows this teacher to leave the classroom for a year and work as a general resource for the entire school. The award also gives the teacher an opportunity to conduct research and work on projects related to their own professional growth.

Ms. Mills appears to have the respect and admiration of school administrators, students and staff. She was the first resource person recommended to us by the school principal to help with the ITEC study. She is intensely interested in the educational application of computer technologies and has been instrumental in building the school’s computer program. Ms. Mills acts as a resource to teachers throughout the school who are experimenting with new learning technologies. She recently stated that she believed that "teachers at Zuni are now ready to move away from the highly structured activities associated with programmed learning laboratories and move on their own to construct activities that reach higher order thinking skills".

Ms. Mills' 5th grade classroom has two computers in it: an Apple IIGS and a Macintosh. Limited observations indicate that these computers are an integral part of the class curriculum. Computer-generated artwork, writings and projects decorated the walls, and students gathered around the computer to work on simulations and notes for a history project. Students also worked in computer laboratories that were set up for drill-and-practice software but were used by Ms. Mills for "word processing related to class projects rather than programmed learning".

**Higher-level Cognitive Activity**

The entire ITEC study is based on a concept (higher-level cognitive activity) that has never been clearly defined in American educational literature. Although school districts around the nation require that such activities be included throughout the curriculum, the application of this mandate is purely idiosyncratic to the teacher and school. In order to better understand the perceptions that the staff brought to the task of teaching higher-level cognitive skills, the research team asked Zuni teachers and staff to define higher-order thinking skills in a short written response. 49% of the respondents spoke only in general terms about what they perceived these skills to entail. These responses fell into three major categories:

1. (35%) Operating at Blooms higher-order taxonomic levels which include the synthesis, analysis and evaluation of knowledge;
2. (39%) Applying knowledge and skills to problem solving;
3. (33%) and being able to go beyond what is immediately obvious in the pursuit of #2.

23% of the respondents went beyond general discussions to specify how they actually work on higher-order thinking skills in their classrooms. 26% of these respondents felt that the major strategy for incorporating these skills was "questioning techniques involving open-ended questions". 23% of the respondents mentioned computers as "tools" or "strategies" to reach this goal.

Direct quotes, (presented below), from teacher responses indicate a variety of perceptions regarding the definition of higher-level thinking skills:

"Younger Children need to explore reality and imagination...the need to listen to stories where problems are related and solved"
"...children need to use all of their senses to facilitate their thinking skills."
"...constant work on caring and understanding in and out of the classroom."
"...more than rote memorization and facts."
"...encouraging students to analyze a subject."
"...conceptualizations and generalizations should be incorporated."
"A primary goal of computer usage should be ...creativity and analysis."
Reflections on Phase 1 of the ITEC Project

"...inspiring students to want to learn more on their own."
"...learn to deal with basic logic in making sense of their world."
"I am not sure what higher order thinking skill are how to apply them."

The Lessons

The lessons observed involved students with "Lego/Logo" which combines Logo programming with a plastic construction set. Students can build models which use electric motors, gears, sensors, pulleys, and wheels which are then controlled by Logo programming on the computer. Seymour Papert, the inventor of the Logo programming language, states, "In Logo environment...the child...is in control: The child programs the computer. And in teaching the computer how to think, the children embark on an exploration about how they themselves think...Thinking about thinking turns the child into an epistemologist."

Unlike most lessons, students were give only the most general guidelines and were asked to develop the problem, solve it, and then apply what they had learned in the "manufacture" of the final LEGO/LOGO product. The video tape indicated that the degree of "high-level cognitive" skills employed by each student differed greatly. Some students developed complex "widgets" combining gears, pulleys and intricate LOGO programs to drive them; while others built the most elementary gadgets that did little but play music and spin around. Even though the assignment called for a greater degree of inquiry and problem solving than would be found in a "normal" classroom lesson, it was obvious that different students were able to challenge themselves according to their own motivation and abilities. No amount of careful planning technology and or "high order" curriculum can ameliorate differences in developmental readiness and motivation.

The teacher plays an important role in helping all students reflect upon what they had done. The questions were open-ended, yet asked the students to reflect and explain. Some examples from the tape illustrate the teacher's questioning approach:

"What are some ways you could adapt this if you had the time?"
"What other difficulties did you have developing this project?"
"What were some turning points where you felt that you had made some good breakthroughs?"
"What started off as a simple pencil flinger turned into something quite elaborate, what did you do to develop this idea?"
"What kinds of things are you working on adapting today?"

ITEC's General Research Question

Conditions that provide "a positive impact on children's higher-level cognitive functioning":

"The teacher him/her self must be operating at higher-levels of cognitive functioning in order to act as model or guide for students."
"The computer must be part of the "regular" curriculum that students interact with every day rather than some special set-aside project."
"The entire curriculum should support higher-levels of cognitive functioning."
"Computer use should be problem oriented."
"Computer time should support student communication and collaboration and should not be highly individualized as is often the case in programmed instruction."
"In the case of the site under study, the entire faculty was committed to the use of computers. This type of commitment creates a "critical mass" which promotes experimentation and creative use of learning technology tools."

Overall Reflection on Phase 1

The variables of importance, research questions, and categories of data were determined a priori and presented to researchers in the ITEC instructions/forms. This approach ignores some of the principles of qualitative research which suggest that the best data and the most valid description/analysis of variables in a situation under study must come as a result of intense fieldwork guided by generally stated research questions that leave room for the "insiders' perspective" to emerge and inform the results. The ITEC format was a "fill-in-the-blanks" approach that assumed all relevant and important questions were already known.

The US team found the time frame for Phase 1 to be unrealistic for more than a pilot study. Privacy laws and research ethics acceptable to school districts in the United States require bureaucratic approvals and parent permission for children's participation in any research project. Getting the necessary approvals takes considerable time and must be completed entirely to school district satisfaction before any research can begin.
The ITEC goal of international collaboration to answer imperative educational questions relative to the applications of computers in schools is a worthy one, even where philosophical and methodological differences among the researchers exist. Thus, it is important for us to consider and refine the structure and "processes" of the ITEC research model, as well as the "outcomes", so that this type of collaboration will continue.

**Recommendations for Phase 2 of ITEC**

It is recommended that one of the major objectives of phase 2 of the ITEC Study should be:

- the continued refinement of the evaluation paradigm and assessment instruments and procedures.
- clarification of the concept of "higher order" thinking skills as applied to computer based instructional tasks.

In the long term, the joint work of the international team on these issues may represent the greatest contribution of the ITEC project.
Reflections on Phase 1 of the ITEC Project

4.7.12 Summary Report on ITEC Phase 1 Participation, Bulgaria

by V. Tsonova, Bulgaria

Motivations for Joining the ITEC Project

A group of researchers from Bulgaria joined Phase 1 of ITEC for several reasons:

(a) All of us recognize the fact that in a society rich with information and technical equipment, the skills for thinking are becoming essential qualities that have to be trained from the early school age. That is why we consider the answer to the ITEC general research question to be of importance both for the school practice and for science.

(b) All of us are well aware of the fact that the research on the impact of computer use in classroom settings on higher-order cognitive functioning of children is still at its initial stage.

(c) We approve of the ideas presented in ITEC's overall model of the variables accompanying children's computer use in school, and in particular the stress on the computer being integrated into the curriculum rather than being just a supplement to it.

(d) The very general social context of computer use is still closely bound to a fear of the computer, mainly by adults. This phenomenon has to be studied. The Bulgarian children, as potential users of computer-based information technologies, must be protected from this feeling. Children could influence their parents' attitudes toward computer use.

(e) The Bulgarian youth have an interest in computer hardware and especially for software development.

(f) There is experience in computer use in schools in Bulgaria. There are computers, trained teachers, and software both at school and university levels enough for their regular use in education and research. Since late 1982 microcomputers have been used in the educational sphere in Bulgaria. There are many examples in Bulgarian classrooms of educational success based on regular computer use in the teaching/learning process.

(g) Starting from 1987 some of the members of the team had participated in the preparatory activities of the project. The main ideas of the early papers of the project met our own ideas and our desire to participate in such a research project.

(h) We wanted to have personal contacts with leading experts in the uses of information technology in education from different countries.

Description of the Community, School, Teacher, and Class

The number of students in the selected class (from the 5th Grade) was 32. Most of them were 11 years old. More than half of the class had had computer experience. In the 4th school year, the students had lessons involving computer-assisted learning, two lessons a week for five months. Those lessons aimed at the acquisition of some Logo commands and skills for person-computer interaction at an operational-technical level. Of the students, 15 of the boys have also participated in a school circle for Lego-Logo activities, and 8 girls and 13 boys have had experience with computer games (at home, in youth clubs,) once a week.

The teacher is a young charming woman, loved by the children. During the period 1984-1989, which is also all of her professional life, the teacher has participated in ten courses, seminars, workshops, etc., in Logo, organized by the Bulgarian Research Group on Education, and in two international summer schools relating to Logo.

The Bulgarian Phase 1 school can be described briefly by saying:

(a) It is a common, large state school for general education, with 12 school grades, for day students only.

(b) The typical entry age of the students in 6-7 years and the exit age is about 18 years.

(c) The school is autonomous only in some respects; i.e., it can distribute the money it gets from the research centre.

(d) The school follows the typical model of formal "teacher-student" interaction.

(e) A low percentage both of the teachers and students (less than 10%) have access to computers at home.

(f) A comparatively low percentage of the teachers (between 10-30%) make some use of computers for instructional purposes.

318
As compared to other Bulgarian schools, the ITEC school is in the top quarter with respect to its computer equipment.

The computers are located in different places in the school buildings.

The students live in the neighbouring area and their parents are predominantly of intellectual professions and have graduated from universities or colleges.

The school has quite a good and long-term experience with experimental activities in education.

Description of the Computer-Use Lessons

In the computer-use lessons, there were more than three computers available, which were being used by more than three-fourths of the students in the class during the time of the videotaping. The computers were in a computer room.

The software used was a programming language and the activity was an informatics lesson, whose goals appeared to be primarily practice and mastery, concept development, or problem-solving and experimentation.

The students using the computers in the video spent approximately more than ten minutes at the computer, showing in general an apparently high degree of on-task concentration on the computer-use activity. In general the students worked in pairs with the computers and interacted with each other continually during the computer use and related to each other in generally a cooperative manner that was usually task oriented.

The students generally could be described as displaying moderately enthusiastic behaviour, with neither particularly serious or particularly animated expressions, and with apparently high absorption in their tasks.

Reflections on Observed Behaviours Assumed to be Associated with Higher-Level Cognitive Functioning

The teacher felt the following were typical examples of children’s behaviours associated with computer use in the classroom that demonstrate “higher-level thinking”:

(a) The children can express by themselves the intermediate goals to be reached in the process of solving a learning task.

(b) Children can perform actions of self-control.

(c) The children make a quick and correct transfer of the newly acquired learning skills to similar learning tasks.

(d) The children can explain to others (classmates, the teacher) their way of solving a problem.

(e) The children can put themselves in the place of another student in order to follow and evaluate her/his way of solving a problem.

(f) The children are becoming the teacher’s partners in the teaching/learning process.
Reflections on Phase 1 of the ITEC Project

4.8. Reflections on the Reflections

By B. Collis, Netherlands

The reflections in this chapter show that ITEC has without doubt accomplished one important goal—the stimulation of international thought and debate about the impact of computer use on children's metacognitive development. There seems little disagreement among the researchers that higher-level cognitive functioning occurs, observably and meaningfully, in classroom contexts where at least certain teachers are including computer use within their instructional procedures.

Where the researchers differ in opinion relates to the methodology that should be used to study this metacognition-computer use interplay in a cross-cultural project. While all the researchers agree the domain of study is complex and multipart, many of the researchers still would have preferred, or at least strongly recommend for any subsequent study, that some measures be chosen for pre-and post-test data collection and for control-group comparative purposes. At the same time, however, some of the researchers, notably the USA team, felt that too much structure was placed upon the project, both conceptually and methodologically. So there is a difference of opinion.

The researchers were generally not too enthusiastic about the videotapes as a research tool. Most acknowledged the limited view of what was going on that could be captured through a single video-camera, and felt the technique could not effectively be used to show up the indicators of higher-level cognitive functioning in which we were interested. However, the alternatives suggested—more interviewing of students, more testing and observations, long-term comparisons of computer-using and computer-non-using children—were all considered carefully in the development of ITEC and not used, for a number of reasons, among them the burden they would have placed on the researchers in terms of much more intensive and long-term data collection. The requirements of Phase 1, as streamlined as they were, became very difficult for many of the researchers to meet.

This highlights another point: the researchers generally agreed that an important benefit of participating in the project was the opportunity to collaborate internationally with others in different cultures interested in the same overall questions. However, a number of the researchers indicated more personal contact would have been desirable during Phase 1. This is certainly true, but the difficulties of organizing this (and funding it) when so many countries are involved and very little central funding is available made the contact aspect difficult to maintain as well as could or should have occurred. Not all the researchers are reachable by FAX or electronic mail; any question that was sent out for discussion generated a stream of replies that usually spread out over many months' time. This makes dialogue difficult—when should we synthesize a discussion and move on? When we have responses from half of the researchers? When the last responses take many months to return, keeping the project on its timeline as well as building discussion and dialogue are difficult. And even when our travel or at least some of our local expenses were able to be funded, there was never one time when all the ITEC researchers were physically together and only a handful of the researchers have been at all or all but one of the meetings that have occurred. These are unavoidable consequences of trying to maintain a long-term study based on the involvement of senior researchers, all of whom are very busy with many other commitments.

Nonetheless, most of the ITEC participants appear to agree that participating in the project was a valuable experience for them and their colleagues. The suggestions offered for a follow-up study are constructive and useful. Many of the participants seem interested in being involved in a subsequent study. All appreciated the stimulus of the Project and the human networks developed within it. We may not have changed the world, but we understand it a bit better. And we have had the pleasure, as professionals involved in the investigation of computer use on children's thinking and learning, of seeing examples from around the world of children using computers in a large variety of ways, ways that their teachers and they, and we, believe are valuable.
5.1 Introduction

One of the major purposes of ITEC was to stimulate international consideration of the impact of children's computer use on their metacognitive development, within the Project certainly, but also outside the Project. This has occurred, in a number of ways. Papers about the project have been presented at various international and national conferences (see Appendix A) and national and international discussions have taken place, stimulated by ITEC's approach to research in this area.

In this chapter, we focus on two large-scale events, structured around ITEC and its components. One of these was an international conference, "International Perspectives: Education and Technology", sponsored by the Education Technology Centre of British Columbia, Canada, 24 October 1990. Twelve ITEC researchers were guests of this conference and were asked to make presentations, not on ITEC itself, but on major issues in education in their countries, and how computer use was being organized in relation to those major issues. These papers, by the ITEC researchers, give a fuller look into the cultural and contextual situations in which their ITEC investigations took place than was revealed in their ITEC-specific reports and thus are useful to include in this Final Report of Phase 1 of ITEC. Their inclusion here is with the kind permission of the Education Technology Centre, British Columbia, which holds the copyright to the Proceedings of the Conference. The papers comprise Section 5.2 of this report.

Another major international conference structured around ITEC and its research issues was the Fourth International Conference, Children in the Information Age, held at Albena, Bulgaria, in May 1991, as part of the long-term relationship between Bulgaria and UNESCO (of which ITEC is a part; see Section 1.1). The call for papers for this conference was structured around major issues and themes of ITEC and researchers from around the world were invited to submit papers reflecting their own perspectives on these themes. ITEC researchers who were present were able to discuss the different perspectives on methodological and conceptual issues with the researchers who papers were selected for the conference and use the debate to enrich their own input to ITEC.

Many papers were submitted to this conference; of those that were finally selected 13 appear in Section 5.13, with the kind permission of Prof. Ivan Stanchev, Scientific Director of the overall Children in the Information Project in Bulgaria.

Papers by ITEC Researchers Presented at the Conference "International Perspectives: Education and Technology", 24 October 1990, Educational Technology Centre, British Columbia, Canada, are reflected below. The completed proceedings are available from: Dr. J. Mussio, Director, Education Technology Centre of British Columbia, P.O. Box 2040, Sidney, British Columbia, Canada V8L 3Y3. ITEC appreciates the support of the Educational Technology Centre for many aspects of its work.
The title of the document is: "Papers by ITEC Researchers Presented at the Conference "International Perspectives: Education and Technology", 24 October 1990, Educational Technology Centre, British Columbia, Canada. are reflected below. The completed proceedings are available from: Dr. J. Mussio, Director, Education Technology Centre of British Columbia, P.O. Box 2040, Sidney, British Columbia, Canada V8L 3Y3. ITEC appreciates the support of the Educational Technology Centre for many aspects of its work.

Preface

What are the major educational problems facing countries in different parts of the world today? Is technology seen as supplying some solution to at least a few of these problems? To what extent are governments supporting national initiatives with respect to technology and education? Of what value are the answers to these questions to educators involved with computer-related technology in British Columbia?

These were the major themes of a special one-day conference at the Education Technology Centre of British Columbia, Canada, on Wednesday, October 24, 1990 that was attended by over 70 persons, mostly from British Columbia, but also from other Canadian provinces and from other countries. The 12 participants from outside Canada were members of the "ITEC" Project research team. "ITEC" stands for "Information Technology in Education and Children" and is a long-term project, instigated by UNESCO, and supported by national and international groups.

In ITEC, examples of exemplary use of computers in the classroom with nine- and ten-year old children in 16 lands are being analyzed to look for patterns of teacher practice, classroom use, and organization of computer-related learning activities that seem to have an effect on children's higher-level cognitive functioning. The countries involved in ITEC are Bulgaria (which also is the major source of international support for the project), Canada (represented by Dr. Lloyd Ollila and his team from the University of Victoria who are partially supported in their ITEC work by ETC), China, Costa Rica, France, Hungary, Israel, Japan, Mexico, New Zealand, Netherlands, Romania, Sweden, U.S.A., U.S.S.R., and Zimbabwe.

Through the sponsorship of ETC, a meeting of 13 members of the ITEC research team took place October 22 and 23 at Dunsmuir Lodge. The ITEC participants then took part in the ETC seminar, International Perspectives on October 24.

Many of the thoughts and ideas presented at the seminar are reflected in the papers in this volume. What cannot be captured fully, of course, is the enthusiasm and sense of emotion that accompanied many of the discussions at the symposium. The serious economic challenges being faced by the developing countries, and the day-to-day difficulties being faced by teachers, students and researchers in these countries, had a particular impact on the participants.

The overall impression of the seminar is one of common problems and challenges—and positive experiences—with regard to computer use in schools, despite widely varying cultures and contexts. We see many different strategies being used to bring computers into the school experience and we certainly see that there is no "right way" for this implementation to occur. What we do see, at the seminar, and more generally in our experiences with successful school-based programs, are committed educators, not technicians, working from the context of considerable sensitivity to their respective country's problems and potentials.

We are grateful to the authors for making their papers available for publication. The paper prepared by Lloyd Ollila and David Wighton of the University of Victoria was not presented at the symposium, but we felt that it was important to include this paper in order to reflect a Canadian perspective. We have also added the paper by Hoebel and Mussio, as it captures many of the points presented by ETC staff in separate discussions with the ITEC participants.

Some of the papers that were translated by the authors from their native languages into English were edited, but only where it was deemed essential for communication purposes; we trust that we have maintained the original intents of the wording. Aside from these edits, however, the papers are presented here as received by the authors.

We are grateful to a number of people who devoted time and energy to assemble this document. Pat Henman and Shelly Higgenbottom of ETC played a key role in coordinating the flow of documents from the various countries; Laura Atkins of ETC managed the preparation of the document itself, while Karen Hodgson designed the cover and the interior layout. We are also grateful, of course, to the authors themselves for contributing their thoughts and ideas.

Betty Collis  
University of Twente  
Enschede  
The Netherlands

Jerry Mussio  
Education Technology Centre of  
British Columbia,  
Sidney, B.C. Canada
In 1990, the French educational system welcomes nearly 14,000,000 pupils and students. With 1,131,316 teachers and non-teachers, 78,091 schools, 72 universities and a budget of 242 million FF, the "National Education" is a huge institution facing several problems, in particular its adjustment to culture and economy. When education and professional training seem to be essential priorities, it appears that a true effort of quality, involving many aspects of the functioning of the system, is to be undertaken. In this context, Information Technologies (IT) have already obtained a place, but their role remains to be defined more precisely, based on past experiences and the prospects they offer.

The Political Demands

There is in our country a broad consensus about the necessity of a real effort in the field of education. More exactly, what are the wishes in that field and the main problems encountered?

A Teaching for Everyone

With the July 1989 law governing Education, its priorities found expression in a need for increased research on the appropriateness of the educational system in relation to the necessity of a right for all young people to acquire general knowledge as well as a recognized qualification and training suited to economic, technological, social and cultural developments.

This law organizes schooling in academic cycles: 3 cycles from the nursery school to the end of the primary school, 2 cycles in the middle school and cycles in different lengths for high school and vocational school. These Education Technology Centre of British Colombia periods are linked to national objectives, curriculum and criteria. However, ensuring continuity in applying the 1989 text, requires all the members of an educative community (i.e., general schools and vocational colleges and secondary schools) in the collaborative creation of educational establishment drafts which define the objectives and curriculum specific modes of implementation.

Otherwise, the views on Education are epitomized in the following way: it is to bring, before the end of the century, each class of age to a professional certificate and 80% to the A; level standard (i.e., the baccalaureate: secondary school examination giving university entrance qualification).

The Challenges

Actually, one may wonder what the consequences will be with respect to the diploma's value, that is, concerning: its prestige, the possibilities it offers and the advantages that one gets from it when the holders will be 65 or 70% of a generation instead of the current 37%? Will it not dissuade young people more and more from the manual professions? What will be the fate of the 20% of pupils leaving the system without the diploma or of the pupils at a lower level? Such a quantitative objective confronts the educational system and the whole society with a wide range of questions, which are all the more difficult since the educational system is faced with the concerns of social farewells and of inadequacy.

Our system has respect for an essential principle of equality of treatment. In this respect, until the end of the first cycle in secondary school, all pupils are supposed to learn the same things at the same rate. Nevertheless, it appears that careers in schools are still deeply bound to geographic and social origin and to school experiences from the primary level (which increase this phenomenon), which results in failure of a part of the population.

Moreover, Education has to try to adapt pupils to the cultural and socio-economic aspects of the contemporary world, through the development and the enhanced value of a wider range of abilities, including forming man and citizen. However, teaching is constructed in reference to a certain category of knowledge and does not deal with the different forms of intelligence. The present diversification of the paths open to pupils (340 different high school diplomas), offers some major drawbacks: their hierarchical organization and compartmentalization influence curriculum from the colleges, reinforce the abstract nature of teaching and change the direction of the judgement passed on the system by the society. In addition to that, teaching presumes acquired qualities of the person that it does not develop, whereas in reality teaching needs, to foster changes in mentality which will enable our country to be true to itself, to filter into an international life in a quick evolution and to take part in the building of a European culture.

A teaching for everyone and the need for social fairness and adequacy of the educational system correspond to an urgent social demand, but they also create strained relationships within the system itself, which point to the necessity of changes.
5.2.1 The French Educational System  

P. Gabriel, France

The Components for Change

The draft budgets' shares for Education in 1991 (19% of the state budget) and professional training (3%), translates in figures the significant role that the necessity of raising the population training standard has for the nation as indicated by the higher financial outlay, compared to the preceding year's figures of 9% and 8% respectively.

The Line of Action

The main part of this money is allocated to staff for the creation of new posts, and for the reevaluation of teachers' conditions of life, mainly in order to fight against the recruiting shortage. The measures concern both the staff of the National Education and the staff of the private schools, at the primary level and the higher Education level. 12,880 new posts are planned for 1991, of which 10,293 are teacher's posts (7,613 school teachers and 2,680 teachers for higher Education).

Otherwise there are two sets of measures which have priority in the 1991 budget. In the first place, there is the renewal of teaching with the generalization of the IUFM (Instituts Universitaires de Formation des Maîtres: University Institutes for Teacher Training), which corresponds to the restructuring and improvement of the previous teachers' training system: the IUFM are intended for both primary and secondary teacher training. (The previous system planned a two-year training for primary school teachers in the "Ecoles Normales" and a one-year training for secondary school teachers in other training centres.) Furthermore, applicants must possess a license, and the IUFM staff is comprised of both teachers and researchers. Other sides of teaching renewal lie in the creation of the "Priority Educational Area" policy, the continuation of a "Reading Plan" and the development of foreign language teaching at the primary level.

In the second place come measures in the direction of the university, which is supposed to welcome an increasing number of students in the near future: the implementation of a plan for the development of university buildings (2.3 million FF), and a particular help plan to improve the students' conditions with 6,000 new flats and the raising of the scholarship fund (15%).

On the other hand, in order to improve the system, national education experts suggested evolution's that require the participation and the mobilization of present or potential partners: the professional machinery industry, training schools, in-service training, frames, professions and local communities.

Teaching and School Organization

The great heterogeneity of pupils, in their origins, ways of thinking and rates of maturation, must be better recognized, as is done in the Migeon Report. It recommends the staggering of the learning of reading over a period from the age of two to the age of twelve. Moreover, two other kinds of arguments are moving towards a lightening and personalization of the curriculum.

First, the existing relationship between forms, curriculum and ages (i.e., a form corresponds to a curriculum and an age considered as "normal", beyond which failure emerges), is holding up efforts regarding community education initiatives and the searching for and finding of solutions for urgent difficulties.

Second, the extension of obligatory schooling and the possibilities of in-service training have changed the primary and the secondary schools' roles. It no longer justifies the present encyclopaedic, sometimes unrealistic, features and organization of the curriculum.

The necessity of spreading out over a larger period the learning about each topic, and of integrating the notion of form into an objective teaching built up on systems of reference and capitalizable units, has several consequences:

1. The Contents
To give every pupil the possibility of carrying out his or her own degree course means to reconsider the contents taught: to establish coherences, to suppress some repetition, to overhaul and to update curriculum, attempting to make up a scientific and technical nucleus; it means to move towards a real assimilation of knowledge which doesn't risk leading to a lowering of the level.

Within this context, curriculums have to be looked at again and reduced. The role of the primary level now consists of giving pupils the basic knowledge (to express one's self, to read, to write and to count), of learning mutual life, and of developing a critical mind and intellectual curiosity. In this respect, it seems necessary to put emphasis, up to this level, on foreign language teaching, which should be systematic at all levels. A reappraisal of the content at the secondary level and at the university level should restore their efficiency.

2. The Way of Examination
The idea that we have in France of examination is not easily reconcilable with the orientation described above and further thought must be given to changing exams.

5.2-3
3. The Staff Role

Counting on autonomy in a context of expanded decentralization implies that schools are made aware of their responsibilities; and that teacher involvement is developed, notably, that the help of teachers and career advisers (i.e., guidance counsellors) to pupils' orientation, is crucial.

4. Research and Evaluation

Such orientations require the stimulation of applied educational research and the development of international cooperation. In particular, researchers could carry out an inventory and evaluation of localized experiments realized by pedagogical teams, and disseminate the results. In these perspectives the generalization of evaluation, which is desirable, should concern innovations, staff and functioning as well.

5. Post-Scholar Teaching

The relationship between initial and continuing education and the effectiveness of continuing education must be developed. A way to succeed in this can be to give other ambitions to the Education Credit, which assures remuneration to young and adult people who undertake study, until they obtain at least a professional qualification. Diversification of funding, through further involvement of the economic players, appears as a possible way to adjust the socio-economic demands of Education.

The funding and the priorities defined by the authorities are components for necessary changes that require more than financial support. Concerning these issues, Information Technologies (IT) can play an important role, but with respect to this subject, as we will see, the French educational system is here again in a transitional phase.

IT in the French Educational System

The national policy for IT implementation, as with audio-visual implementation, went through a wave of massive grant-giving, which partly explains the present profusion of experiences. However, the need for consolidation of the integration of the new technologies, and in particular that of IT in the educational system, remains.

Introduction of Computers

In 1965, teaching about IT entered into University study with the first lessons at the Master's degree. Ten years later, a section in the National Committee of the National Centre of Scientific Research was created. But another pedagogic relationship between IT and Education appeared toward 1970. On the one hand, the technologies of the tertiary industry, especially expressed as a way of automation for management, were introduced in secondary school. On the other hand, the founding experience of the '58 high schools' undertaken under the dual signs of teacher training and research in Education, broke away from the then existing trends (i.e., the learning of a programming language or programmed learning) and precluded subsequent development operations.

In 1979, the 10,000 computers operation took place and in 1985, with the governmental plan "Computers For Everybody" (CFE), about 150,000 computers were distributed in 50,000 schools and 110,000 teachers received a short period of training (i.e., 3 weeks). The cost of the CFE plan was estimated at 1.8 million FF (1.5 million for the hardware and the rest for teacher training and software).

In 1986, a serious, sharp check was given by the minister of Education of the moment to the voluntarist policy of his predecessor. The financing and the implementation issues have been so open to criticism that it seems only common sense that this operation is an example of what must not be done in the field of public marketing.

Since this period, additional acquisitions have been realized by local communities, teachers or schools themselves. At the beginning of 1990, the Prime Minister announced the coming in of education establishments of 150,000 new computers, with the equipment plan launched in 1985 to be completed at the start of the 1990 new school year.

Two objectives of the 1979 to 1985 policy remain constant in the texts which came with these grants and which are still references: first, with respect to IT, to heighten pupils' awareness to a new dimension of society's environment and, second, to favour the renewal of teaching methods. According to the school level, emphasis lies on the cultural aspects of IT: at the primary level, on learning of technology and integration of IT in the usual course of the dispensed teaching; and at the secondary level, on IT technical and professional dimensions in the specialized paths.
5.2.1 The French Educational System  

P. Gabriel, France

The Present Situation

There is an abundance of experience that attests to a real interest on the part of the teachers in IT and to the relative success of the CFE plan. However, the problems encountered with equipment and the lack of teacher training can explain why many pupils still leave primary or secondary schools without a minimum of familiarity with the new technologies. Very often the computers have stayed in the boxes and the use per student, in 61% of the schools, is evaluated at under three hours per month and pupil.

One of the problems lies in teacher training: there is a nucleus of trained teachers, but the great majority of them are not even familiar with educational technology. At the time of the developmental period (1970 to 1980), owing to voluntary initiatives, a one-year training for teachers was organized for some of them; then the training was reduced to three months or six weeks.

Besides, the problems of equipment are serious: delays, quality and usefulness of the software, reliability and adequacy of the hardware for the teaching have prejudiced computer use. Thus a lot of teachers express the opinion that the time spent in front of the machines is somewhat disproportionate to the expected educational acquisition. This observation underlines the importance of information, documentation and teacher training with respect to promising practices that must be evaluated as the conditions of their generalization. This also shows the role of educational research.

It is a delicate task to draw up a taxonomy of the research fields, seeing that of course it runs the risk of being incomplete. There are a lot of communities of academics or teachers, where research, experimentation or innovations are carried out; each of them called specialists of the different disciplines and with their own subjects and methodologies. Some of them are inclined towards the creation and exploration of tools, and others are studying how educational objectives could be reached with given tools. Arbitrarily, the main ways of working lie in the following areas:

a) IT as an auxiliary in teaching with tutorials, multimedia and artificial intelligence;

b) IT as an object of teaching and culture (i.e., programming);

c) IT as content renewal (simulation of settings, logo and mathematics, word processor and French, etc.) and,

d) IT as contributing to cognitive development and its effectiveness.

Regarding the ministry policy orientation, it is now described as pragmatic, and continues to move in that direction. For example, the tasks of the Education Inspectorates have been, in particular, to evaluate the innovation results and to prepare transitions. However, because of this orientation, which may appear as a wait-and-see policy, and because of the choice of decentralization, schools' drafts and local communities will play the most important role in the establishment of IT decisions, just when the situation appears to need an overall and coherent policy.

Therefore, five years after the CFE plan, the success of IT in the French educational system is qualified. But, the grounds that bear out its interest for Education, and the results expected, are widely didactic. In that field too are a number of orientations, such as the capitalization of the experiences and the transfer of the knowledge, which are major concerns linked to the demands and issues and parts of the creation of a "new teaching" in the near future.

References


5.2 - 5
General Information about the Netherlands and the Dutch Educational System

The Netherlands

The Netherlands with its 14.5 million inhabitants is one of the most densely populated countries in the world. Basic industries, transport, and business services, together with a highly developed agriculture, are the bases for its prosperity.

Central Functions of the Dutch Educational System

The educational system has three central functions: the development of the personality of the students, the societal and cultural development of the future citizens, and the preparation of the student towards future professional activities.

Overview

The educational system is organized according to the divisions Primary Education (age group: 4 to 12); Special Education (age group: 3 to 20); Secondary Education (divided into general and vocational streams (age group: 12 to 20); and Higher Education (university, higher vocational education, "Open University"; age group: > 17).

Financial Aspects

The total expenditure for education has decreased from 23.7% of the total government budget in 1975 to 15.1% in 1989. In absolute terms however, the budget for education has risen from 17 billion Builders in 1975 to 29 billion in 1989. In comparison to the GNP (gross national product) of the Netherlands, the amount expended on education in terms of a percentage of the GNP has hardly changed over the last fifteen years (between 7 and 8%).

Number of Students

The number of students in Primary Education is approximately 1,433,000. In Secondary Education the numbers are 744,000 in general secondary education and 595,000 in vocational education. There are 161,000 students in Higher Vocational Education and 165,000 in University. Special Education has 105,000 students.

Specific Characteristics of Dutch Education

In the constitution of the Netherlands the "freedom of education" is a crucial aspect. As a consequence, there is a great variety of schools in The Netherlands. The main distinctions are "public schools", "Roman-Catholic schools" and "Protestant-Christian schools". Diplomas of all these schools are generally more or less of equal value.

Compulsory education is from the age of 5 till the age of 16. When students attain the age of 17 they have to go to school for at least two days a week. At 18 this is reduced to one day a week.

The Ministry of Education and Sciences finances the schools. The money is mostly provided by general taxes paid by everyone but partly by contributions of the participants. The central government creates, through rules and laws, a general framework the schools have to obey.

Because of the commitment to individual freedom of education, the Ministry of Education and Sciences makes its rules only after extensive consultations with external advisory committees representing the different educational sectors and various groups of the different school participants (such as students, parents, and school personnel).

Six nationally supported "pedagogical institutes" support the educational system. Their task is to develop new strategies for educational innovation and to improve the quality of the educational sector.

Main Themes of Educational Policy

A long-lasting discussion has been going on in the Netherlands about the content of the educational program for students up to the age of 15 to 16. The possible introduction of a so-called "middle school" is a central issue in this discussion.

There is special attention given to specific populations within the educational system, especially towards students with physical and psychological handicaps and students from minority groups. Special measures have been taken towards the improvement of the capacity of regular education in order to stop the growth of special education. Female students are being stimulated to study the so-called more exact subject areas, such as mathematics and sciences.
5.2.2 The Dutch Educational System

J. Moo run, The Netherlands

Special attention is also given towards information technology, with an emphasis on its use in vocational education.

Challenges

In order to meet societal demands many issues have be dealt with and require special attention: the availability of a sufficient number of good teachers; the relation between the demands of society and the supply from schools, especially with respect to the skills of the future labour force; the renewal of education and the development of lifelong learning facilities; and financial management of the educational sector.

Information Technology in Dutch Education


Beginning with a preparatory phase from 1982 until 1983, the Dutch government has played an active role in the stimulation of new technologies in education. A five-year plan (1984 to 1988) called "the Informatics Stimulation Plan" (INSP) was executed. Its original priorities were towards the development of "computer literacy" and the creation of "human capital", especially in the context of vocational education. Activities were concentrated in five clusters:

1) creation of an infrastructure for courseware development,
2) school-related projects in the different school sectors,
3) preserves teacher training,
4) in-service teacher training, and
5) educational research.

The management of the Answer project was executed by a special staff formed within the Ministry of Education and Sciences, and supported by several external project managers and their support staffs, including the Centre for Education and Information Technology (COI) of the University of Twente.

Special Projects:

The NIVO Project (1985 to 1989)

The NIVO project was set up as a coordinated effort of the government and industry. It raised funds to provide each general secondary school in the Netherlands with at least 11 computers (MS-DOS compatible). The project organized in service training for at least three teachers of each of the schools participating in the project, and stimulated the development of educational software. In addition to hardware, each school was also provided with a so-called starting package of educational software and lesson ideas about how to use computers in education.

Special Projects:

The POCO Project (1988 to 1992)

The POCO project started as a targeted response of the government to the lack of adequate courseware in education. Special funds were allocated to start a special effort to develop more courseware. The project was carried out under coordination of a specialized courseware development institute in the Netherlands (the Educational Computing Consortium). The choice of the topics for the courseware packages was done in very close coordination with the target schools (primary, general secondary, and vocational secondary).

Special Projects:

The SURF Project (1985 to 1994)

The main objectives of the first SURF project (1987 to 1990) was to increase, through mutual cooperation between the computing centre of the universities and institutes for higher vocational education, the quality of teaching and research. Main emphasis was put on realizing computer networks within and between institutions, and the creation of a number of so-called "expertise centres" in different areas connected with computing in a broad sense or making use of network facilities to distribute information about certain subject areas.

A new project has been proposed for the period 1991 to 1994. This project will continue to focus on facilitating the creation and use of networks, the acquisition of software packages, and the continuation of the provision of special services through expertise centres and information dissemination.

General Projects:

The PRINT Project (1989 to 1992)

Since 1989, a new four-year program called PRINT has been launched to continue the work of the INSP. The PRINT program is focused on primary, special, general and vocational secondary education. Separate programs have been started for higher vocational and university education.
The abbreviation PRINT stands for "Project for the Implementation of New Technologies." The PRINT project is managed by a national steering committee composed of representatives of the six national pedagogical institutes.

The objectives of PRINT are:
(a) the development and production of courseware, including manuals and instruction on the integration of courseware into the curriculum,
(b) information and advisory services for the implementation of the computer into daily teaching practice,
(c) information and advisory services for selecting courseware,
(d) in-service training for teachers on the use of hardware and software, and
(e) supplying the pedagogical support institutes with adequate tools (both material and non-material) to support the implementation of new technologies in the next decades.

The major characteristic of the PRINT program is its emphasis on the implementation and integration of information technology into the curriculum.

Special Projects:
The COMENIUS Project
Where the NIVO project was focused specifically towards secondary education, the COMENIUS project is focused towards primary education. The COMENIUS project is set up as a combined effort of the government and organizations representing the management of the primary schools. The project will provide each primary school in the Netherlands with a number of MS-DOS compatible AT computers. The number of computers depends on the number of students in each school. On the average, one computer will be provided for each sixty students. In addition, a so-called starting package of educational software will given to the schools. For example, Windows 3.0 will be included in this package. Finally, in service training will be organized around the use of the starting package and specific lesson ideas about how to use computers in education.
5.2 Conference "International Perspectives: Education and Technology", 1990, Canada

5.2.3. Educational Computing in Mexico  

M. Murray-Lasso, Mexico

Introduction

Although Mexico was the first country in Latin America to install a computer (a vacuum-tube IBM 650 at the National University of Mexico in 1958, [Refs. 1,3]), it is only recently that computers have started to be used seriously as a teaching aid at the primary and secondary level. Without doubt, the principal reason for this has been the popularization of the low-cost microcomputer. In university education, the computer has been used in Mexico since its introduction as a research and administrative tool, and in some academic administration chores such as producing multiple-choice type examinations, but very little has been done to use it as a teaching aid. At the lower educational levels, a government program to introduce computers in the public primary and secondary educational system has been in place during the last six years. A considerable amount of educational software has been produced for this program, but the economic crisis which Mexico and other Latin American countries experienced during the eighties limited the amount of computers that have been installed, which is still very small in comparison to the number of students that have to be served. At the same time, private schools are proceeding at a much faster pace, a situation which is widening the gap between the "haves" and the "have nots", as was noted for many countries by the delegates of a UNESCO Conference on the topic [Ref. 3].

In this article, the panorama of educational computing in Mexico is described briefly so the reader may have a general impression of how the field is developing in Mexico and what can be expected in the near future.

The Primary and Secondary Mexican Educational System

Mexico is one of the largest Latin American countries with a population of little more than 80 million, of which more than half are 19 years old or younger. The primary and secondary educational system of Mexico has close to 25 million students, while the university system has about 1.5 million, including undergraduates and graduate students. There are about one million primary and secondary school teachers in Mexico.

Mexico is a country of great social contrasts in which there are a few very rich individuals and a very large number of poor people, with a thin middle class. The contrasts became more pronounced with the economic crisis of the eighties. The purchasing power of the income of the workers has lost more than 50 percent since the administration of President Echeverría (1970 to 1976). One of the groups that has been hit the hardest are the teachers. Currently a full-time, full professor at a Public Mexican University with a Ph.D. degree earns less that U.S. $600.00 per month, while primary and secondary school teachers earn around U.S. $160.00. Under these conditions many teachers hold more than one job to make ends meet.

The difficult economic situation is also reflected in the school budgets. Most public schools do not have a library, a telephone or a copying machine. Some do not have enough money to purchase all the chalk needed during the year and the Parents' Association has to raise money for such expenses. Some very important efforts to build municipal libraries are a big help. The aim is that each county have at least one library with a basic collection of books on a wide selection of topics. Several schools in the area can use the library as a resource.

The Public Educational System of Mexico has traditionally been very centralized with one curriculum imposed on the whole country by the Ministry of Education which provides free text books for the students, all of whom follow the texts closely. The curriculum has been so regulated that it was customary for a newspaper published by the Federal Government to publish the homework for the day in the different study areas, because supposedly all the students in the country had to do the same homework every day. In actual fact, the coordination has never been quite that good, although nominally all classes should have been advancing at the same rate.

Recently the Ministry of Education initiated a Modernization Program that tends to integrate the study topics that were previously isolated, put more emphasis on problem solving and independent thinking and to decentralize the decisions and have the curricula depend more on regional situations. Regrettfully the first presentations of the Program were apparently done in a rush with little care and it has been strongly criticized in several quarters. About seven years ago there was in the Ministry of Education an Educational Revolution that decreed that every teacher should have the equivalent of a Bachelor of Arts degree in Education, whereas previously teachers generally had the equivalent of a senior high school education imparted in Normal Schools scattered throughout the country. The National Pedagogic University was founded to comply with the mentioned decree and we are presently seeing the first graduates of the program that was implemented.
Introduction of Computers in the Primary and Secondary Public School System

**Hardware**

During the Educational Revolution of seven years ago, it was announced that the Ministry of Education would introduce into the secondary and technical public school system in the order of 100,000 microcomputers as teaching aids. That number has been revised a number of times and presently about 14,000 microcomputers have been introduced. (Some of these computers are also in the primary schools which have recently been added to the program.) Of this number about half are 8-bit machines based on a stripped down Radio Shack Color computer II called MicroSEP (SEP stands for Secretaria de Educacion Publica Ministry of Education) with memories ranging from 16 Kbytes to 128 Kbytes (with most of them in the lower range), that were manufactured in Mexico under license of Tandy and Microsoft. At the beginning the computers had no printer nor diskette driver ports. The display was done on a 20 inch color TV set. The resolution for the faster graphics screen is 280 by 192 pixels. Auxiliary memory was provided by a cassette recorder which was quite unreliable and the programs had to be recorded three times to increase the probability of loading the programs successfully.

Many educational programs were developed under heroic conditions. Since the machines had no printer ports, the developers had to copy the listings of the BASIC programs by hand from the displays in the color TV screens and had to manually update listings of the programs as changes were introduced. There were almost no development tools available, so, in order to merge two pieces of a BASIC program developed in separate machines, it was necessary to load from tape one of the pieces (generally the longer one) and type by hand the shorter piece to finally record the merged program on audio tape [Ref. 4].

Due to the difficulties with the reliability of the cassette auxiliary memory, some of the cassette recorders were replaced by ROM packs that contained about 50 BASIC educational programs each. This essentially solved the reliability problems in the loading of the programs but left the machines without the possibility of recording any of the work done by the students. The latest first generation MicroSEP computer has a 5.25 inch diskette drive from which the programs can be loaded and gives the opportunity of recording work done by the students. No more of this first generation of computers will be introduced. The keyboards are in English and lack some of the letters and signs needed in Spanish. To introduce them special codes involving special keys such as Ctrl have to be used.

Presently the second generation computer for the Government Program called COEEBASEP (COEEBA stands for Compuclon Electronica en la Educacion Basica- Electronic Computing for Basic Education), of which there are about 7,000 in place (and this number is rapidly growing since every year the number of machines installed doubles), is an IBM-compatible Personal Computer based on the 80286 microprocessor. All the machines that the author has seen are Tandy machines, although other brands could easily be introduced. The machines have a 640 Kbyte memory and 3.5 inch diskette drives and a much higher resolution than the first generation computers. The computers for class use (group interaction), have 20 inch color TV sets for display that are interfaced to the computers through a special card. Other computers, which will be used in a Laboratory setting interactively by students doing projects and learning computer languages, have standardsize monitors.

**Software**

At the date of writing this, about 375 educational programs have been developed, mostly for the three years of secondary school. The primary school cycle is now also officially incorporated into the program and work is under way to develop specific software for them. Of the programs developed, most of them have been done under contract by various Mexican software developers with the participation of Mexican teachers and students under the supervision of ILCE - Instituto Latinoamericano de Comunicacion Educativa. The ILCE is an international organization, headquartered in Mexico City. It is part of the Organization of American states and works closely with the Ministry of Education of Mexico in the COEEBA Project. Almost nothing has been taken from other countries' efforts to introduce computers in education because the people at ILCE feel that Mexico has educational problems unique to its population and culture. Nevertheless the ILCE staff and the software developers have had communication with, and seen software from, several countries and have researched their national projects as well [Ref. 5]. ILCE has a team of about 80 people working in the COEEBA project including technicians in programming and electronics, teachers and others such as graphics designers and educational experts.

Of the programs developed, about 16% are for the teaching of Language Arts (Spanish is the language spoken in Mexico), 19% for Social Sciences, 35% for Natural Sciences and 40% for Mathematics. Most of the programs developed are geared to group interaction with the computer since generally a school has only one microcomputer available for all the groups. Thus the letters and illustrations on the screen are large enough for the pupils seated in the back row to see from their seats. This forces messages to be very short because long messages take several screens to be displayed. The personal interaction with the students is very limited. This author has seen classes in which the students in a class of 40 line up so that each student has the opportunity to type a one letter answer to a multiple choice question, that operation taking a good portion of
the class period. In most instances the role of the computer in the classroom is to serve as a prop to initiate discussions and to serve as a flexible slide projector.

Besides using computers as teaching aids in the classroom, a number of Informatics Workshops with 10 computers each are being implemented and scattered throughout the country where the students of several nearby schools will be will be able to work on projects assigned by the teachers and to learn computer languages. Before a school is assigned a computer, it is required that it build a proper computer classroom with an adequate electrical installation. The operating expenses, cost of the ILCE - provided software and other materials are absorbed by ILCE. There is a charge, however, for the computers themselves, which are often financed by Parent Associations in each school, sometimes with financial aid from private companies.

Much of the software that was written in BASIC for the first generation MicroSEP is being adapted to work in the GWBASIC of the second generation machines. This software had several limitations, an important one being the amount of memory available in the first generation machines. New programs that will take advantage of the characteristics of the second generation machines will be written in the "C" programming language.

Private Schools

The COEBA project is exclusively for the public schools of Mexico. Most private schools have introduced computers but there is no national project for this purpose. In most cases what is done with the computers is to teach programming. The two most popular languages taught are Logo for primary schools and BASIC for secondary schools. Generally a private school with a population of about 1,000 students has a computer laboratory with 20 to 50 computers. In most schools the computer is not integrated to the curriculum and there is a special "computer teacher" instead of having the regular teachers use it as a teaching aid. Besides programming languages, many schools are teaching packages such as word processing, database managers, spreadsheets and presentation and drawing packages.

Typically a school will hire a computer engineer to introduce computing to the school. The computer engineer will be familiar with the hardware offered in the local market and will acquire several machines without an integrated educational plan to use the machines. The result is that the students will all wind up taking an optional course in programming or in a package, but the regular courses will be unaffected by the presence of the computers in the schools.

There are exceptions to the scheme described. Some schools, often the ones connected with foreign communities (German, American, British, Israeli, Japanese, etc.), receive advice from teachers in the fatherland as well as educational software in the language of said country and they are as advanced as those countries in the application of computers to education. We thus see some private schools already using large databases in CD ROMs and other multimedia. Some schools are connected to international educational networks and participate in advanced projects with schools from other countries. In general, however, there is little educational software available in the Spanish language and when there is, it is generally not integrated into the Mexican Curriculum. Most of what is available is in foreign languages related or not to the curricula of the country of origin. Many of the students of private schools are considerably better to-do socially than the students of the public schools and often they have computers of their own and are rapidly acquiring the information culture on their own through magazines and software they acquire by themselves.

University Level, Educational Computing

Universities in Latin America (and Mexico is no exception), are elite institutions and thus they do considerably better as far as resources are concerned than other educational institutions at a lower educational level. Some universities in Mexico have done a good job of introducing computers although their use as a teaching aid is still very low.

Probably the most prominent university in Mexico, in its use of computers, is the Instituto Tecnologico de Monterrey which has 26 different campuses in the country that are connected through a computer network that transmits voice, data and video. This allows them to broadcast in the network courses to be taken by students in different campuses, with the opportunity for the students to ask questions through telephone communications. The Institute has about 2,000 microcomputers, about half of them connected in the Institute's Network. They are evenly divided between Macintoshes and IBMs.

The Institute was the first higher education institution in Mexico to offer an undergraduate program in computer science and because of the great numbers of microcomputers available, teachers regularly leave assignments in almost all subjects that require the computer to be used for the completion of the assignment. Registration is done on microcomputers with interactive programs that access a large database, that inform the students of the courses that they are entitled to take, how many places are still available, and similar information. Naturally, the computers are used extensively for research at the Institute. The Instituto is a node of Bitnet to which it is connected in the next link to the National University and several other Universities. The students of the computer science courses organize yearly a well-publicized Symposium in which prominent speakers from Mexico and other countries present recent developments.

Another university that is quite active in its use of computers is the National University of Mexico, an institution with about 350,000 students and 20,000 in the teaching staff, making it one of the largest
universities in the world. Recently the university has acquired a considerable number of microcomputers both with grants from manufacturers and with internal funds, and has distributed them all over its various campuses in all the schools and research institutes. The use of the computer has grown so much that many schools and institutes have their own computer centres, generally centred around a Minicomputer such as a VAX machine with many microcomputers and terminals connected.

The National University has an internal network which, although less advanced than the one of the Instituto Tecnologico de Monterrey, is one of the main nodes of a National Academic network being installed in Mexico which connects many of the Universities in the country. It is also a Bitnet node. There are plans to acquire a Cray Supercomputer for the National University which already has an experimental research neural net plus two large mainframes.

In spite of the mentioned activity, the use of computers as a teaching aid is still very small. The efforts being made are isolated and very few pieces of educational software have been created. Although there are more than a hundred degree granting programs in computer science in Mexican Universities, the use of the computers in education in all but a few of the universities is quite limited.

Other Educational Computing Activities

Besides the formal educational computing activities mentioned above there are a number of more informal extracurricular educational computing activities being carried out by several institutions. Among the prominent ones is a project labelled Galileo, by a private institution that has received some sponsorship by the National Council of Science and Technology, that for a fee teaches computing and sells educational software and consulting services outside the schools. It uses several packages both developed "in house" and acquired in foreign countries. Recently this program has been reducing its activities considerably in the area of children and has concentrated more on training for work and in giving courses for adults, granting diplomas and degrees in several specialties including computers in education, computers in medicine, computerized design and manufacture and artificial intelligence.

A second project sponsored by the National Council of Science and Technology involves the design and manufacture of special educational computers based on IBM PC compatible machines together with educational software tools (a HyperCard type of software), as well as educational adventures and lessonware. One of the pieces of software developed, called Hypertool, is a large program with more than 80,000 lines of code that is capable of handling hypertext, graphics, animation, sound and question-answer evaluation.

A third project under the Mexican Academy of Sciences involves the installation of computers in public municipal libraries and the offering of courses in Logo, word processing, database manager packages and spreadsheets, free of charge to all the young people interested. It also has an educational program in the Museum of Technology in Chapultepec Park in Mexico City. Several tens of thousands of young people have gone through this program that gets its funds through a Board of Patrons involving officers from the Ministry of Education and prominent Mexican businessmen.

Some groups that are part of the Public Educational System of Mexico have special projects that are functioning largely due to the initiative of individuals with little or no official help from the government. Among them is a group of hearing-impaired teachers that with the help of the National University is teaching some 200 children, using Logo and some packages of the Story Board type. The teachers obtain volunteers that do work without pay and they also obtain donations in software and materials. Recently the government approved four computer-teacher jobs with pay to continue the program. Their lack of working space of their own (they are housed in an old house near Chapultepec Park in Mexico City) has prevented them from accepting a donation of a network of microcomputers together with educational software translated into Spanish that was offered to them by a private company. In spite of the tribulations, about 1,000 hearing-impaired students have benefited from their program with very satisfactory results.

They are one of the four groups in Mexico that are participating in an International Research Project partially sponsored by UNESCO and led by a team from Bulgaria to study the effects on the metacognitive functioning of children using computers in the classroom. A second group of this nature works with preschoolers of the federal public school system in the State of Mexico. Staring with a donation of two computers they have developed educational software (more than 150 programs in the form of educational games), and with no government funds have promoted the acquisition by Parents' Associations of computers for 11 schools, that use their software which is distributed free of charge to the schools.

A third group works at the National University and without any funds from the University has convinced teachers to give courses free of charge for training of university administrative workers using equipment loaned by the University. The group has worked through the STUNAM, which is the University Workers' Union and has given several courses to about 200 workers free of charge in topics such as Operating System for IBM PC compatibles, word processing, database managers, spreadsheets and similar packages. They have also organized a free Symposium for the workers of the University and are planning to organize a Society for Worker Training, in which besides training workers in computing will also give language courses (English being the most solicited), report writing, and similar topics.
The Ministry of Education has some decentralized institutions that publish magazines on the topic of Educational Computing, develop educational software, provide consulting and advising services, train teachers, and install computer networks connecting schools of education and similar activities. Two of them are the Centro de Procesamiento Arturo Rosenblueth and Comunicacion e Innovacion.

To promote Educational Computing the Mexican Society for computers in Education (SOMECE: Sociedad Mexicana de Computadoras en la Educacion) was formed four years ago. The author was the Founding President. It is formed mainly with teachers, researchers, psychologists, computer scientists, software developers and people in the computer industry. Among its activities it organizes National Symposia on Educational Computing with equipment and software shows, and publishes proceedings. To organize its activities it calls upon other interested organizations such as the National Academy of Engineering, several universities, the Academy of Sciences, the Ministry of Education, software publishers and computer manufacturers and others. Six National Symposia have been held in various cities of Mexico for the Primary and Secondary Educational Computing and Three for Higher Educational Computing. Each of these meetings draws from 300 to 500 participants and about 100 papers.

The Society also organizes local conferences and has local chapters in the cities of Monterrey and Merida besides the large chapter in Mexico City. It publishes a newsletter. SOMECE is an organizational member of the International Society for Technology in Education (ISTE) headquartered in Eugene, Oregon and Washington, D. C. and participates with ISTE in the organization of a Latin American Seminar on Education, the second of which will be held in Mexico City in April 1991. It has also participated in other international activities including a UNESCO Conference in Paris and several other conferences in Scotland, Jerusalem, Guatemala, the United States and the Soviet Union. It is also involved in several international research projects with the participation of various other countries and foreign universities on topics such as educational software portability and metacognitive functioning of children using computers in the classroom.

Conclusion

Because of the adverse economic conditions of Mexico, educational computing in the country has not developed anywhere as much as it has in developed countries and even in some developing countries such as Senegal, Brazil, Cuba and Costa Rica. However there is a reasonable amount of activity in the field. There is a National Government Project for the Public Schools in which about 14,000 computers have been installed and 375 educational programs have been developed. Because of the small numbers of computers, the strategy of use of the machines is that of group interaction with little in the way of personal interaction.

Even under these conditions most of the 80,000 schools in Mexico have no computers at all and very few of the one million teachers have had any computer training. In the private school sector, which comprises less than 10% of the student population of 25 million students, the availability of computers both in the schools and in the homes is considerably higher, although in many of the schools the use of the computer has not been very creative except in the finest schools associated with foreign communities. The result is that the gap between the economically powerful and the poor is regretfully widening with no great hope of correction in the near future. Several small groups are active in promoting the use of new information technology in education. However, the numbers are such that the final effect is quite low for the needs of the country at large. No real solution to the problems mentioned is in sight.

References

5.2.4. The Computer as a Pedagogical Tool at Rannebergens Centrumskola

B. Bengtsson, Sweden

Abstract

This paper describes a full scale project with the computer as an integrated, pedagogical tool in the junior and intermediate stages of the compulsory school. The project is part of a three-year trial period initiated by a report from the Ministry of Education to the Government to use the computer as a tool in the everyday work of an ordinary school.

Background

In Sweden the use of computers has until recently been restricted to the secondary and upper secondary school level and mainly to the following educational fields.

Computer literacy

At secondary school students are entitled to a course in computer literacy integrated with other subjects and aimed at giving a general competence and illustrating the impact on society and on human beings of a computerized society.

Vocational training

In upper secondary school there are many different educational programs aiming at future professions or further studies at the university level. Their purpose is to reflect the use of computers in different occupations and to confer up-to-date skills through the use of modern techniques.

Computer science to train future computer experts

Instruction is provided in upper secondary schools.

The use of computers as a purely pedagogical tool to enhance the quality of education and to augment the potentialities of teaching is not yet officially approved of in Sweden. The Ministry of Education therefore defined a strategy and the Government approved of a three-year trial period to test the computer as a pedagogical tool in the everyday work of an ordinary school and to broaden the use of computers to all stages of our compulsory school system and especially to the lower age groups.

The Project

This particular project is one of the few fullscale ones in the junior and intermediate stages of the compulsory school in Sweden. It is sponsored and supported by The Local Education Authorities in Gothenburg, The Swedish Board of Education, The Ministry of Education, The Teachers' Training Institute within the University of Gothenburg and IBM. The project started in August 1989 and will run for three years. Up to now we have completed the planning of the project, the budgeting, the activity analyses, the choice of hardware and software, the in-service training and an evaluation of the teachers' attitudes towards the computer as a pedagogical tool.

The school chosen (Rannebergens Centrumskaola in Gothenburg) is a typical, comprehensive elementary school with students from the age of seven to the age of thirteen.

Study Objectives

Turning information technology into a tool for teachers and students, with a view to streamlining and at the same time improving the quality of school instruction, is the most important task in the project. Research will be done in the problems of pedagogics and methods in this field. We will investigate if the computer has a role to play as an educational aid in the school of the future and explicitly for the students and teachers at the elementary school level.

A guiding principle in the project is that the computer should only be used as a teaching aid when it is expected to expand the scope of teaching or to improve its quality.

The overlapping aim of the project is to integrate the computer as a pedagogical tool and to study: its consequences on the organization of the school, the teacher's and the student's role; the effect on the contents in the present curriculum; and the attitude to and definition of what kind of knowledge we are going to offer our students. Its starting point is the regular activities in an ordinary elementary school. It should activate the ordinary teacher not only the computer enthusiasts. The teachers, the students and the local school administration will take a decisive part in the formulation of the activities in the project. The new infrastructure demanded by the new technology may also prove to be a valuable hidden pedagogical resource.
Some of the main study objectives are:

- to implement the computer as a pedagogical tool in the elementary school;
- to identify parts of the curriculum where the technology can substantially improve education;
- to investigate the demands on computers and computer environment for computer-assisted teaching;
- to let teachers in the project school use the computer as a personal, administrative tool - a resource computer containing all software is therefore placed in the staff room;
- to use and evaluate different kinds of software for computer-assisted teaching;
- to produce and evaluate teaching aids in the form of user-friendly manuals, teacher's guides, student's guides, textbooks and exercise material;
- to test and evaluate different models for inservice training of the teachers;
- to find, test and evaluate a suitable organization, infrastructure, pedagogy and methodology for computer-assisted teaching in this age group;
- in collaboration with private publishers, to translate and adapt appropriate educational software from abroad to the Swedish elementary school and develop our own software; and
- especially to take into consideration and study the needs for handicapped students.

The Present Situation

As I mentioned earlier we have so far defined the guiding principles, financed the project, built the organization for the project, given the teachers an introductory training and installed hardware and software. One teacher has been trained to become the computer coordinator.

A number of project groups have been formed in different subject areas. The teachers involved have been specially trained in how to use the computer as an educational tool with due respect to the expected new demands on pedagogy and methodology. Each project group has analyzed the present curriculum and chosen essential and important parts of it, considered suitable for computer-assisted teaching.

During the project all parties involved will continuously evaluate the effects of the computer as a pedagogical tool according to the given study objectives.

Effort is made to continuously inform interested parties in the community and the Swedish school system about the findings and results. It will give the authorities a basis for a decision as to whether to introduce computers in this new educational field or not and to support their use, and if the outcome is positive, to subsidize the acquisition of computers, software, in-service training, further research and the building of a new infrastructure within schools in Sweden.

The Effects

The attitude towards the new technology has been analyzed in an evaluation of a number of interviews with the teachers, performed during the planning phase. The in-service training of the teachers according to a realistic and activity-oriented three-day course has been very positive. Most of them regularly use the computer as a personal, administrative tool. The resource computer in the staff room to a great extent contributes to this. It is also encouraging to notice that the teachers also to a great extent use the open-ended, integrated software packages for purely educational purposes to help students collect, analyze and present data.

A first informal evaluation of the students' attitudes shows that they very easily learn to master and use the new technology. Practically everyone is using the computer lab and the open-ended software packages Wisepak, Storyboard Plus and a number of lessonware, relatively short application programs that complement or occasionally replace a school lesson. The computer lab is a busy, open resource in the middle of the school.

Some of the present activities are the computer in the writing process, keyboard training, the use of databases in geography, telecommunications, desktop publishing, the building of a database for the school library and the computer as a creative tool in music and art.

The project has already initiated an active, pedagogical debate and discussion among the teachers and the administration. That will probably generate many new, interesting aspects around the computer as a pedagogical tool, increase the commitment in questions concerning education, pedagogy and methodology and give students and teachers a new and more appropriate knowledge in their subjects and a useful computer competence for their future studies.
Introduction

Education is being confronted with four major forces that will impact on the shape and structure of our educational system for the next 10 years.

- One is the growing demand for restructuring our present educational system,
- the second is the rapid growth of computers and the use of telecommunications in education,
- the third is a change in the view of the nature of the learning process
- and the fourth is a growing interest in creating the global village in education.

The specific mix and blend of these forces will largely determine the way our education system will look as we enter the 21st century and the role that technology will play in education both nationally and internationally.

This paper will review:

- Some of the more important recommendations made in the United States for restructuring education.
- The role that the new information and communication technologies can play in transforming our schools.
- The need for changing our views of the learning process in the application of our present technology and in designing new technology applications.

Reform and Restructuring Education

First of all I would like to talk about the growing movement to restructure education. We have barely survived the national call for reform and a host of reform activities have been initiated at the local and state level. Just when you thought it was safe to return to the classroom - what should appear - but a global trend toward the restructuring of schools. A major impetus for the transformation of education is the realization that we are being catapulted into the information age.

In recent years, we have witnessed remarkable breakthroughs in science and technology leading to an explosion of knowledge. It is estimated that the total knowledge of mankind doubles every 7 to 8 years. At present over 2,000 books are published daily and the rate of production of information continues to accelerate! The rapid developments in fields such as biotechnology, medicine, space science, telecommunications and new materials are moving us from a world society based on raw materials and production to one increasingly based on human resources and knowledge.

Each day we are confronted with more evidence that our world is growing ever smaller and more interdependent. As noted by Capra (1985):

We live today in a globally interconnected world in which biological, social and environmental phenomena are all interdependent... we need a fundamental change in our thoughts, perceptions and values.

The interconnected Ness of the worlds extends beyond our ecological and economic systems to our fields of inquiry. It is clear that most of our world’s problems do not neatly reside within a single academic discipline or field of inquiry; rather they span across many of the artificial boundaries of knowledge we have established and institutionalized within our universities and schools. Our interconnectedness is also manifested in the growth of the world’s communication systems. We now are able to witness events as they occur across the globe including scientific achievements, political events, armed conflicts or natural disasters.

Coupled with the knowledge of our growing interdependence is the awareness that the world is presented with an array of problems of unprecedented complexity. In fact, a number of scientists have asserted that perhaps for the first time in history, mankind is confronted by a widening gap between the complexity of world problems and the intellectual power of individuals and societies to solve them (Betoken, 1979).

The Need for an Educational Paradigm Shift

In response to this complex set of circumstances, educators across the globe are now struggling for ways to make significant changes and improvements in their educational systems. This is a formidable task that has been likened to that of sailors trying to rebuild their ship at high sea (Harste et al, 1984). Undergirding many of the present educational restructuring efforts is an awareness that we must develop a new vision of education for the 21st century a vision that will assure that students in all countries will have:
the skills and knowledge needed to function effectively in a rapidly changing technological and information-based society and to contribute to the economic and cultural development of their respective nations;

- an awareness of the global issues and problems we share in common and an appreciation for the intellectual and cultural richness of other societies; and

- the critical thinking and collaborative problem solving skills as well as the commitment needed to work with their peers in other nations to forge new solutions to the growing web of global social, political, economic and ecological problems.

Thomas Kuhn (1963) suggests that revolutions in science come about when the old theories and methods won't solve new problems. He calls these changes in theory and methods a "paradigm shift." Based on the cries for educational reform that are echoed across the world, it appears that there is growing consensus that our present educational theories and practices are not working as well as they should. The educational experiences we are providing children are not having the desired effects and our students often see them as boring and irrelevant to their lives.

While our educational systems may have served us well during the industrial age, there is widening consensus that changes are needed to bring our educational systems into alignment with the new information age. Many educators and government leaders believe that the applications of the new information and communication technologies should play an important part in this realignment.

In efforts to begin restructuring our schools, a number of themes have surfaced at the national level including:

- Increasing the productivity, efficiency, cost effectiveness and accountancy of our schools;
- Providing parental choice, with schools competing for students;
- Providing for decentralized decision-making, deregulation and reducing the bureaucratization of schools; and
- Capitalizing on the opportunities provided by the new information and communication technologies for enhancing the quality of education.

Up to the present time, the reform efforts in many states have focused on increasing the accountancy and productivity of schools.

Our nation's business leaders have been some of the most outspoken proponents of this view and advocate the application of the business model (with some minor variations) to our school systems. In doing so, they often forget that our students are not products and our schools are not factories or businesses.

One most important aspect of the emerging business model, however, is the recognition that the most successful and dynamic business organizations have abandoned the top-down, hierarchical, rule-based organizational structure still so prevalent in our schools. The new business model emphasizes the value of the flexible, adaptive, and decentralized business organization (Peters, 1987). This dimension of the business model often contradicts the recent efforts of legislatures to improve schools by imposing more top-down restrictions and regulations.

Technology and Transformation

Perhaps the most positive theme that is surfacing nationally, is the recognition that technology can play a part in reforming education. Although much of the present focus is on computers in the classroom, educational telecommunications can and should play a significant role in the transformation process. There are those who remain sceptical of technology's potential in education. Some assert (perhaps rightfully so), that the new information and communication technologies, such as computer-based learning and interactive television, have not yet yielded the promised benefits - and, like other educational innovations, will ultimately fade from the educational scene. I would caution the sceptics, however, to remember that the two most common errors we make in predicting the impact of new technologies are that we underestimate:

- the time needed for the diffusion of the technology, and
- the eventual consequences of the new technology.

Even what may appear to be an innocuous technological innovation can have unforeseen and profound consequences. One example of this is the introduction of the stirrup in medieval Europe. This may not appear to be a "quantum leap" technological invention, but White (1962), an expert in medieval history, asserts that the stirrup ultimately changed the entire shape of European society in the middle ages.

Because it changed the ways wars were fought and won, it ultimately transformed the entire political, social and economic structure of medieval Europe. With the advent of the stirrup, for the first time, soldiers were able to wear metal armour and carry heavy weapons without falling from their horses. The result of this technological innovation was that the cavalry, which previously had played a relatively minor role in warfare,
suddenly became an invincible force on the battlefield. The only effective defense against the heavily armed cavalry was to develop your own armed cavalry. Similar to the advanced weapon systems of today, the employment of armoured knights was a very expensive enterprise. In the agricultural-based economy, the produce of a great deal of land was required to support the knight, his attendants, weapons, armour, horses, etc. Large allotments of land were provided to the knights by their rulers to help cover these costs. In addition, a code of chivalry was developed to help maintain control over these powerful warriors. Thus, the lowly stirrup triggered a series of events that ultimately transformed medieval Europe into a feudal society.

Another and more recent example of the unforeseen impact of a new technology was the introduction of the "horse less carriage" at the beginning of the century. Many predicted that this new technological innovation would never replace the horse because of the poor road conditions and unreliability of the equipment at that time. Even the most optimistic could not envision the impact that the automobile would have on totally reshaping our way of life.

Interestingly, whenever a new technology is introduced, we can only think of its application in accordance with familiar metaphors of use. Thus, when automobiles first appeared they were generally thought of as "horse less carriages." In many ways we are still in the "horse less carriage" stage in our thinking about and use of the new computer and communication technologies. We still see widespread use of "electronic workbooks" in classrooms primarily because teachers are familiar and comfortable with that mode of instruction. The integration of more powerful simulation, hypermedia and AI tools into instruction is still neither well understood nor widely used by most teachers, and similar to classrooms, we still have dominant use of "talking heads" in many of the current interactive television efforts in states across the country.

Contributing to this problem is the lack of understanding of the full potential of the new technologies to enhance learning and other human endeavours. Computers are great at storing and processing information and can perform millions of computations in seconds. Humans, on the other hand, are not particularly good at rapid computation or the instant recall of thousands of items on a list. We are, however, particularly adept at seeing patterns, holistic trends, in generating hypotheses and ascribing value to people, events and things. A teacher can walk into her classroom and immediately sense if there is something wrong. These are things that, at least at present, no computer can do.

Rather than attempting to compete with computers, we should relegate to them the tasks that they do best, e.g., the processing and storage of voluminous amounts of information and performing routine, tedious and boring tasks, thereby freeing us for more creative and complex endeavours. Here is an example of such an application. At the Centre for Technology and Education, we are presently working on the development of a robot that will sit at a computer and perform drill and practice exercises, freeing the child for more interactive and higher level learning activities. This device will serve as a prototype for another robot we are developing for use in the home. It will sit in the family room after dinner and watch television, thereby freeing the family members for more interesting and creative activities such as reading and talking.

Views of the Learning Process and Uses of Technology in Instruction

Many options and strategies for reforming education are being considered and implemented in our nation's schools, including lengthening the school day, changing the curriculum, adopting year round schools, lowering the size of the classes, increasing standards and accountancy, and, of course, placing computers in classrooms. One aspect of change that is often overlooked, however, is our view of the learning process.

Over the years, instruction in many of our classrooms has reflected the view of learning as a process of information transfer. In this view, the teaching-learning process is seen as one of transferring meaning from the teacher's mind (or textbook) to the student's mind (Harste, 1985). This view of the learning process tends to emphasize memorization and recall of facts. The criteria for judging the success of the teaching-learning process is how much information is transferred into the mind of the student.

Many of the instructional activities that still occur in classrooms reflect this view (e.g., use of workbooks, teacher lectures, etc.). The initial applications of computers to instruction supported this view of learning as evidenced by the predominant use of drill and practice software and courseware containing rigid linear instructional sequences with little control provided to either student or teacher. Unfortunately, a number of distance learning courses still reflect this view of the learning process. Students sit and view a talking head with only the opportunity for perhaps a few students to raise a question from the large array of classroom sites.

More recently, the view of the learning as an Interactional process has received increased attention and emphasis. In this view, both the student and the teacher (or text) are seen as contributing to the learning process. Meaning resides both in the minds of the teacher and in the mind of the student. Learning results from the ways these two meaning systems contact and interact with each other. Teachers ascribing to this view place greater importance on the knowledge and experience that the student brings to the learning process (Harste, 1985). They also tend to provide more opportunities for discussion, small group interaction and collaborative instructional activities in the classroom. Some of the better tutorial educational software programs (in which students have greater control of the instructional sequences or presentations), and software that allows students to build their own endings to stories support this view of the learning process.
In distance learning, we have seen courses such as the one between Harvard University and Beijing University that uses an audio-visual graphics system that provides real opportunities for interaction between the instructor and the students. This distance learning project uses regular phone lines but provides slow scan images of the instructor and students, real time presentation of computer text and graphics and the ability of both the instructor and the students to write on the computer displays using a graphic tablet. Although presumably a more limited medium, still the way the course was designed, it provides constant voice and graphic interaction between the instructor and students who are many thousand miles away.

A third view of learning as a Transactional process (Rosenblatt, 1978), is beginning to emerge on the educational scene. According to this view, learning is seen as a process by which learners outgrow their current selves. Rather than viewing learning as a process of information transfer, with the major variable being a faulty learner, transaction sees the coming together of information and the learner as an open potential - ever changing as a function of the context of the situation and the knowledge, experience and interests brought to the setting by the student. The notion of transaction establishes new functions for teaching and learning at a time when we are beginning to understand the failures of our traditional methods and approaches to learning. Instead of information disseminator, the role of the teacher becomes one of mentor, facilitator, and even co-learner in the learning process. The learning environment is designed to provide students with the opportunity to access knowledge and to synthesize and apply that knowledge to other situations and learning tasks (Wilson, 1988). The increased use of open-ended computer-based tools such as word processors, spread sheets and, databases, as well as problem-solving and simulation software, can support the transactional view of the learning process. However, teachers who do not ascribe to or understand the transactional view of learning can easily trivialize the use of these new and powerful tools, e.g., using word processors simply as electronic typewriters.

In educational telecommunications projects, a transactional approach to learning would emphasize the participation and active role of the students at the remote sites in making joint presentations, discussions, explorations, carrying out multiple site projects with shared data bases, etc.

A powerful but under-utilized learning resource is the use of educational telecommunications as a means of supplementing instruction, providing in-service training and providing access to information resources, technical expertise, and on-line mentors. One example of such an approach is embodied in the Educational Native American Network Telecommunications System.

The Educational Native American Network (ENAN) is a nationwide telecommunications network based at the University of New Mexico Centre for Technology and Education and sponsored by the U.S. Department of the Interior. ENAN serves teachers, students, and administrators in Indian schools and certain professionals in the field of Native American education. The ENAN system allows participants from around the nation to send electronic mail, participate in on-line conferences, download data from ENAN libraries and engage in a variety of interactive educational activities.

ENAN offers those involved with Indian education opportunities to:
- Access information bulletin boards on important BIA activities, state and regional education activities, and other professional data;
- Share instructional ideas, lesson plans and other materials with teachers in other schools around the nation;
- Provide students opportunities to communicate with peers in other schools, participate in on-line interactive projects and learn a variety of telecommunications skills;
- Develop and implement their own on-line activities with the assistance of ENAN staff; and
- Find on-line support and advice regarding administrative and other computer application questions.

ENAN is very sensitive to user needs and as a result is constantly evolving to meet those needs. Users suggest new bulletin boards and activities and work with the Center to implement ideas that will benefit the ENAN community. A few new and ongoing activities on the network include:

- The Chigger Byte Journal: An On-line Journal for Teachers
- On-line university course offerings from two institutions
- The Deep Space Probe: A science simulation
- Portraits: A collaborative writing project
- The Whole Language Support Bulletin Board
- User to User Assistance
- The SIPI Upward Bound Project
- The Guest Speaker Project
5.2.5 The Implications of Technology for School Reform

P. Resta, U.S.A.

The Dig: An archaeological simulation allowing students to work through all aspects of a complex site project.

Another example of such an approach is the National Geographic KidNet Project. Using computer-based communications, students across the country do real "sciencing" rather than simply learning about science. Through the joint and synergistic efforts of students and teachers across the country, the KidNet classes generated research data on acid rain that resulted in map corrections to the projections of scientists.

These are only a few examples of how educational telecommunications can serve the educational and cultural needs of schools in rural/isolated areas.

Although learning by doing has been known to be a powerful learning strategy for some time, we find that most educational activities still focus on learning about something. A story may help illustrate the point. The director of a small town Little League was encountering some serious problems. A great many more children wanted to play in the league than the town's one ball field could accommodate. It was clear that an additional field was needed to serve the growing number of players. A public meeting was held and the director described the need and costs for constructing a new playing field. After some long and difficult discussion, there did not appear to be any means for raising the needed money. Finally, an older man in the back of the meeting hall rose to say he had a way out of this dilemma:

From now on let's require that all kids study baseball before they are allowed to play. We can have them study the bats, balls and mitts; learn all the rules; go out and measure the distances between bases and from home plate to the fence; have them measure the length of the bats, the circumference of the balls; study the leading baseball stars and their statistics, and so forth. By the time they have finished with their studies, no kid will want to play baseball and we can save the cost of a new field!

Fortunately we are seeing a shift in our view of the learning process, with greater emphasis on participation and involvement of students in activities that have real solutions and consequences. We are seeing greater collaboration between students, students and teachers and between teachers. We are also seeing the creation of exciting new playing fields for learning both in and outside of the classroom. Telecommunications can help provide access to these new intellectual "playing fields," whether they be national electronic databases, access to world class scientists or collaborative learning projects between classrooms thousands of miles apart.

Cultural Understanding and Educational Telecommunications

As part of educational transformation, it is time to develop a vision of education that helps develop our students' awareness of not only their nation's traditions but the richness and diversity of the other cultures on our planet. It is also time to help create more cooperative and collaborative environments for learning in the classroom in order that our future world leaders and citizens will be better able to collaborate in helping solve the growing array of global problems.

As eloquently stated by General Secretary Gorbachev,

*There is a great thirst for mutual understanding and mutual communication in the world. It is felt among politicians, it is gaining momentum among the intelligentsia, representatives of culture and the public at large... We are all students, and our teacher is life and time. I believe that more and more people will come to realize that through RESTRUCTURING in the broad sense of the word, the integrity of the world will be enhanced. Having earned good marks from our main teacher-life, we shall enter the twenty-first century well prepared and sure that there will be further progress* (Gorbachev, 1987, p. 254).

The educational use of telecommunications offers great potential for quenching this thirst for mutual understanding and communication. It provides us with a unique opportunity to help develop students in schools across the globe, who understand and are prepared to work collaboratively with their international peers in helping meet the challenges of the twenty first century.

During the past few years, we have seen the growth of educational telecommunications projects that link classrooms in different countries together. Recently, we linked students in one of Albuquerque's high schools with students in a school in Moscow. The impact of these projects has been electrifying - and the student interest and excitement about communicating and working with students in another country has infected the entire school! Through the Copen Foundation and the Apple Global Education Network, a number of our classes are now working on significant projects with students in other countries that would not have been possible earlier. Such applications clearly indicate the important role that technology can play in revitalizing education and facilitating the restructuring of education in the U.S. and in other countries.
5.2 Conference "International Perspectives: Education and Technology", 1990, Canada

References


5.2.6. Educational Perspectives in Hungary After Forty Years of Communist Rule

M. Csako, Hungary

In 1989, the Hungarian Ministry of Education called upon a group of educationalists, sociologists, economists and other researchers to contribute to the preparation of a new educational reform. When their papers had been written and put together the editor found that the only title appropriate to the volume was: "NO MORE REFORMS, PLEASE!" (1).

One may be surprised by such a high level of conservatism in a time of rapid political, social, and economic changes. But a short glance at the frequency of reforms since 1961 (marked by arrows in Figure 1) can already offer a general impression of understanding the experts' reluctance towards new reform.

![Figure 1](image)

Besides the waves of reforms, Hungarian education has had to support three national legislation acts reorganizing its structure and reorienting its policies: one after WWII, one in 1961, and one in 1985.

All these reorienting and restructuring laws and reforms resulted in deterioration of educational infrastructures, the degrading of the quality of teachers, a low level of teachers' salary and working conditions, and steadily surviving cultural inequalities. "Voila," the heritage of the new democratically elected government in education.

Three large clusters of factors can be pointed out when looking for the causes of this situation:

- political developments,
- demographic trends,
- and the impact of the economy.

The Changing Effect of Politics

Each of the three educational laws were inspired by political changes.

After WWII most Hungarian educationalists and politicians wanted to democratize and modernize the school system through structural changes. They increased the length of compulsory schooling to eight years and integrated the various types of elementary schools into one eight year type "general school". At the secondary level, three main institutions have been formed: two full time, i.e., four year schools (the gymnasium for general education and the technikum or later technical secondary school); and a shorter, three year, vocational school. (See Figure 2.)

While this gives almost a free hand to higher education, and the technical secondary produces technicians and other middle level employees with access to higher education, vocational schools train future skilled workers who have no further place to go within the educational system.
Even through so many changes since the forties, the overall structure of the system has remained the same until now.

Figure 2: The School System in Hungary

The idea of democratization proved to be an illusion in the forties. First, religious teachers had been chased from schools, or forced to deny their faith; then educational activity had been reshaped following the ideological and political needs of the Communist Party. Teachers giving bad marks to the children of workers and peasants were qualified as "the enemies of the people." Those who gave them free way through their classes were however treated the same way because they had decreased the quality of the school's output. So professional traditions had systematically been broken, along with teachers' backbones.

The Education Act of 1961 was one of the first signs of a new political course labelled later as the Kadar regime. It abolished the formal positive discrimination of workers' and peasants' children as well as the negative discrimination of the children of office workers, intellectuals, and private entrepreneurs in schools. As a result of lifting formal obstacles, social and cultural inequalities reappeared at once and became a strong motivation for the reforms which followed.

During the Kadar era, repression against teachers became somehow limited to explicit political (or religious) cases, and to those qualified as such. Teacher training institutions "hit" by the same policy during the fifties had lost their ability to produce "real" teachers while the old generation - having better professional skills but not daring to use them any more - slowly disappeared.
When the new wave of democratization brought about a larger autonomy for teachers by the third Education Act (of 1985), there were no more teachers capable of making use of it. One of the major tasks of the new educational government is to reanimate teacher training in Hungary.

What Demography Can Do to Education...

The Hungarian schools have suffered severe demographic pressure put upon them by incompetent communist governments. The minister of social affairs completely outlawed abortion in the early fifties, causing a high tide in the birth rate (See Figure 3). This wave entered the general (primary) schools around 1960 and attained the secondary by the end of the decade.

Unfortunately, the Kadar regime repeated the mistake of its Stalinist forerunners twenty years later, just in time to have the largest number of cohorts enter the age of fertility. The next wave of high birth rate was built on the first and their children are struggling through an overcrowded school system only to face rapidly growing unemployment in the nineties.

In this respect, the perspectives are even more uncertain because the restrictive measures of the Kadar regime were demanded by those nationalist intellectuals, then somehow by those in opposition, those who now govern Hungary. And just another twenty years are elapsing...

![Figure 3: The Trend of Birthrates in Hungary](image)

The Impact of the Economy

The economy is seen by many observers as having some good periods during the last forty years in Hungary. Its impact on education, however, can be painted by one colour: education has always been one of the lowest priorities of the national budget. The more the economy is submerged in crisis, the more the educational share is diminished.

Teachers' salaries have never kept pace with inflation (which reached more than 30 percent in 1990). More and more school buildings are nearly falling down and there is no money to buy new equipment or even to have the blackboard repainted.

However, the mid-eighties saw the largest single investment project in the history of Hungarian education: the National School Computer Programme. Have the government and its high officials miraculously been hit by some divine enlightening? Experienced and sceptical observers such as I am do not believe it. It seems to be rather one of those irrational budget decisions, many of which have had a devastating impact on Hungary's economy (such as the "aluminium project," the "Olephine project," and recently the Danube dam). The only advantage to the National School Computer Programme was that for an extraordinary cost it offered in the mid-eighties the only possibility for many Hungarian children to have a first look at a microcomputer. Since then the whole policy is to be reconsidered.

The new democratic regime inherited a deep economic crisis. The standard of living has constantly been diminishing through the eighties and today one third of the population lives on the poverty level or below and the next third is threatened to fall into the same position every day. (See Figure 4.)

While the former communist government could give more for education, as they proved with the introduction of the National School Computer Programme, they left their successors with an empty treasury, unable to give more for educational goals.
Instead of money, the new government offers more autonomy: decentralization is on the top of its agenda. The communist governments followed the policy of controlling the whole educational process beginning with the input factors, through the curricula, maintenance, pedagogy, and everyday activities in schools, to the final output. The new concept, supported by most experts, is to keep only the basic curriculum and the output controlled by the Ministry of Education. With assuring the maintenance of the public schools, and allowing the private initiative to enter education, and having an appropriate output assessing examination system based on the national basic curriculum, the whole educational process can be put under the control of democratically elected local authorities.

Uncertainty prevails everywhere. In this situation teachers and parents are equally worried and are losing their orientation. Their incoherent behaviour, especially that of the teachers, makes it more difficult to find good solutions in practice. However, teachers are and remain the most important factor in education and this is the point the sociologists, educationalists, and economists recognized when joining in the chorus: "No more reforms, please!"

Reference
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5.2.7 Using Computers in Education: The Romanian Experience

I. Diamandi, Romania

Abstract

This paper presents a few methodological principles regarding a way of organizing computer-use technologies in the instructive educative process, through the insistence on the use of educational computational games and aptitudes-forming programs aimed at developing divergent thinking. A few of the experiments on introducing information technologies into the Romanian educational system are briefly presented. The most interesting conclusions were not those related to the results correlated with the initial objectives, but some collateral ones.

Games Nature Plays

I once read the significant story of an Indian who gave his son a bow and some arrows. He explained to the child what he could do with that "toy" and did not forget to stress something: "It is only by practicing yourself and not by looking to the other’s practice that you will learn to use the bow." The child is a little scared and doesn’t know how to start. Then his father tells him not to hurry, but to aim carefully and send away each of his arrows. But mostly, he had to learn from his wrong blows. "That's how you will learn to use the bow and will become a good hunter," the Indian ends his advice for his son.

I started with this story considering that it can be a representative model for the way of experiencing transition: initiating a child in a game that he will need in an adult’s everyday life, resembles the present day initiating of a child in computer games. As with the little Indian, one must first explain the functioning, then the subject remains alone in front of the machine: the other’s experience cannot replace his own practice. Of course, he will learn to avoid the mistakes already made and to correct himself.

Experience, the knowledge or the rules, are, in fact, the main difference between simple play (spontaneous, accidental communication) and a game (a clearly organized language of communication, with certain rules that should be known). In learning these rules one gains the ability - and then the performance - which means ability plus a series of data that depends on psychological or medium-related factors.

Any child enjoys playing and also, any game has an educational content, even the drill-and-practice game. (They determine abilities of the algorithmic type, which are impossible to form otherwise.)

The educational efficiency when introducing a game activity in the instructive process, is directly linked to the role of the teacher in the teacher-student relation. The teacher must know both to organize the game "and to direct it towards educational purposes without modifying it."

Future's Games: Intelligent Tutoring Systems

Generally, computer games are individualized, even if more pupils are playing them. In order to avoid the contradiction between this fact and the actual use of the team games (when each player has a certain part and the decision is drawn after the group debate), one should imagine and project new games (for many players), or imagine another way of organizing the game. This is anyhow a necessary thing, since most of the computer games contain few or no instructions for the teacher (regarding the way of organizing the group and the competition in the class).

Figure 1: Logical Game Schema
There is a more difficult problem with logical games. Most of the logical games are easy to program as they are formed within the simple schema shown above (Figure 1).

We must admit that programming such a game doesn't involve special technical problems. The pupils themselves are able to realize it. That is why such games were not successful, although they contain many elements that develop thinking. But much more important is organizing a game in order to realize real progress, because often, it may happen that the pupil makes mechanical moves without overtaking and thinking through the information provided by the computer. The ideal would be to overtake all the information.

In order to realize this, every pupil should have an expert on that specific game near him. This cannot be done by the teacher (not to mention that there is only one teacher and a whole class of pupils).

But what is the part of the computer? What is the difference between such a game and a classic one? In this case the computer must be a game partner, a friend who gives a hand and some advice when necessary. So, the solution is to produce logical games (of the intelligent tutoring type game) in which the computer should help the pupil in a friendly way, and should notice whether there is or is not real progress in thinking, a real strategy. The first intelligent tutoring system for a game was implemented by Brown & Buton (1978) to explore differing monitoring functions and various tutoring strategies. Their system could evaluate the student's moves and provide an intelligent critique in the Socratic style. In addition, it could answer a question about the value of a card and provide heuristic remedial recommendations (hints).

D. Dicheva (University of Sofia) and Benedict du Boulay (University of Sussex) have further developed this experiment with the creation of a structural model of the student and by improving the coaching and the way in which expertise is embodied in the system.

Encouraging the Direction of Creative Capacities Development

An analysis of our national educational system shows that present day education is overwhelmed by the informative aspect, to the prejudice of the formative one. All the modifications of programs and curricula in the last few years had as their only effect, their overloading with crowded information and the elimination of the last formative features of education. Other conclusions drawn from this analysis have also shown a rigid education system, characterized by a non permissive, authoritative atmosphere, where pupils have very little initiative during teacher-student interaction, while student-student interaction is almost non existent.

Taking into account that aptitudes are not creative by themselves, but become so only if activated and fructified through creative reasons and attitudes, an experiment has been started that should lead to the stimulation of pupils' curiosity, spontaneity and initiative, while educating their sensibility towards the others' ideas and feelings.

During the instructive process, the pupil obtains information as well as various modalities of operating with this information (intellectual habits). Most of the ways of operating with information are algorithmical-type methods, determining an unique reaction (convergent thinking). The introduction of the techniques of informatics into the educational system has developed these habits. Therefore, among the computer-using class activities that determine convergent thinking, one may mention those of: learning a programming language and even programming itself (especially for BASIC, PASCAL and FORTRAN), as well as using drill and practice or problemsolving programs and most of the educational games. But the research regarding intellectual structure has pointed out that creative persons have highly developed divergent thinking (i.e., the ability to find multiple solutions to the same problem). The typical exercises based on divergent thought can solicit different cognitive activities: for instance, multiple ideas associations, developing and completing, etc.

How can these exercises be constructed starting from the types of divergence already mentioned? Here are a few examples:

a) one is given the part (a fragment) and is asked to imagine the whole (e.g., one is given a syllable and is asked to find as many words as possible that include/begin with this syllable)

b) one is given a fragment of the whole and is asked to imagine other fragments that can be the former's substitutes, etc.

Obviously, exercises based on divergent thinking will not replace exercises based on convergent thinking but they can present moments for the study of different aspects of educational programs.

The ITEC Project

Is there a computer impact on children's cognitive development? If so, how can one evaluate it synthetically, taking into account that up to now, although there have been many attempts to solve this problem, no complete response has yet been given. How does culture influence this impact?
All these terribly exciting questions have been alarm signals for the direction of this field in our country. These have led us to participation in the ITEC Project for the purpose of improving the quality of our national educational system. The conceptual and methodological framework for this endeavour has been provided by the leaders of the project - Betty Collis, the Netherlands, and A. Jablensky, Bulgaria. For the study and the analysis, a system of variables has been taken into account, including those referring to: the type of programs and equipment to be used; pupil’s and teacher’s model; types of social interactions (student-student and teacher-student relations); ways of integrating the computer-use in lessons, etc. The experiment, that should offer the necessary information regarding those variables, was directed by the above-mentioned principles - considering that respecting them should imply a positive impact on cognitive development. During the first cycle of the first phase, we have obtained the following items, which are now being analyzed so as to offer answers to the project questions:

- 4 videotapes containing: a general description of the school and its environment where the experiment takes place, and three typical examples of computer use during some lessons. The examples show:
  1. using an educational game for gaining orienting aptitudes and for problem-solving while working on a team;
  2. using a traditional program for aptitudes forming (recognizing names, with their gender and number - a Grammar lesson);
  3. using a logical game (moving the knight on a table of 5X5 then of 3X3), to educate anticipative thinking;
- a videotape of the discussions among the 3 pupils (during the first game). This tape is about to be analyzed; and
- recordings of the duration and the answers given during the third game. The recordings are about to be analyzed.

Although the experiment is still in progress, certain conclusions are beginning to be drawn, proving the existence of a positive impact on cognitive development.

Other Projects on Improving the Methods in Schools

Between 1985 and 1990 many experiments and projects aimed at improving educational methods took place in our country. We present a few of those, together with our main conclusions:

1. The BAMBI Project directed between 1986 and 1988 by the Institute for Computer Research (ITC) aimed to experiment on computer use as means of general culture, with children of 4 - 8 years. Researchers investigated the possibility of transferring family's education towards the school education. As the existing teaching material was insufficient, some students in Mathematics (at the Bucharest University) were asked to replace the rest of the teachers. The satisfying results encouraged the idea of attracting some pupils in the college or even secondary school (from the high school of Informatics in Bucharest) as teachers. They were able to have a few years of experience in using the computer and besides, the team of teachers and scientific researchers offered them books and didactic projects. The results were amazing. The best results (the group of pupils with the best final results), were the groups with the youngest teachers: the teachers who were themselves pupils in the college or in the secondary school. The researchers that watched their lessons noticed a friendly atmosphere, propitious to study and work; and that the pupil-teachers had organized their lessons intuitively, without special didactic training, yet with the best results.

2. Between 1985 and 1990 pupil debating teams for computer use have been organized. They aimed to make pupils obtain the best possible performances during organized contests. 9 to 14 year-old children were organized in different groups (according to their ages) and attended intensive courses on computer use, and on learning to solve problems with the aid of the computer. Although it was not a compulsory extra-curricular activity, the involved pupils were treated in an authoritative way, aiming strictly for their best performances. Those who got the best results were chosen as further subjects of more difficult instructive program. Those who were unable to obtain such results were eliminated. The team representing an institution at the yearly contest consisted of four pupils of different ages. At the yearly contest, each pupil had to present a program he or she had made him or herself. My task as a teacher of an intensive course for each of the finalist teams allowed me to notice that a little before the contest, the pupils in some teams were very tired (which caused them obtain poor results). In this case I decided neither to present them with a course, nor to give them any indications for the contest programmes - I just left them alone. I saw how powerful teams appeared - pupils of different ages helped each other (without anybody's advice) - with older pupils becoming real teachers for the smaller ones.

3. In 1988, in a computer-using camp, the learning of the Prolog programming language was experimented on. All involved pupils had been chosen as being skilled in Maths. Three groups were formed: the first of pupils who had been using the computer for 3 to 4 years (using BASIC); the second of pupils who...
had been programming in BASIC for 1 to 2 years; and the third of pupils who had never programmed a computer. At the final test pupils, in the 1st and 3rd teams respectively, obtained very good results, while the pupils in the second team obtained much poorer results. The conclusion: it is not necessary (sometimes even not indicated) that pupils should start their active initiation into computer-programming with BASIC or even Pascal type languages. The by-passing of some stages and the initiation of pupils directly into more advanced languages is not a mistake.

References


5.2.8. Educational Issues of Technology Use in the Bulgarian Schools
V. Tsoneva, Bulgaria

At the present moment a process of thorough social change is taking place in Bulgaria. This process started on November 10th, 1989 and is demonstrating that the Bulgarian people are very eager for the democratization of the country.

With respect to the educational system a change from education based on a one-party system society towards education based on a multi-party system society is being observed. The last year brought a lot of change to schools in Bulgaria. These changes are bound mainly to:

- the instructional content and organization of the educational process,
- the structure of the curriculum, and
- the improvement of conditions for the teachers' labour.

1. The instructional content for schools now has to meet the obligatory requirement for depolitization of the school.

1.1. All the school textbooks in social science, Bulgarian language and literature were revised for the purpose of making them compatible with the democratization process in Bulgaria. Thus, the instructions of the Ministry of Education, addressed to the teachers, with respect to what should and what should not be taught in grades I to 11 (12), covers 111 pages! Only 103 textbooks needed no correction and could be used in school, while in another 79 textbooks a lot of topics were crossed. For example, the instructional contents in Socio-economic Geography, had to be actualized with respect to the radical changes in Bulgaria and in the East European countries, the new relations East-West, the characteristics of each of the countries undergoing changes, etc. Another school subject History, has a special role in the efforts for school depolitization and its transformation into an institution capable of creating historic thinking and national consciousness on the part of students. Some of the illustrations of themes that had to be dropped from the curriculum in History in the 8th grade are as follows:

(i) Communist Manifesto,
(ii) Paris Commune- a first attempt for a dictatorship of the proletariat,
(iii) World in the epoch of imperialism,
(iv) International workers' movement at the end of the 19th and the beginning of the 20th century,
(v) Basic conclusions in the world development in new times.

Four textbooks were evaluated as appropriate only for second-hand paper use! Those were the textbooks in Music (2nd grade), Music (5th grade), Ethics and Law (9th grade) and Man and Society (11th grade).

The solving of the problem of school democratization is seriously hampered by the general economic crisis in the country and by the shortage of paper, in particular. There are no notebooks in our stores, for example.

I would summarize that development of a politically independent school curriculum is now underway in Bulgaria.

1.2. The new organization of the school educational process has as its outcome an obligatory 5-day school week with 20 to 30 lessons per week depending on the student's age.

Starting from the present school year our students can make their choice with regard to professional training in the last grades of the senior school. It must be noted here that almost all the schools in the country meet the students' wish to get a professional training in school in parallel to the general secondary education. As for the vocational schools, 21 of them introduced a foreign language straight from the first year - 14 lessons per week and moving to 4 to 5 lessons per week during the next three years. This combination of vocational and foreign language training is expected to give our students a good start at professional realization after they graduate.

2. The structure of the school curriculum is being changed as well. Its main change follows a transition from a linear education to a cyclic education. That means that the same fact will be covered by the student several times at different school grades, each time being interpreted from different aspects and in different depth.

The number of schools in Bulgaria is now about 9000 and the number of teachers in them about 120,000 (Table 1).
The population of the country is about 8 million. 7.3% from the national income goes to the schools. This sum is extremely insufficient and it covers mainly building schools, purchase of equipment and the salaries for the teachers (Table 2). Higher salaries for school teachers were introduced, but unfortunately only as a result of a lot of symbolic teachers' strikes all over the country during the last year. At the present moment the shortage of classrooms in the united secondary polytechnic Al schools is extremely high (Table 3).

In general, there is not enough money for the creation of a modern built and equipped school network in Bulgaria. At the present moment, when schools all over the world have already become computer oriented and in some countries have even forgotten about the use of chalk, the Bulgarian school remains with strong computer-orientation but without chalk in the classroom.

The national programme for computer use in schools was started in 1985. It focused on three main ways of using computers in school:

- the computer as an object of learning;
- the computer as an instrument in the instruction/learning process;
- the computer as an instrument for performing school management.
The programme proposed activities for teacher training on computer use and research work on computer use.

Now there are about 18,000 microcomputers in schools, which means that every 14 students has one computer and can have access to it for about two hours per week. The computers in the majority are of the type PRAVETZ-8 (Apple II) and only in some of the schools are there PRAVETZ-16s (IBM PC compatibles).

One of the main issues concerning school-based computer use in Bulgaria is how to use the computer at school lessons. The last decade in our country has been marked by two approaches for computer use in school lessons.

The first one manifests the idea of introducing a separate school subject of "Informatics." Within this approach, since February 1987, such a subject has been introduced into the last two grades in both United Secondary Polytechnic Schools and the Technical Schools for Vocational Training. Three different textbooks on Informatics are available to the teachers and the students, all of them following the same curriculum. The instructional content in Informatics focuses on the programming language BASIC, the theory and practice of algorithms and a brief acquaintance with the potential of the microcomputer for performing calculations, producing and using graphics, word processing, data bases, etc.

Several years earlier, in 1983/84, the RGE (Research Group on Education) introduced the subject "Informatics" in the first junior class (5th grade) in three of the schools from the RGE chain.

In 1984/85, the same subject was introduced in the second junior class (6th grade) of those three schools and in the first junior class of all the RGE schools. The textbooks for the 5th and the 6th grades introduces the students to the same basic notions for programming, using the programming language Logo as a tool.

The second approach to computer use in school lessons is based on the idea of integration of the computer into the instructional content. This approach, being recently a leading tendency in many countries, is becoming more popular with specialists in Bulgaria. The Ministry of Education started introducing that approach in 1988/89 with regard to Mathematics. Thus, elements of informatics were integrated with the instructional content of Mathematics for the 8th grade of the mass school. In 1989/90 the same approach to computer use was applied in the 9th grade in the Mathematics lessons. Following the basic principles of the RGE for the development of instructional content and for the performance of classroom activities, the approach is now one of:

- integration AI approach to studying the school subjects, and
- learning by doing.
The students from the RGE chain get acquaintance with some elements of Informatics as part of the encyclopedic education straight from the primary classes (Grades 1 to 4). For the first time in 1989/90 the students from Grades 1 to 4 got some experience at computer-managed models of the type Lego-Logo. In the third junior class (7th grade), the Informatics knowledge starts infiltrating into Mathematics. The computer system "Plane Geometry" is Bulgarian-developed software that uses the basic notions of the Logo language. The objects and the operations in this system are adequate to the basic objects and operations in Plane Geometry. Using the computer system "Plane Geometry" the student can test an unlimited number of hypotheses that help him to prove the theorems in a classic way.

The research findings indicate that the educationally sound computer environment based on Logo facilitates both learning and instruction activities of the students and the teachers.

Bulgarian researchers, school teachers and principals in the majority are oriented toward the application and study of the entire educational potential of computer-based information technologies in school education. As proof of their interest in the problems of computer use in school, some facts from scientific life in the educational sphere in Bulgaria are presented:

1. Bulgaria initiated and is now coordinating the activities of the International Research Programme "Children in the Information Age."

1.1. One of the "outputs" of this Programme is the International Conference "Children in the Information Age." Since 1985 Bulgaria has been the host of three biennial International Conferences devoted to a common topic: new information technology and children. The Conferences have attracted the participation of wide audiences of scientists and educators from all over the world, and the published proceedings contain wide, rich reference material.

The Fourth International Conference "Children in the Information Age", scheduled for 21-24 May 1991 (Albena, Bulgaria), will focus on the cultural, social, behavioural and cognitive aspects of the uses of information technology in the education of children.

1.2. Another result from the endeavours of this Programme are the activities accompanying the ITEC Project.

The ITEC Project (Information Technology in Education and Children) is a multinational investigation of the effects of classroom computer use on children's higher-level cognitive functioning. Its pilot stage (Phase 1) started in January 1990 and is still proceeding. The Project involves a detailed study of 22 classrooms in 17 countries. The classrooms, all of which include children in the 9 to 11 year-old range, share the characteristic that computer use is a regular component of instructional activity. The Co-Principal Investigators of the ITEC Project are Prof. Assen Jablensky, President of the Bulgarian Medical Academy, and Dr. Betty Collis from the Educational Department of the University of Twente in the Netherlands.

1.3. Based on a document signed between the former Bulgarian State Committee for Research and Technology, UNESCO and UNDP, for assistance of 4,000,000 Leva (Government contribution) and US $200,000 (UNDP contribution) for the period 1987 to 1990, an International Research Centre in Educational Informatics was founded in Sofia in 1987. Its overall aim is to conduct and promote national research into methods and techniques for introducing Informatics into the educational life of children, and to assist the international community to pursue similar endeavour by means of making its research facilities and training programmes available to interested scientists and students from other, particularly developing countries.

2. A lot of research work is being carried out by Bulgarian specialists on computer use in in-school and out-of-school activities. Most of the results from this work are presented in journal articles, proceedings from local, national and international scientific conferences, books and textbooks. Here is a short illustration of some of the books that focus on children's computer use, and that were published in the last two years (1988-1998) in Bulgaria (see below).

It must be mentioned here that the Bulgarian specialists who work on the educational problems of computer use were very pleased and encouraged by the foundation in our country, in September 1990, of the Open Society Fund. The Open Society Fund will finance numerous educational and cultural initiatives of Bulgarians in our country and abroad and will establish new contacts and channels of information in the educational sphere as well. Now we have a new institution in Bulgaria which we shall rely on in assisting our activities on the ITEC Projects. Thus, we plan to apply for financial assistance from the Open Society Fund for short-term specializations and participation in conferences and seminars abroad for the members of the Bulgarian ITEC Project team.
In conclusion, I think that education in Bulgaria has now been given the chance to accelerate the country's movement towards European and world achievements in science and culture. I believe that the international cooperation between the Bulgarian researchers and their colleagues from other countries will foster that process.

The RGE was found in 1975 under the Bulgarian Academy of Sciences and the Ministry of Education. It aims at carrying out an experiment with a new educational system in 27 schools.

References

5.2.9. Costa Rica: Facilitating Educational Change Through a Computer Programme for the Young

C. Fonseca, Costa Rica

Fabiana Alvarado, 12, is a rural school girl who, like the other 115,000 Costa Rican children in all areas of the country, participates in a Computers in Education Program created in 1988 by the Costa Rican Ministry of Public Education and the Omar Dengo Foundation.

Fabiana had never used computers prior to her joining the Program. Today she does not only use computers in school, what is more, as she herself puts it:

I asked Santa to bring me a computer for Christmas. My father said we had no use for it. I convinced him that if I got it, I would take charge of his business accounts (1).

Fabiana's father owns a small furniture store in rural San Isidro del General. Her family "saved and saved" so she could use the computer, and she is presently in charge of her father's accounting.

The use of computers in school changed Diego's personality. Timid and insecure, Diego, 12, refused to appear in public or participate in school activities. Today, he says the computer has reassured him, made him more secure because he is appreciated for what he does. At his young age, he already shows a talent for architectural design.

Mario, 9, learned to programme the computer on a notebook. His sister Tania, 11, taught him at home using her own notes after her computer lab sessions. When he joined the class, to everyone's amazement, Mario had exceptional command of the tool and was ready for quite complex projects.

What is more, as a result of the Programme, these children's teachers and their lab attendants have developed an interest in computer-related educational projects and innovative activities associated with them, which are not even computer-based.

The constructive approach to knowledge on which the Costa Rican Computers in Education Programme is based, has provided teachers not only with the computer as a tool to enhance learning, but with new methodologies to work both within the computer lab and outside it.

Surprisingly, teachers are trying out ideas and activities that, while being computer independent, bring into life what Seymour Papert very often has called "the stone soup effect" (2). The computer does not seem to be as important as what can happen around it.

Still, the Costa Rican experience confirms what internationally has become persistently more and more evident: teacher training and teacher involvement in computer programmes and innovative technology programmes has to be seen as a process. Innovation per se does not seem to catch on just by being referred to or demonstrated. The process of adoption and appropriation that the teacher must go through, as Dwyer, Ringstaff and Sandholtz have described (3), is often slower and more complex and irregular than normally acknowledged. It requires adequate training but above all, on-going support.

The Costa Rican Computers in Elementary Education Programme

In Costa Rica, the Computers in Education Programme was created in 1988 by an initiative of President Oscar Arias Sanchez and his Minister of Education, Francisco Antonio Pacheco. It is a pint effort carried out by the Ministry of Public Education and the Omar Dengo Foundation to contribute to the improvement of the quality of the teaching and learning process and to modernize Costa Rican society.

The Omar Dengo Foundation is a private, non-profit organization created in 1987 to contribute to the improvement of the quality of Costa Rican education. The Costa Rican Computers in Education Programme is the result of a joint effort between the Ministry of Public Education and the Foundation. At the time of the creation of the Programme, some important educational policy decisions were made that defined the mode of implementation.

Contrary to what was at the time the most widely extended international trend in industrial societies, which favoured the introduction of computers at the secondary level and for computer literacy purposes, Costa Rica decided to introduce computers to enhance the learning process, to improve the quality of education in the basic subject matters, and to stimulate cognitive development, problem solving skills, creativity and logical thinking. The computer literacy aspects associated with the Programme have been conceived as a valuable by-product derived from higher educational goals.
What is more, the Ministry of Public Education and the Omar Dengo Foundation decided to introduce computers first to the pre-school and elementary school children. It was preferred to initiate this transformation process with the young, who are generally more open and flexible. The objective behind this decision was to contribute to the creation of a generation of Costa Rican children who are better prepared to face the challenges of the future and who are naturally familiar with computer technology and its applications from an early age. This obviously implied a commitment to develop a similar programme for the secondary level in the short term.

From its onset, the Programme was planned to bridge out from the school’s educational activities into the community where the computer labs are located, in order to contribute to the socio-economic development of different areas of the country and to reduce the generation gap which might be derived from intensive computer use by the young exclusively.

In Figure 1, the more generalized model of the introduction of computers into the educational systems of industrialized countries during the 1980s is contrasted with that generated for the Costa Rican public school system.

Figure 1: Computer Introduction Models

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<tr>
<th>More Generalized Model</th>
<th>Costa Rican Model</th>
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<tbody>
<tr>
<td></td>
<td>University</td>
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<td>Community</td>
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<td>Community</td>
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<td>Elementary</td>
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Emphasis on Computer Literacy and Computer Skills for the Market

Emphasis on Educational Computing, Development of Cognitive Processes and Link to the Curriculum

The Programme's Objectives

The Costa Rican Computers in Education Programme's objectives are:

1. To contribute to the improvement of the quality of Costa Rican education.
2. To contribute to the development of a new attitude towards science and technology in students and teachers.
3. To familiarize students and educators with the use of the computer and its various applications.
4. To stimulate the processes of learning, creativity and logical thought in students and teachers.
5. To complement learning in various disciplines, especially those that lead to the development of logical thought.
6. To contribute to the improvement of the quality of instruction in basic subjects: Mathematics, Science, Spanish and Social Studies.
5.2 Conference "International Perspectives: Education and Technology", 1990, Canada

The Programme was planned in three stages:

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<th>Stage</th>
<th>Laboratories</th>
<th>Children (Year)</th>
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<tbody>
<tr>
<td>Stage 1</td>
<td>60</td>
<td>63,000 (1988)</td>
</tr>
<tr>
<td>Stage 2</td>
<td>70</td>
<td>48,000 (1989)</td>
</tr>
<tr>
<td>Stage 3</td>
<td>35</td>
<td>35,000 (1991)</td>
</tr>
<tr>
<td>Total</td>
<td>165</td>
<td>146,000</td>
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At the end of the last stage, the Programme will involve approximately 40 percent of the nation’s pre-school and elementary school students. At present, over 30 percent of the Costa Rican school children participate.

The Programme has a broad geographical basis. In order to provide equal opportunities to children in all areas of the country, priority has been given to rural and urban-marginal (inner city) schools. Figure 2 shows the distribution of the computer laboratories throughout the nation (through 1989). The schools where labs are to be installed are chosen by the Ministry of Public Education. Among the criteria for selection are: school location and enrollment, number of existing laboratories per district, interest of the school’s teachers in participating in the Programme and teachers’ acceptance to participate in training, community interest and motivation, and possible complementary benefits derived for the region where the lab will be located.

Figure 2: Computer Labs Distribution
5.2.9 Costa Rica: Facilitating Educational Change

The installation of computers in laboratories provides an optimum cost-benefit relation, greater coverage of the student population, and greater efficiency in maintenance.

Computer Environment

Each laboratory contains 20 computers with colour monitors, a printer and a local network. Nevertheless, in 1989 some labs with only 10 computers were installed on a trial basis. And in 1989 the first programme in a single-teacher school was initiated.

In 1991, the labs will additionally have a telephone line and a modem in order to connect them into a national telecommunications network. This will allow better technical and pedagogical support and provide the children with the benefits derived from telecommunications educational options.

The Children's Activities at the Computer

Students attend the lab two school periods a week, in sessions lasting forty minutes each. In some schools, lab time is concentrated into a one eighty-minute period. The children work at the computer in pairs. Team and interdisciplinary work are fostered.

Normally, all the students in the school attend the sessions. They go to the lab in the company of their homeroom teacher. There they work with the support of a lab attendant - a homeroom teacher herself working overtime at the lab. The laboratory is considered as a time and place for exploration.

Students are introduced to the computer through the use of Logo. This powerful educational tool was carefully selected to meet the Programme's pedagogical objectives. One of the central elements leading to the selection of this tool was the fact that Logo requires the teacher's active involvement, not only in the command of the technology in which it runs, but, more important, in using his or her own potential to generate learning contexts microworlds - for and with the students.

Logo is both a programming language and an educational environment based on Piaget's genetic epistemology. With Logo, the computer is not used to present information to the student. The student does not have to react to instructions provided by the computer. It is the student who is in command. It is the student who instructs the computer. What is more, Logo allows active exploration of ideas and concepts by both student and teacher.

The version of Logo used in Costa Rica is Logo Writer in Spanish. It includes both Logo's graphic power and a word processor. This makes it possible to combine graphics and text.

Within the Programme most lab activities are centred around educational projects defined by the homeroom teacher and the lab attendant jointly. These projects are almost always related to the children's curricular activity and formulated on the computer through the use of Logo.

Around these projects, children do research, plan, discuss ideas, decide on the characteristics of the specific concept they want to develop and look to the teacher for support and guidance as to the computational or educational tools needed to put it into being. In this activity they integrate different areas of the curriculum. Frequently different children work on different aspects of a problem or topic. They later integrate the various components into a multi-page project which synthesizes the whole class's endeavour. The process involved in these productions is much more important than the final product. Still, not infrequently these projects turn into pieces of software or "didactic materials" that teachers and students can use in other school contexts.

Tutor and Teacher Training

The initial teacher training programme was planned with the assistance of Dr. Seymour Papert, who, together with Marvin Minsky developed Logo at the Massachusetts Institute of Technology (MIT). Dr. Papert acted as consultant through a contract the Omar Dengo Foundation signed with IBM, the supplier of the computer equipment.

A group of twelve Ministry of Education teachers and professors form the University of Costa Rica were selected to start the training programme. These first "tutors" were trained personally by Dr. Papert in the winter of 1988. Tutors became the leaders in the training programme and the core element in the follow-up and support activities which constitute one of the central building blocks of the project.

Today, these original tutors have gone on to other responsibilities. They coordinate the different regions in which computer labs have been placed. They are also responsible for the creation of training programmes and of research and development activities. New tutors have joined. Some of them have their base in the different regions they have been appointed to, and are responsible for day-to-day follow-up and support.

In each school, the principal and two to four teachers are formally trained as lab attendants. Participation of the school administrator has been a crucial element in the Programme's success. Training has been defined as a process. Every year a two-week, full-time training session is provided to all lab attendants in the Programme. Special sessions are also offered to inform and involve homeroom teachers.
Lab attendants work half the day as regular teachers and complementary time at the computer lab. The decision to introduce this work pattern was based on the impossibility on the part of the Ministry to appoint full-time lab attendants. However, in some respects, it has been seen as a highly positive characteristic. This format tends to emphasize the idea that this is a programme of teachers using computers and not of specialists in computer science and informatics helping out teachers to introduce technology. As a matter of fact, in the selection of lab attendants there is no requirement as to previous computer experience. What is seen as essential is the teachers' interest in renewing methodology and the openness to change. The teacher should have a certain mental framework to be able to see him or herself as a facilitator and to be able to break away from the traditional "teacher as authority" concept.

In-service training and constant support constitute the fundamental pillars of the Costa Rican Computers in Education Programme, and are carried out at a national level and in the various regions of the country (Figure 3).

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**Figure 3: Training and Support Program**

![Diagram](image-url)
To support all this, the Omar Dengo Foundation created a **Teaching and Research Centre** which is in charge of generating all inservice training activities and developing pedagogical materials. Periodically, the Centre involves international consultants both for overall Programme planning sessions as well as for the development of specific training programmes. The Centre is basically devoted to the preparation of Costa Rican teachers. However, it periodically trains professionals from other countries in the Latin American region.

Furthermore, the Omar Dengo Foundation is in the process of generating, with the aid of the Inter American Development Bank, an academic programme to provide tutors and teachers participating in in-service training activities with further opportunities for academic growth. As of 1991, the Foundation will sponsor a Master's Degree Programme in Educational Computing, through a contract with a foreign university. It will also generate a Bachelor’s Degree in Educational Computing which will be created jointly with the Costa Rican Distance Learning University (UNED).

**Other Training and Development Activities**

The Centre publishes a monthly newsletter, *Innova*, which is distributed free of charge to all teachers participating in the Programme and to other Ministry of Education authorities. *Innova* is seen as an additional tool in the training process. It includes articles on topics of interest for the teachers' work with computers and also examples of projects that the lab attendants are developing in different regions of the country.

An **Annual Meeting of Teachers of Educational Informatics** (Computer Education) is held yearly for the purpose of expanding teachers' knowledge of the field and allowing them to exchange ideas and concerns. In 1991, this annual meeting will become an international conference as it has been planned to coincide with the 5th International Logo Conference to be held in Costa Rica in October.

In addition, since 1989, the Programme hosts an annual **Children's Computers in Education Conference**. In this activity school children from all over the country meet to present the premium projects developed in their schools during the school term. In 1990, projects will deal primarily with science and technology topics.

**Other Complementary Programmes**

In order to secure the Programme's proper growth, the Foundation has developed other complementary programmes. Among these are:

1. The Informatics Community Programme, which after school hours offers computer application courses to citizens in all the communities where the computer labs are located. Teachers frequently participate in these complementary courses on computer literacy. Through this Programme the computer lab becomes an information Centre and modernizing element within the community. Several interactive software projects on social interest programmes are under development. Among them is "How to request a loan for housing," prepared with the support of the Housing Bank.

2. The **Telecommunications Programme** will go into national operation at the beginning of 1991. This telecommunications network will connect all the 130 schools participating in the Programme and will open up new channels for educational and technical distance support. What is central to it from the pedagogical point of view is how it will allow children from low income families and educationally deprived areas of the country to be able to exchange information with children in other areas and to be able to access educational databases at the national and international level.

3. A **Computers in Education High School Programme** is in the process of being developed. It will include the introduction of computers in technical, vocational and academic high school environments. The idea is to complement and expand the computer experiences the children in the elementary school programme have had and to carry this new generation of Costa Rican children further in their process of cognitive growth and academic development. The introduction of computers in secondary education is at present being analyzed by the Ministry of Public Education.

**Multi-Institutional Framework**

To carry out a programme of this magnitude, a developing country such as Costa Rica must make use of different resources springing from various sectors of the society. In this sense, the Omar Dengo Foundation has acted as a catalyst and activator of initiatives and support.

As a result, the Programme rests on a multiinstitutional framework which, besides the Ministry of Public Education and the Omar Dengo Foundation, includes the support of the Presidency, the Ministry of Science of Technology, and the Costa Rican universities, among others. International organizations such as AID and UNDP have provided important funding components. The local communities have also contributed significantly.
The Costa Rican Computers in Elementary Education Programme is the result of much planning and effort on the part of Costa Rican intellectuals, politicians, and educators. The Programme selected a model of introducing computers that is "teacher-centred." The positive response of the Costa Rican educators has been the cornerstone of the Programme's success. Those teachers have accepted the challenge of opening up to information technology and attempting to change and enrich an otherwise obsolete educational system.

The Costa Rican Computers in Education Programme is characterized by "a sense of mission," as Dr. Seymour Papert has stated (4). The Programme's focus is beyond the scope of technology. It aims at the gradual transformation of Costa Rican education and society.

Dr. Claudio Gutiérrez, a researcher in the area of artificial intelligence and former President of the University of Costa Rica, has said about the Programme and its teachers:

I rejoice with you in the existence in Costa Rica of a non-directive educational paradigm based on computer science... Logo children are discoverers: they will discover the multidimensional territory of mathematics... The teachers accompanying them are not kings: the highest title to which they can aspire is the honour of being called "baquianos" (which means "path-finders")... What a beautiful definition of the present-day teacher! (5)

Many Costa Rican teachers are slowly starting to become facilitators and travel companions -"baquianos"- in this exciting and demanding era of knowledge exploration and technological change. To them, the computer may very well become a spring board for professional development and personal change. For the children, as Fabiana, Diego, Mario and Tania very well show, this process has already begun.

Notes

(1) Fabiana Alvarado, student from the 12 de Marzo School in San Isidro del General. Taken from an Omar Dengo Foundation video recording, January, 1990.


Introduction

New Zealand is situated in the south-west Pacific Ocean and consists of two main islands (North Island and South Island) and a number of small islands. It is similar in size to the British Isles or Japan (New Zealand Official Yearbook, 1990). With a total population of 3.3 million, its indigenous Maori people only make up 12% (403,185) of this self-governing nation (1986 census figures). The majority (80%) of New Zealanders are of European origin, predominantly of British Isles origin. British sovereignty was established in 1840 by the signing of the Treaty of Waitangi between the British Crown and the Maori tribal chiefs. The Treaty is a contract in which the Maori people gave up its rights and power of sovereignty in exchange for British citizenship. The treaty also guarantees Maori possession of lands, and protects Maori taonga (treasures) including the Maori language (Ballard, 1990).

Education is compulsory in New Zealand for all children between 6 and 15 years of age and most children begin their formal education before primary school, at the age of five. There are six years of primary schooling (beginning at 6), and five years of secondary. There is a core curriculum for primary education, which covers English, Mathematics, Social Studies, Arts and Crafts, Science, Physical Education, Health Education, and Music. Maori language is used as the language of instruction only in a few primary schools, although programs providing insight into the culture and traditions of Maori people are in all schools. This core curriculum continues up to the second year of secondary (except for health education) and after that students may choose from a wide variety of subjects. In the later years of secondary education, students can sit in national examinations to get qualifications. In the third year of secondary (Form 5) there is a School Certificate Examination, and in the fourth year there is a national Sixth Form Certificate Examination.

Up till September 1989 the New Zealand Education System was predominantly statecontrolled. The central government is the main provider of educational services, from primary to tertiary. Beginning in October 1989, however, most government responsibilities have devolved to local schools, and independent and semi-independent institutes provide most essential educational services (e.g., Special Education Service) to schools. The government also introduced the "userpays" system to tertiary education.

In the past few years there have been tremendous changes in the New Zealand education system. Several working parties have been set up by the government to investigate options in matters such as school administration, assessing educational standards, bicultural education, and curriculum issues. Very recently a consultative committee was established to recommend policy to the Ministry of Education concerning information technology in the school curriculum. A programme initiating developments has now been approved (September, 1990). These changes are mainly a response to the changing economic structure of the country, and also to a different conception of how the national economy should function. With the emergence of a "New Right" ideology, the main concern of the government is to foster a climate for free competition among "self-interested" individuals. It is believed that in order to achieve maximum efficiency the state must let the market force take control. The emphasis on "choice" and the non-interfering policy lead to the most drastic reform of school administration in New Zealand in 1989. It is quite clear that the reform encourages a wider participation of the local community on the education process and also opens up opportunities for the development of bicultural education. These significant educational developments will have implications on the use of technology in classrooms. In this paper we will briefly outline the school administration reform, discuss some issues in the education of Maori children, and highlight the implications of computer related technologies in these developments. First we provide a background to the development of computer education in this country.

Computers in Education

New Zealand is a late-comer in terms of computer use in education and computer-related technologies are not as widely used in New Zealand classrooms as in some overseas countries. Data from a recent IEA study showed that although all secondary schools are using computers, approximately 25% of the primary schools in 1989 were not using computers at all (Chamberlain, 1990). Another more optimistic estimate reported that the average number of computers in New Zealand schools is between 0.5 and 0.6 computer per room (Sallis report, 1990). The reasons most frequently given by principals for not introducing or having
computers available to students in primary schools were inadequate financial resources to purchase computers, an insufficient number of computers, and the lack of training for teachers (Chamberlain, 1990).

There has been very little documentation on how computers are being used in schools. A general observation is that in primary schools the most popular application is word processing, but there are only a few schools which can successfully integrate computers into their normal curriculum activities (Sallis report, 1990). In the secondary schools, the predominant classroom use of computers is in computer studies classes. Secondary schools offer a variety of computer studies courses and it is listed as a subject in the Sixth Form Certificate. In 1988, about 14% of the secondary students took computer studies/awareness courses and about 6% sat for the Sixth Form Certificate Examination for computer studies (Education Statistics of New Zealand, 1989).

It is clear that teacher training in computer education is inadequate. At present, there are six Colleges of Education responsible for teacher training in New Zealand. Each of these Colleges has 1 to 1.5 lecturers either teaching courses in computer studies and computer applications across the curriculum or providing support to lecturers in other curriculum areas (Sallis report, 1990). Some of the universities also provide undergraduate and graduate computer education courses for pre- and in-service teachers. There is no doubt that New Zealand provides high quality teacher training in computers in education (see Figure 1 for a sample course content, (Watts, 1990)), which mainly focuses on how children can learn effectively with the computers across the curriculum, rather than learning from the computer. But the lack of resources severely limits the number of teachers that can be trained.

Figure 1
Computer Education for Teachers Recent Course Content, 1989

- Computers in New Zealand schools
- The skills of word processing
- Word processing in the classroom
- Desktop publishing for teachers
- Logo and the learning process
- Logo programming
- Computer-assisted learning
- Databases and learning opportunities
- The use of spreadsheet in education
- Computers in pre-school education
- Computers in special education
- Authoring languages

Government Directive

In the last decade there has been no clear national guideline as to the role of computers in education. There were some piecemeal initiatives but most of them were short-lived. For example, there was an initiative in the early 1980s to develop New Zealand’s own microcomputer and educational software which would be supplied to every secondary school. However, for various reasons the plan was "scrapped" even though the project was in the final stage of development (Green bank, 1989). The setting up of the Computer Courseware Development Unit (later renamed Computer Education Development Unit) in 1983 to provide advice to teachers; and the introduction of a Computer Awareness course (aimed at junior secondary classes, ran for 12 sessions of 50 to 55 minutes each, covering technological considerations, applications, socio-economic issues, and programming) could be seen as a partial commitment of the Department of Education in computer education (Hodson, 1990). In addition, funding was provided for teachers to conduct 19 exploratory studies so as to provide information to the government with regard to the effectiveness of computer applications in education. However, up until recently only three reports of the study have been published, with no policy implication on the recent government - initiatives. With the devaluation of education services, the four-member Computer Education Development Unit was replaced by six District Advisers on Educational Computing in late 1989, who are responsible solely to the six Colleges of Education. So at present there is no national coordinating body to direct the use of computer-related technology in New Zealand classrooms.

In May 1990, the Minister of Education announced the setting up of a working party, to recommend to the Ministry policy goals for the use of information technology in the school curriculum; to prepare options
for achieving key objectives derived from these goals; and to estimate the costs of implementation. Within two months the committee submitted a report to the Ministry and recommends two policy goals (Sallis report, 1990):

1. That all students will have the opportunity to increase the efficiency and effectiveness of their learning at all levels and in all subjects through the appropriate use of information technology.

2. That all students, through access to appropriate information technologies at all levels of education, will leave school with the necessary skills to take their place in an information society.

Based on their recommendations, the Minister of Education immediately announced an information technology program, which is scheduled to commence early in 1991. The program has five key components (Sallis report, 1990):

1. A major commitment to teacher training at both pre-service and in-service levels.

2. The provision of resources (written material and videos) and advisory support (in the form of 10 additional advisers) in educational computing.

3. The appointment of a national coordinator, who will identify training needs and plan and coordinate suitable programs for teachers and boards of trustees.

4. The establishment of a fund ($12 million) to assist schools in low-income communities to acquire computer equipment and software.

5. The inclusion of information technology in the new National Curriculum.

Since the announcement of this program, the Ministry of Education has appointed a national coordinator, and allocated $400,000 for a "pilot" school-based teacher training program. It seems that the government has finally decided that some sort of national support in the use of information technology is needed in the 1990s.

Some Major Educational Developments

Reform of School Administration

One of the major education developments of New Zealand is the recent restructuring of school administration. The idea behind it is to make the school system more efficient and more accountable by giving parents and the community more power and more choice: schools are to be "self managed instead of being controlled by government" (Tomorrow's Schools: Dispelling the Myths, no date). The government's view on the education system is that it is inefficient and the key to efficiency is to declare it as a "commodity to be traded in the marketplace" (Grace, 1988, p. 14). Without state intervention, schools can become independent, self-managing and competitive (Ballard, 1990) and thus provides free choice to education consumers (i.e., students and parents). Education is no longer perceived as a public good (Lauder, Middleton, Boston, & Wylie, 1988).

Under the new structure, the basic unit of school administration is the individual school which is under the control of a board of trustees. The day-to-day control of instruction and the implementation of policy formulated by the board of trustees is the responsibility of the principal. The board of trustees is expected to be responsive to community educational needs and to design programs and courses to meet them, within national guidelines. The board of trustees is made up of "five parents elected from the community, the principal, one staff member, and one student setting the general directions, policies and priorities for that particular school" (Tomorrow's Schools, 1988, p.3). Each board of trustees can appoint its own teacher staff, including the principal. Except for the salaries of the teaching staff, it has the final responsibility on its funding, provided as a bulk grant by the government. To be accountable, each school board is required to write a School Charter specifying its goals, within the overall national guidelines for education, and is held accountable for meeting the goals. An Education Review Agency is set up to review the performance of the schools once every two years.

Implications for Computer Related Technologies

With the introduction of a totally new structure and administrative system for education, there is an emphasis on efficiency (meaning fewer people and more work) and accountancy (meaning, all decisions, particularly financial decisions must be adequately explained and defended) (McMillan, 1990). Also, the call
5.2 Conference "International Perspectives: Education and Technology", 1990, Canada

for more systematic record keeping will require a heavier use of computing equipment (the Ministry of Education is encouraging schools to send in student and administrative information in computer disk format). These management needs, in addition to the need to purchase computers for teaching and learning purposes (pressure from parents who definitively have much more say under the new administrative structure), will mean more computers in schools. As a result there may be a spin-off effect where more teachers will "get on" to computers and use it for teaching and learning purposes. However, it is more likely that because of the lack of resources most schools will have insufficient computing equipment to meet both the administrative and teaching - learning needs. The concern is that computer resources will be diverted away from teaching and learning towards administration and management (Hodson, 1990).

Under the present administrative reform, each board of trustees has the freedom to buy whatever services the board considers appropriate (but may not be educational!). That may have implications on the recently announced information technology program me. For example, the teacher training provided in the program me may not be welcomed by some school boards and they may refuse to "buy" the service. In fact, it is known to the authors that at present some schools have such a negative attitude towards computer-related technologies that they refuse to having anything to do with computers. Also, one of the goals of this program me is that student leaving school will have the "necessary skills to take their place in an information technology." There is a concern that some schools will be under pressure from the parents to offer more hard-core computer studies courses, rather than using the computer as a creative tool across the curriculum.

**Issues in Bicultural Education**

The response of New Zealand to the challenge of catering for ethnic diversity is unique by first attempting to come to terms with the indigenous people of the land (Irwin, 1989). This bicultural perspective is seen as the first step to multiculturalism. Under the present administrative reform, bicultural education has to be included in each school's Charter. But how it is implemented is subject to the decision of each board of trustees.

Apparently there is an opportunity for the Maori people to take advantage of this reform to enhance their language and cultural development.

One of the major problems for the existing education system is that it does not cater to the needs of the Maori children. This can be seen from the low retention and achievement rates of young Maori learners. Compared to other OECD countries, New Zealand has a much lower retention rate for post-compulsory education. Of the 19 member countries of OECD where education data was available for comparison, there were only two countries (Spain and U.K.) which have a lower enrollment rates than New Zealand (49.0%) in the 15 to 19 age group in 1986 (OECD in Figures, 1988). The median enrollment rate was 71.2%. The retention rate for the Maori children is even lower (4.1% in 1979, compared to 20.1% for non-Maori). Although there was an improvement in retention in recent years, it was found that retention has improved much more for non-Maori than Maori students (Tomorrow's Standard, 1990).

Besides low participation rate, there is a major concern for low level of achievement for Maori children, compared to non-Maori students. For example, in 1985, while 60.9% of the non-Maori students passed School Certificate Examination in English, only 37.5% Maori passed the same examination. It was similar in mathematics where the figures were 65.8% and 40.6%, for non-Maori and Maori students, respectively (Treasury report, 1987). It is also alarming to note that in the same year while about one-third of school 'leavers' (post-compulsory) had no formal qualification, nearly two-thirds (62.3%) of Maori student left school without any formal qualification (Government Management, 1987). It is also noted that of all the Maori students who left secondary schools in 1984, 23% had only finished their first or second year. The corresponding figure for non-Maori students was 6% (Government Management, 1987). Maori students are also disadvantaged in university education. In 1987, Maori students only accounted for 3.8% of the university enrollment. Considering there are larger proportions of Maori than non-Maori in each age group under 30 years (e.g., 39% of Maori under 15 years old, compared with 24% of the total population), and the Maori population accounted for 12% of the total population (New Zealand Official Yearbook, 1990), there is clearly a concern for equity of access to post-secondary education.

Under the present economic hardship, with an unemployment rate of about 12%, children leaving schools with little qualification are most likely to end up on the dole. An earlier figure (1986) showed that nearly 15% of the Maori were unemployed, which must be drastically increased during the last four years with the worsening economy and increasing unemployment. (The unemployment rate of that year was 6.8%.) It is particularly difficult for Maori youth to get employment. Even in 1986 when the economy was in better
shape, 57.8% of the Maori in the 15 to 19 age group were unemployed (for non-Maori, it was 34.8%). It would even be harder for them to get a job now.

There are many reasons for the low retention and underachievement for Maori children. Walker (cited in Irwin, 1989), suggests that most Maori children see little relevance to them at school, which lacks cultural diversity. According to Walker, they also have an ambivalent attitude towards education. To achieve in the pakeha world may mean a loss of Maori identity, a price most Maori people are not prepared to pay. To them, this monocultural system discriminates against Maori people, as pointed out by Awatere (1982):

...The education system is the major gate which keeps Maori people out. There is an invisible sign over the kindergarten door, play centre, school, and university. That sign reads "maori keep out: for white use only". White people can't see this sign, you have to identify or be identified as a Maori before you can see it... (p.41).

The response from the Maori people is to move outside the mainstream educational institutions and set up their own early childhood centres, the Kohanga Reo. Te Kohanga Reo (language and cultural nests), special child care centres, have been established by Maori to provide an educational environment in which children can learn Maori language and Maori cultural values. Presently there are about 640 Kohanga Reo centres in New Zealand. Under the present school administration, groups of parents representing at least 21 children will be able to withdraw from the existing arrangements and set up their own schools (Tomorrow's Schools, 1988). Maori people have already taken advantage of this provision and have so far set up 8 primary schools.

Role of Educational Technology

It seems that computer-related technologies do have a role to play in Maori education. The main issue here is not how the computer could help Maori children achieve, which it probably will, but the way computer related technologies could be integrated into the Maori society and help develop Maori language and culture. In bicultural education the problem is lack of human resources in the teaching of the Maori language. It seems that multimedia applications with video presentations could be a way to redress this problem. In the cultural aspect, databases could be created. It is argued that computer-related technologies have to be used in a culturally appropriate manner. Only in this way the Maori identity will not be endangered. The computer is not being used to replace Maori culture, but to strengthen it. For example, some Kohanga Reo have already been using a multimedia system for language learning and archiving Maori "oral history." In this program ten Maori elders have been interviewed and recorded by the multimedia system for Maori history. The system is invaluable in retaining Maori culture (since the program has been used, the majority of the elders being interviewed have passed away). The Kohanga Reo and other Maori education programs (e.g., the ACCESS program for the Maori unemployed) have recognized the role of technology in education and have been advancing the use of technology in education in a culturally appropriate context (Laws, personal communication, 1990). Their motto of using technology is: "use technology today not to keep in touch but to stay ahead."

Final Remarks

In this country computer-related technologies have not yet had a major role to play in education. The preceding discussion has outlined some of the possibilities and implications in the use of technology in the school system. It is clear that most educators and administrators recognize its importance in education, but because there is a lack of human and capital resources, and a lack of concerted effort and guidelines that it is not until recently that the use of technology has a high priority on the education agenda. The recent government initiatives show that New Zealand is catching up, but in its own way. Being a late-comer may be advantageous: at least mistakes can be avoided and energy will not be wasted in reinventing the wheel.
References


5.2 Conference "International Perspectives: Education and Technology", 1990, Canada

5.2.11. Computers in Canadian Schools: A Review of Events in the 1980s

D. Wighton and L. Ollila, Canada

Preface

This paper presents a brief review of the major events and trends related to educational computing in the public schools of Canada during the 1980's. It is neither official nor complete but rather represents impressions and data gathered over the past years through our contacts with officials in various provincial Departments of Education and School Districts.

In Canada, education is a provincial responsibility. As will be seen through the comments offered below, the 10 Canadian provinces have answered the challenge of introducing computer technology into their schools in slightly different ways. This report does not describe in detail the actions of any one particular province but summarizes only the general strategies that have been employed during the decade 1980-1990.

The Beginning

Although computers had been present in Canadian schools earlier, the increased availability of the microcomputer at the beginning of the decade spurred a rapid increase in interest. This interest was felt first at local levels as schools acquired one or two microcomputers, generally through the efforts of individual teachers, parents, or administrators. The presence of these few microcomputers resulted in further interest and additional pressure on the local authorities to buy even more computers. These purchases were often acquired through discretionary funds, through local fund raising efforts, or through donations from local businesses, parent groups, etc.

As microcomputer use began to gradually spread through the schools, increased pressure was felt by school district and provincial authorities to develop plans for their acquisition and use. Problems of incompatible hardware within a school/school district, inappropriate purchases of hardware and software, inadequate training of teachers, and lack of direction and planning began to surface. As these problems multiplied, and as increased pressure for assistance was felt from the local districts, Provincial Departments of Education began to respond, for example by setting up pilot programs (British Columbia) or establishing provincial task forces (Alberta). Over a period of years, a variety of provincial programs were established in the different jurisdictions. These programs addressed such areas as guidelines for hardware acquisitions, procedures for software evaluation, and development of computer related curricula. Special funding, primarily for hardware purchases, also was provided in many cases.

Hardware

In the first half of the decade, the major emphasis of Canadian schools wishing to develop computer program was on acquiring hardware. At that time, many microcomputer brands were being marketed and many different computers could be found within the same district, and even within a single school. Generally however, schools in the western provinces tended to have mostly Apple II computers while the eastern part of the country was dominated by Commodore brands. In many parts of the country, hardware acquisitions were facilitated through provincial funding, usually in some form of cost sharing arrangement with the local districts. Alberta, for example, initially established an "approved" model and purchased quantities of the product for resale to schools. This program however proved to be unsatisfactory as local dealers undercut the government's price and complaints were received from other producers about unfair competition. A subsequent program allowed Alberta schools to make their own decision on what brand to buy so long as it met certain minimum standards. This three year program provided $32.5 million in matching grants.

Ontario adopted a different thrust entirely, choosing to develop its own educational computer (the "Icon") and providing it to provincial schools at a subsidized price. Between 1984 and 1985, it is estimated that $30 million in hardware support was provided to school districts. In subsequent years, other computer brands met the required standards and were approved for sale to Ontario schools.

Quebec faced unique problems in finding computers that supported the French language. However this problem was overcome by 1984 and a program of financial support was provided ($42 million over three years) for the acquisition of hardware.

Over the decade, these types of funding programs greatly increased the number of computers in the schools. In British Columbia, for example, the schools had approximately 6,000 computers in 1983 (ratio of students to computer = 80:1). By 1989, that figure had grown to an estimated 33,000 computers (14.5:1). Currently, hardware in the schools tends to be either Apple II, MS-DOS, or Macintosh machines. In general, there is now less concern on acquiring hardware and more emphasis placed on how they can be integrated into the curriculum. As reported by Vachon (1991), the ratio of students per computer for the country as a whole is approximately 15:1, however this ranges widely from region to region.
Software

As schools acquired more and more hardware during the decade, there was increased demand for quality software. Several provinces (e.g., Manitoba, Alberta, Ontario) entered into agreements with MECC for licensed access to their library of materials. However, purchases were also made from other commercial suppliers. As the number of software producers in North America increased rapidly, and as the quantity of CAI materials on the market became overwhelming, Canadian educators found it increasingly difficult to locate appropriate courseware products. This problem was made even worse by the general poor quality of software that were being produced in the first half of the decade. Some courseware evaluations were being conducted in a number of centres, but these assessment programs were limited in scope and could not keep up with the demand or with the production of new materials.

Through the Council of Ministers of Education Canada, agreements were established with all ten provincial departments of education to alleviate some of the problems of evaluating courseware. National criteria for the evaluation of courseware were established, and standards on how materials were to be assessed were agreed upon. These included requirements that evaluators were to be trained, that assessments would be done by more than one person, and that classroom teachers would be used. In addition, arrangements were made to share assessment results through a national database of courseware evaluations.

This program was set up by the middle of the decade. Unfortunately, due to economic problems, and changes in program priorities, the number of evaluations being done by the various provinces was severely curtailed, thus limiting the value of this database.

Another common problem in acquiring software throughout the decade has been the relatively poor level of funding that generally has been provided to schools. Whereas provincial funding was established to assist with hardware acquisitions, the costs of acquiring software were generally left to the school districts to absorb. They, in turn, often left it to the schools to find the necessary funds, for example through discretionary funds, library budgets, etc. Many schools currently do not have appropriate software to make full and effective use of the hardware that they have purchased. This problem was eased somewhat through a growing emphasis on the use of computer tools (which do not require a large number of different software programs), but effective CAI use generally was severely hindered by the dearth of quality courseware in the schools.

Even if more funding were available, the high cost of software would continue to be a problem for most Canadian educators. A related problem is the lack of Canadian materials which has forced schools to rely on American products, many of which do not fit well into the Canadian curricula. Two provinces initiated developmental programs. By 1986, Ontario had planned the development of over 150 pieces of educational software and had provided seed money for local software developers in the amount of $13 million. This program was made necessary by the adoption of Ontario's own educational computer, a hardware system which was not supported by commercial software products. Quebec also faced serious problems in finding appropriate software as the size of the market was not large enough to support development of commercial products in the French language. Software development funds were made available in that province as well.

Initiatives for a national software development industry were suggested by the National Research Council Canada which argued that the Canadian market could support a strong CAL industry, with sales to the public schools, consumers, and the industrial training sector. Unfortunately, their suggestion of a national program of development financed through federal funds was not adopted.

In summary, the problems of finding quality materials to support the hardware in the schools remained throughout the decade. This was eased somewhat as schools began to increase their use of computer tools, such as word processing, databases, etc. However, schools wishing to use their hardware for instructional purposes continued to face problems in identifying appropriate materials and acquiring them. Local software evaluation committees, and the use of assessment reviews such as Only the Best, and The Preview Guide were common approaches to solving these problems. In addition, there was some subsidization of software purchases at the provincial level.

Teachers

Canadian teachers are gradually accepting the new technology and experimenting with it. In 1986 in British Columbia for example, school districts reported that approximately 40% of their teachers were computer literate and were actively using computers. In the same year, it was reported that in Alberta, 72% of the schools had identified one or more of their teachers as "extensive users". The total number of teachers in Alberta schools who were identified as extensive users was 12% of the teaching force. These figures have continued to climb as hardware has become more accessible.

Providing support to teachers (e.g., workshops, in service, access to consultants) is a critical requirement for successful integration of the new technology. In Manitoba, consultants were hired to support teachers throughout the province and professional development workshops, normally of one day duration, were offered to educators each spring and fall. In addition, in a joint government-industry initiative, local software development was supported through a developmental centre and easy access to technical consultants. At the end of the decade, British Columbia established an office with in service responsibilities. The focus of
attention in this program was the provision of workshops to local computer coordinators, who in turn provided assistance within their own districts. Other provinces, as well, have provided some teacher training through an in-service approach. Introductory computer courses were also provided at the pre-service level so that students could become familiar with computer technology before they graduated from teacher training institutions. However, teacher support continues to be one of the most critical areas needing attention. In a report to the Ontario government, Smith (1989) stressed that "if Ontario is to maximize the value of its large investment in computers in schools, the major needs are more teacher training and access to high quality instructional software" (p. 9).

Support for teachers was left largely to local districts to provide. In general, responsibilities for the district's early computer program were assumed by a central office administrator. However, as the scope of the program broadened, and as the need for specific expertise increased, many jurisdictions established district computer coordinator positions. In 1986 in B.C. for example, 50% of the districts had designated a person responsible for computer use in instruction within the jurisdiction. One of the responsibilities of these coordinators was to provide in service and on-going support for the district teachers. Typically, outside experts were used initially in workshops but as the expertise within the district increased, local experts gradually assumed the responsibility of educating their colleagues.

Computer resource personnel were designated within schools as well. In 1"X6 in Alberta for example, 77% of the schools had designated someone on staff to provide coordination within the school itself. In 1989 in B.C., 75% of the schools responding to a mailed questionnaire reported having a designated computer resource person. However, it should be noted that at the school level, designation as a computer resource person did not necessarily mean that significant amounts of release time had been provided.

Classroom Use

In the early part of the decade, with minimal hardware available, the predominant use of computers was in "computer literacy" courses. These courses typically focussed on teaching programming (e.g., BASIC, LOGO), although attention was also paid to topics such as the societal impact of the new technology. Formal courses were established in some provincial education system. These were taught as junior high or elementary electives, for example.

As hardware increased, schools began to make use of CAI. Typically, this meant drills in mathematics and language arts as well as keyboarding practice. MECC licenses gave access to a large number of programs which were augmented by other commercial products.

By the middle of the decade, there was sufficient hardware in the districts, and interest on the part of the staff, for coordinated district programs to be necessary. Typically, attention was paid to the senior high first. Computer labs were installed and elective courses established. Some of these courses focussed on business applications (e.g., word processing, accounting), others maintained a programming perspective (e.g., Computer Science), while others were introductory in nature (e.g., Computer Studies).

In the last half of the decade, provinces began developing plans for the integration of computers into the curriculum which, in all cases, has focussed on the development of skills necessary to use the computer as a tool, as opposed to learning to program. At the district level, as additional resources were acquired, computer labs were generally established in junior high and elementary schools. With more and more teachers involved in computer use, the need for segregated computer literacy courses began to decrease and the content of those courses began to be integrated within mainstream courses. Concepts such as "information literacy," "societal implications of technology," and "appropriate uses of technological tools" replaced a narrow concept of computer literacy. As hardware and software resources were limited, typical use of computer labs generally focussed on keyboarding and word processing with CAI being used occasionally. Interest on the part of students was high and teachers generally found it difficult to book as much lab time as might be desired. Schools on the leading edge have been experimenting with the integration with other media (e.g., scanners), electronic sharing, hypermedia, and local software development.

The Current Situation

It is difficult to generalize for all of the Canadian schools since conditions do vary widely from one part of the country to another. However, for discussion purposes, let's examine the situation within a school district that is hypothesized to be slightly above average in its current use of technology and predict a couple of years ahead.

The district likely has computer labs established in most of its schools. However, some computers are becoming obsolete and there has been increasing pressure for additional, up-to-date, computers. In the upcoming years, attempts will be made to update all equipment, ensure each school has one good lab, provide interested teachers with computers for their own classroom use, and consider the establishment of a second lab in schools where usage has been high. In addition, attention will be paid to networking each of the labs and consideration will be given to the purchase of advanced hardware, probably for senior high levels first.
Software use will likely continue to rely on tool applications for the immediate future. However, students and teachers will become unhappy with these limitations and pressure will be felt to expand the school’s instructional capabilities. Limited resources, in terms of identifying courseware materials, purchasing them, and training teachers how to use them, will restrict the effectiveness of CAI applications.

Teacher interest in computers will continue to grow and more of the teaching force will become computer literate. Frustrations will be encountered in accessing the lab on a regular basis, in providing anything beyond word processing, and in getting support (both financial and consultative). More school districts will hire coordinators and informal networks of support between them will become more firmly established.

References


5.3 SELECTED PAPERS FROM THE FOURTH INTERNATIONAL CONFERENCE, "CHILDREN IN THE INFORMATION AGE"

Albena, Bulgaria
May 1991

Note: This conference was organized around central questions of the ITEC Project. Authors were asked to use ITEC issues and methodologies as a stimulus for their articles. Some of the authors are also ITEC researchers (Sections 5.3.1, 5.3.4, 5.3.5, 5.3.7, 5.3.8).

5.3.1 Possibilities and Restrictions of Computer Usage in Instruction as a Problem of Development Psychology

By V.V. Rubstov, Russia

1. An Age Approach to Computer Usage in Instruction

In the course of scientific and technological progress the appearance of large quantities of technical means with new informational possibilities (tape-recorder, telephone, radio, TV, video, computer and so on) has transformed society into a new quality-in-information environment. Life is such an environment requires special teaching and training. Uptil today this work has been organized spontaneously and somewhat fraught with unpredictable consequences. In solving the problem we should not be led by technical means and fulfill only current tasks. We must admit the possibility of both negative and positive effects which a computer informational environment can have on the development of an individual.

Let us consider two classifications of school-children:

a. according to the type of computer usage and,

b. according to the children's ages.

1.1 Classifications of Type of Usage

According to the type of computer usage we can distinguish three classes of people:

1. program designers;
2. professional users;
3. general users.

Program designers are people who have been trained as professional programmers. Professional users are specialists in different professions who use computers for executing their specific professional tasks. The main difference between a program designer and a user lies in the product of their professional activity. The product of designer's work is a program. As for a user, the product of his work is a result achieved by executing the program.

General users may be people of different occupations using computers for automation of routine processes. For instance, it might be a writer using computers for writing a book or following a case history. It might be a clerk putting archives into a computer or a person from any other occupation making use of computer terminals for different purposes: getting information, booking tickets, playing etc.

Surely, the mark-lines between a program designer and a professional user, on the one hand, are sometimes not very obvious, and we may have difficulties in referring a person to one of the three classes. But the classification itself seems to be quite natural and has practical sense.

Differences between the classes of people lie in three areas:

- product of activity;
- character of activity;
5.3 Fourth International Conference, "Children in the Information Age"

- contents and level of knowledge.

A designer is busy with making a program. Programs he compiles are meant to be widely spread, so he must know excellently the theory of programming and methods of program designing. As a rule, a designer spends most of his time on creative work over the program contents, and he needs a computer only on the last stage of this work while making adjusting and testing the program.

A professional user makes use of ready-made programs for achieving professionally significant results. In some situations a user may adapt a given program or work out a new one, but in both cases it will not appear as a product of his labour. It will remain a way to achieve some professional results. A professional user must be capable of preparing problems for computer solution and of working with the base of data. He is to know peculiarities of the machine he uses and its operational system. Because a user does not work with but communicates with a computer, it is a pleasant and in some cases useful business, and it does not require any special programming knowledge. What is quite enough for a user is to know the types of computer facilities. He may possess as much knowledge about programming and computer engineering as a TV viewer knows about TV systems or making film procedures.

1.2 School Age Division into Periods

Traditionally psychologists distinguish three main periods of children' psychic development at school age.

1.2.1. Younger school age.

At this age schoolchildren can communicate with a computer only as generals users. Computer usage at the time helps them to achieve three main purposes:

1. primary acquainted with computer informational environment;
2. acquisition of some social habits (e.g. learning traffic rules etc.);
3. instruction and mental development.

Due to the low level of arbitrariness of psychic processing at younger age the main methods of computer-using instruction may be playing games and using instructional programs.

1.2.2 Juvenile age.

While communicating with a computer a teenager is able to take the parts of both a general user and a (semi-)professional users. But the division of roles is rather conditional yet. Nevertheless, it is most desirable to introduce a course of information science into school curriculum at this very age. Instruction organized according to a common learning program should make children:

1. realize the advantage of computer usage for instruction for different classes of problems not directly connected with mathematics or information science;
2. use one of computer languages for compiling simple programs;
3. work with ready made applied packets (a base of data, a text editor, a graphical editor and other program packets for meeting extra-curricula interests).

There is no need to possess different programs for instructing general and professional users separately at this age. Which part will be taken by a child taught according to a common program depends on his success in education.

1.2.3. Older school age.

In the nearest future (in some countries even now) every schoolboy and schoolgirl above 14 will become at least a computer user. At an older school age two main tasks rise in instruction: further training as a user and primary education as a designer. The aims of training a user at older age are as follows:

1. mastering a computer language or improving it;
2. working with program packets for teaching mathematics, physics, biology and other subjects;
3. acquiring a methodology of structural programming and transforming it to the problem solution in different fields.

Only the first task out of the three belongs to the sphere of programming. The fulfilment of the rest of the two tasks may be looked at as the means of intellectual development of schoolchildren.

The main roles of an instruction program designer are as follows:

1. mastering main programming constructions;
2. acquiring methods effective programming ("from up to down"), structural-modules programming, program compiling technique simultaneous testing, etc);
3. learning the main elements of operational systems;
5.3.1 Possibilities and Restrictions of Computer Usage

V.V. Rubstov, Russia

4. mastering the process of program adjustment.

As can be seen above, the aims of instruction are connected with acquiring not only professional skills, but intellectual habits useful for any practical activity and beneficial for children's general psychic development.

1.3 Objectives and Hypothesis of Investigating Computer Effects on Children's Development

1.3.1 Objectives and Hypothesis of Investigation at Younger School Age

The peculiarity of the learning situation characteristic of junior classes is its orientation towards formation and development of children's learning activity. Pre-school psychic development is ensured mostly by playing activity while at school learning to read, write and do sums requires proper organization of children's learning activity. To make the process of younger schoolchildren's instruction more effective we should apply computer instructional programs. The programs offer instructional games which make use of both visual pictures for construction of children's abstract concepts and different active forms of child's work. Ensuring the control of learning activity, computer instructional programs may serve as an instrument for the development of the main thinking mechanism.

However, computer usage in younger schoolchildren's instruction may produce some negative effects. The most serious among them are as follows: adynamia, breach of communication, and impoverishment (formalization) of knowledge.

Adynamia appears due to the character of child's work with a computer and it may produce a negative effect on the development of force and coordination of motion taking place at this age. Due to the excessive computer entertainment breach of communication may occur when the social situation of the child's development is ruined and a computer becomes the child's main communication partner. Impoverishment of knowledge appears as a result of discrepancy between the operation of objects in real life and on a display screen. In reality a child operates with tangible and visual objects. They are included into real activity and their elements are concrete and are accessible to understanding. Processes of an object's movement and transformation on a computer display lie beyond the limits of children's understanding which may be dangerous for its development.

We purpose to get rid of the negative effects of computer usage by special organization of the educational process. Whether a computer becomes a means for intensifying instruction and intellectual development of younger schoolchildren or if it hampers and distorts their development, utterly depends on the systems.

To check the hypothesis about the character of computer effects on younger school-children's development we should organize an investigation with the following objectives:

1. to describe the dynamics of the main thinking mechanism development in the process of school education with computer usage;
2. to describe the peculiarities of physical, psychic and motor development of younger schoolchildren related to the time they spend with a computer;
3. to describe the dependence of the circle and character of communication on the time a child spends with a computer;
4. to compare the structure of school knowledge in younger schoolchildren groups using and not using a computer in the process of education.

1.3.2 Objectives and Hypotheses of Investigation at Juvenile Age

Both younger schoolchildren and juveniles are mostly characterized by concrete pictorial thinking. While getting knowledge they try to rest upon some visual material. So at this age employment of computer instructional programs may be of great use.

At the same time the thinking of a teenager is becoming more and more logical, systematic, argumental and grounded. It attains the ability for independent analysis, comparison and generalization. At this age children have the urge to come to the point, to understand the cause and effect, to find out relations between individual objects and phenomena, as for using a computer, the transformation form a user to a professional user can be observed at this time.

At the juvenile age a user is capable of self-educational programming in one of the program languages. Besides, the classes of instructional programs are getting wider. A juvenile can use not only game programs but even less diverting ones, e.g., expert programs or ones built on the principles of programmed education.

While learning programming a juvenile gets to know many computer functions. Computer operations with objects cease to be only "black boxes" when a child knows only a procedure's ins and outs. Program compiling, more than mental modelling only, impels him to make deeper analysis of "mechanisms of behaviour". Program behaviour confirms children's understanding of a model and it is the program that estimates his understanding.
5.3 Fourth International Conference, "Children in the Information Age"

True, formal and essential elements are often fused in the program. Consequently, syntactical, semantic and algorithmical mistakes in it may seem equivalent for a beginner. Besides, a program is meant to be used as machine directions, and it is compiled according to the laws of machine logic but not human one. In other words, the program obeys the order of its fulfilment by a machine which is quite opposite to the order of human understanding of the algorithm.

However, the main difficulty of computer usage at juvenile age lies in its restriction of children's communicative activity and in its transformation of the intimacy of human communication into the fields of communications with a machine.

To check the hypotheses we should organize an investigation with the following objectives:

1) to measure how the development of children's logical-combinatory thinking depends on the level of their knowledge in programming and information science;
2) to describe the correlation between essential and formal components of thinking which a computer user possesses at the juvenile age;
3) to describe the development of joint actions in the solution of learning, reactive and communicative tasks.

1.3.3 Objectives and Hypotheses of Investigation at Older School Age

At the older school age the development of operational thinking is finishing and further intellectual development of an adolescent goes along the path of specialization and accumulation of knowledge. The main problem of the instruction in information science and computational engineering at this age lies in teaching to program which is aimed at both program-making training and mental development of schoolchildren.

Programming like any other complicated activity including problem solution offers a good opportunity for the development of thinking. In this aspects it does not differ from other school subjects such as physics, chemistry, mathematics and so on.

The expression "mental development" gets a concrete meaning when we single out the main components of thinking - processes and metaprocesses which can be affected by training how to program and the significance of which goes over the frame work of programmer's activity.

In programming we may distinguish at least three groups of intellectual skills:

1) formal proof of program correctness;
2) "from up to down" problem solution and its structural-modulus presentation;
3) program, adjustment experience.

Formal proof is one of the main methods employed in the course of teaching mathematics, and, to our mind, it does not seem reasonable to teach it in the course of programming either.

Methods of modulus problem presentation and "from up to down" problem solution are quite natural for programming and very essential for any intellectual activity.

The process of program adjustment may be of great significance for schoolchildren's intellectual development. It represents the investigational model of a complex phenomenon when you are to judge about the inner structure and functional plan of a system by its behaviour. It is compared to the investigation of a natural phenomenon, the process of adjustment is so efficient and pressed in time that it seems to the best trainee for creative thinking.

Thus, the main objective of investigation at older school age is a study of universally significant intellectual processes arising in programming. The next important task is to establish the criteria of schoolchildren selection for special training as program designers. The task's urgency can be explained by as a social need in preparing skilled programmers and by the age requirements connected with schoolchildren's professional self-definition.

The same significance has a study of some negative phenomena of computerization. First of all, we should mention a phenomenon of excessive enthusiasm for programming and computer games. People who are used to overestimate programming are called "hackers". The exaggeration of the value of computer games had no special name yet, but its social damage is even greater. Though outwardly, the two phenomena look very similar, the seem to be quite different but in essence, "Hackers" are mostly people of schizoidal and paranoidal type whom attract the possibility to create in programming their own imaginary world. The excessive enthusiasm for computer games is fed by other motivations—the search for strong sensations, recklessness, desire to have a light pastime, etc. This motivation in peculiar to another type of people—those with instable and demonstrative features of character.

In summary, the main objectives of older school age investigations are as follows:

1) to study intellectual processes necessary for programming and having universal significance ("from up to down" problem solution, structural-modulus problem presentation, formal proof, methods of fixing mistakes by outward behaviour and so on);
2) to single out personal and intellectual features which make programmers’s work more effective;
3) to single out personal and intellectual features which distinguish a "hacker" from a skilled programmer.
4) to define personal features and motivation which determine keen interest in computer games.


2.1. Development of Motivation under Computer Influence.

We consider motivation (or motivational sphere of human personality) as a system of motives (i.e. activity incentives) which are concrete manifestations of four main types of human needs:

1) the need in labour (to work, to produce coming, to achieve high results);
2) the need in cognition (to get knowledge, to understand);
3) the need in self-development (self-actualization, self-education, self-expression);
4) the need in communication (to help other people, to receive other people’s care, respect, friendship and love).

The development of motivation comprises:

1) enrichment of motivational sphere, i.e. appearance of new motives - new concrete manifestations of the needs mentioned above;
2) hierarchization and transformation of motivational sphere, i.e. distinguishing leading and subordinate motives in the framework of the same kind of needs and singling out leading and subordinate needs.

Due to computer usage new motives can arise as concrete manifestations of the need in productive activity. It can be explained by the fact that a computer creates favourable conditions for a full and detailed registration of the quality of activity products related to both a certain objective scale of quality of the person’s own activity and to the quality of other participants’ work. A computer introduces a child to some new objects of mature, material and spiritual culture. It acquaints him with new forms of natural and social relations.

Computer usage creates the conditions for fixing a person’s full and detailed information about himself (i.e. the results of his self-education and self-estimation of his personal qualities). So it ensures the emergence of new motives of the person’s need in self-development and self-actualization. Besides, using a computer makes a person seek for different variants of his "Self"-images (his ideal "Self" and his social "Self") and try different ways of his self-development depending on the conditions of his activity and communication. A large TV communication system affords an excellent opportunity for widening the circle of communication according to different aspects: age, education, sex, interest, etc. In the condition of these kinds of communication we can build and further transform an hierarchy in person’s motivational sphere by supporting leading motives and needs and actualizing subordinate incentives for better realization of leading ones.

2.2 Development of Cognitive Processes under Computer Influence.

Computer technologies of instruction are closely connected with activization of such cognitive processes as perception, memory, imagination and thinking. A computer gives a variety of forms of objects belonging to the same class but possessing a different number and a various combination of their informative and non-informative attributes.

A computer may affect memory development if in the process of computer memorizing a child is shown a diversity of semantics relations between different elements of the material (i.e. enlargement of semantics units) and he is given an increased number of objects among which he should recognize those he has seen before. Simultaneously, the relations between the elements of the material may gradually become more complicated, the requirements to extent an accuracy of reproduction may get higher and the aims of memorizing, recognition and reproduction may differ, by the time, quantity and quality of the material.

A computer may also affect the development of imagination because it makes the description of objects more complicated and brings to a display screen either a picture of an object or its imaginary version produced by the program’s author and corresponding to the given verbal description. Besides, the development of imagination is influenced by the processes of mental presentation of objects according to their verbal description and by the increase of number, variety and complexity of things which can be conceived by their description.

As for thinking, we consider it to be the process of search for problem solution and we judge about development by the number of hypotheses put forward in the course of finding a solution and by the way the solution is generalized. Consequently, a computer can produce a positive effect on the development of thinking only in the following cases:
2.3 Computer Effect on the Development of Metacognitive Processes

Speaking about metacognitive processes we mean a person's control and relation of his perception, memory, imagination and thinking. The development of metacognitive processes by a computer is possible because it appears to be means of mediation of children's learning activity, its control and organization. In this case metacognitive processes can be compared with analytic-constructive and reflexive components of thinking developing in learning activity.

The control of perception is exercised by choosing different investigational strategies for objects which should be discerned and by using as variety of investigational methods. A computer affects the development of perceptional control because it can demonstrate to children different methods for analyzing the attributes of an object employing various discerning material. Besides, the children are shown the possibilities of applying the same method for distinguishing different forms and of using different methods for discerning identical forms.

The control over memory processes can be assumed by the selection and usage of a great variety of methods peculiar to memorizing, recognition and reproduction. The development of memory control is connected with the following situations of computer work:

1) when children are demonstrated different methods of memorizing (in particular, semantic memorizing) and they are supposed to use various purposes related to the similar material;
2) when children are demonstrated diverse methods of self-control in memorizing and different ways of recognition and reproduction of the material.

The control over the processes of imagination is exerted by the selection and employment of diverse methods for constructing the picture of an object according to its description and by usages of the increased number of methods for constructing mental images. Computer influence on the development of the control over imagination takes place in the situations when children are demonstrated different ways of constructing images on the basis of the same description but depending on different problem requirements.

A computer affects the control over the process of thinking (i.e. over the search for problem solution) if we consider it to be a planned process of putting forward and checking hypotheses and clearing up the degree of generalization of the solution. The development of thinking includes its high level of reflection which is connected with the possibility of projecting and modelling strategies of problem solution. The computer's effect on the development of the control over searching for a solution is produced in the cases when children are demonstrated the possibility of elaborating different plans of solution of one and the same problem and the ways of constructing different types of problems.

2.4 Computer Functions in Children's Activity (in Creative Work, in New Type of Activity in Self-Development)

The creative activity of children is connected with their creation of works of arts, music, literature and, to a lesser degree, dance, theatre, applied and technical arts. A computer can ensure the development of children's creative activity by applying a diversity of drafts, sketches and other test embodiments of children's projects or by offering to a child different variants of concrete projects corresponding to his own intention (i.e. his intention to express or to shape one of his spirits, ideas or general thoughts). A computer can afford different kinds of effective hints which makes it easier for a child to chooses and shape the project of his future work and to find its adequate technical embodiment. Speaking about new types of activity in the life of children, we mean their mastering the modes of new sport games, new dances, etc.
5.3 Fourth International Conference, "Children in the Information Age"

5.3.2 Evaluation of Pupils' and Teachers' Conceptions and of their Cognitive Behaviours in the Domain of Information Technology

By: G. Chiappini\(^1\), E. Lemut\(^1\), L. Parenti\(^2\), Italy

Introduction

In this paper we try to analyze the cognitive behaviours of teachers and pupils when using a computer in problem solving situations, and to relate them to the conceptions that they have developed in the particular computer environment available on each occasion. We try to study in detail the hypothesis whereby an evolution (or fixity) process of the conceptions which teachers and pupils develop, as regards the operation of the computer-based device with which they work, is strictly related to the evolution (or fixity) process of their cognitive behaviours. We shall also attempt to outline a possible teaching strategy according to this hypothesis.

The content of this paper is part of an extensive research program formed to analyze the potential of computer usage for the development of problem solving abilities and, at the same time, pointing out the most difficult points and obstacles that may arise both from the use of different computer environments (LOGO, BASIC, spreadsheet, database...) and from the different teaching methods which may be adopted by teachers. This research is carried out within the framework of the "Research group for the teaching of mathematics and scientific education in compulsory school" of the University of Genoa (Italy) and the Institute for Applied Mathematics (I.M.A.) of the National Research Council of Italy (CNR).

1. Context in which the observations were made and related methods

The observations made on the behaviour of teachers were conducted during computer training courses attended by 25 mathematics teachers, working at compulsory schools (11-14 years old), involved in our research group as experimenters/researchers. The teachers possessed, at the outset of the course, computer science knowledge that we may define as "elementary" because they had, on numerous occasions, used the fundamental structures of the Basic language (iterations, conditions, assignment, input/output, variables) in class work.

The training was characterized by working on problems selected in such a way that the quantity and organisation of data involved would play a crucial role for the organisation of a solution strategy [5]. The problems had to be solved first in Basic, then in Pascal and lastly in the Macintosh "Excel" spreadsheet environment.

The observations made were conducted on compulsory school pupils who experimented our teaching project. The observations regarding problem solving activities in the Basic programming environment were conducted on a sample of 10 classes (about 200 pupils), whereas the observations regarding problem solving situations in the spreadsheet and database environments were conducted on three classes.

The analyses of the teachers' behaviour are based upon the observations made by the authors of this paper during the refresher course, upon the self-analysis reports of the teachers on their own reasoning processes and upon the analysis of the individual scripts.

The analysis of the pupils' behaviours are based upon individual written and oral tests and upon observations made by the teachers.

Finally, as regards the analysis of pupil-teacher interaction when using computer-based resources in the classroom, we referred to, in addition to the foregoing data, the observations made by ourselves as external observers during class activities and to the reflections matured during work meetings with the teachers.

2. Cognitive behaviours of pupils and teachers in relation to their conception of the computer-based device

The observations made, first and foremost, underline the fact that several difficulties which arise in problem solving with the computer are common to all beginners, whether they are teachers at their first experience in using information technology or compulsory school pupils (obviously asked to solve problems with a degree of difficulty suited to their current knowledge).
5.3 Fourth International Conference, "Children in the Information Age"

In particular, we have often observed considerable mental inertia phenomena, not only in passing from a solution strategy developed in a non-computer environment to a computer-based one, but also in passing from one computer environment to another.

In these processes very often there is the tendency to reproduce cognitive behaviours operating in a widely explored situation, despite the subjects were well aware of the need to utilise the resources available in the new environment.

Moreover, we had the opportunity to check that their behaviours could be related to their "conceptions of the operation of the computer device, underlying to the language or software used" and that, henceforth, we shall for brevity refer to as "conception of the device".

2.1 From a familiar solution to one depending upon the programming language

We shall consider the behaviours of the pupils and teachers we have observed solving the numerous problems in the Basic programming environment. It should be pointed out, nonetheless, that in this paper we do not intend to provide accurate statistics of their behaviours but rather to examine the appearance of both common and specific phenomena. We refer to some previous paper ([5] and [4]) for details of some tests carried out.

We have been able to classify the programs that have been produced into four groups.

1) Programs produced by pupils and teachers which appear to be a direct translation of a familiar strategy developed with pen and paper into the available language.

In particular the pupils of this group are absolutely unable to carry out a verification of their programs neither logically nor formally. Their programs, in fact, have many syntactic and logical errors, the latter mainly due to the inability of the subjects to adjust the action, that they would perform as executors to obtain the desired result, in the space-time domain in which the computer operates.

We have often remarked anthropomorphic conceptions of device arising in these pupils. For example, after carrying out numerous teaching activities (with computer and with pocket calculator), many pupils found some difficulties to accept that the computer could 'forget' the value connected with a variable, when the variable was used in a following assignment instruction.

The pupils and the teachers of this group find it difficult to distinguish their role as builders of the solution strategy from that of the executor.

Both show to have very elementary "conception of the device", mainly based upon the effects produced by executing single instructions of the available language.

2) Programs produced by pupils and teachers where the strategy developed with pen and paper is reorganized to make it more apt to the characteristics of the available language.

The teachers and pupils of the group are still guided in the construction of the program by the familiar solution strategy but they, nevertheless, are able to verify whether the algorithm which they are developing is correct or not and to link functionally together different instructions to adapt this solution to the operating logic of the executor.

The teachers' and pupils' behaviour shows a "conception of the device" which enables them to think about the familiar solution that they have produced, and to choose a way to express it and check if it suits the operating characteristics of the executor.

In these cases we have observed that their "conception of the device" not only support a mechanical translation of familiar strategy, but also allows the subject to carry out successive transformations of the original project of solution.

3) Programs produced by pupils and teachers who have been able to use the structures of the available language to directly develop an effective strategy to run on the computer.

The pupils and teachers of this group appear to be guided when constructing their solution strategy by the fact that the problem to be solved reminds them, in some way, of problems already handled on the computer; they appear to be able to recall one or more programming schemes which are pertinent and effective for solving the problem.

They demonstrate to be able to put behind the familiar solutions and to construct a solution strategy by directly using the resources of the available computer environment, systematically organising operative links between the different instructions. In this manner they prove to have developed a very articulate "conception of the device", enabling them to systematic approach in the problem solution.

In several cases we have noted that the recalling of a programming scheme generally causes specific difficulties, as it is necessary to apply a standard structure to a problem context of
specific characteristics. The major obstacles that the subject must overcome are due both to the need to correctly interface the variables of the scheme with those of the problem to be solved and to integrate the structure of the scheme into the specific computation processes required by the problem.

4) Programs produced by pupils only which have not been able to perform any solution or which have no logic sense with respect to the problem or to the device logic.

The pupils who have produced these programs belong to the lower end of the class. Their work demonstrates their inability to orient themselves in a problem solving situation which requires them to keep track of external constraints, brought about by the computer.

2.2 From a similar solution to one in a database or spreadsheet environment

In these environments the subject puts her/his own solution strategy into practice by means of the software command system.

Even by working in these environments we have remarked that phenomena of inertia are also apparent when passing from a familiar solution strategy to a computer-based one. These phenomena, in several cases, may be explained by attempting to analyze the behaviour of the subjects in relation to the contrast that may be generated between the logic with which the human executor works and the logic incorporated in the available command system. In other cases it can be explained by the particular representation offered by the device which forces the well understood approaches to solutions to be put into practice.

For example, when the pupils constructed a database, a particular choice of codes used to specify the degree of education (AN: illiterate, LE: primary school certificate, ME: secondary school certificate, MA: school-leaving certificate, LA: degree) and the generations of great-grandparents, grandparents and parents (B, N, G) expressed the need for adherence to the semantics of the context. They were aware of how the computer operated to perform sort-operations and they had verified, on a small sample of data that the command used to sort the three generations, according to the degree of education, did not produce, with those codes, a useful result for interpretation purposes. The adherence to the semantics of the context did not permit them to explain why the result was without any "logical meaning" and hence the majority of them was unable to suggest a new structure of codes suited to achieve the required purpose.

Subsequently, while the database was being interrogated, we often noticed modes of behaviour in line with executions which could have been carried out without the computer, but which were inadequate in relation to the operating logic of the device. For example, on various occasions they attempted to put into practice behaviours compatible with a "find and sort" procedure (simultaneous operations) which they were able to deal with pen and paper, whereas the program was not designed to do this and hence this led them to make errors.

The next example, on the other hand, is aimed at emphasizing the difficulties which pupils appeared to have when they abandoned well known and familiar solution strategies to design a functional strategy in the spreadsheet.

After about 15 hours of activities the following table was given to the pupils:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOODSTUFF</td>
<td>PROT. (G)</td>
<td>FATS (G)</td>
<td>CARBO. (G)</td>
<td>EN. (cal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANCHOVY</td>
<td>16</td>
<td>3</td>
<td>0</td>
<td>9</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORANGE</td>
<td>1</td>
<td>0</td>
<td>0.5</td>
<td>21</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BANANAS</td>
<td>2.5</td>
<td>0</td>
<td>4</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

where they asked to modify it in such a way that it could be used to determine the quantity of fats, proteins, carbohydrates and calories furnished by any diet category.

We remark that problems of this kind were already handled by the pupils in past years with an arithmetic approach to the problem.

5.3 - 9
We have observed that very few pupils spontaneously add a "quantity" column and correctly handle this variable in the various equations used to determine, in new corresponding columns, the specific contributions of the foodstuff on the basis of quantity.

Most of them resort to strategies which are practically identical to those which they would have used should they have worked with pen and paper. For example these pupils add columns to indicate proteins, fats..., and the energy furnished by the foodstuff consumed, but not the "quantity" column. The quantity of foodstuff is included each time within the formulas regarding the foodstuffs of a particular diet (randomly selected by the child from those previously described by the teacher so as to allow the pupils to familiarize themselves with the problem situation).

These behaviours underscore the difficulties and obstacles that prevent the pupil from abandoning a well known arithmetic based strategy in order to construct an adequate one in line with the available instrument.

As regards the use of a spreadsheet, we had also noted similar difficulties experienced by the teachers during the refresher course. On various occasions we have noticed solution approaches of arithmetic type arising in the subject who had complete command of relations existing between data and variable of the problem to be solved.

For example several teachers did or did not include the reference in a formula on the basis of the meaning or lack of meaning of the value contained in it (zero for example was not considered a meaningful value), while other entered the numerical value directly into the formula instead of the reference of the cell containing that value. In this manner they demonstrated to have great difficulty to get away from the arithmetic type of approach to the solution, deeply rooted and understood. Hence, in line with this they interpreted the available software as if it were a powerful calculator offering the opportunity to store all the essential computation sequences in order to obtain the required result.

3. The role of the teacher

In this approach to problem solving with the computer there are no apparent difficulties, in general, (not even at the lower levels of the class) to teach the pupils some instructions or commands of the available computer environment.

As we have observed earlier, the crucial problem is to co-ordinate together different instructions or commands respectively, in order to form formal structures or sequences of commands which the pupil can recognize as pertinent with respect to a global hypothesis which she/he can advance when constructing the solution strategy.

Building up this capability, in relation to the difficulties and obstacles described in the foregoing paragraphs, raises the crucial problem of what role the teacher should play in the classroom.

The wide-spread teaching approach requires the teacher to convey the essential information to develop solution strategies with the computer, through motivated examples, to the class and to subsequently stimulate the pupils in the proper manner to do exercises with this information (teacher as a "conveyor"). In this manner the teacher undertakes a teaching initiative in which the activities of understanding the solution strategies developed in a particular computer based environment should serve to build up the pupil's capabilities essential for subsequent activities where the pupil alone will be required to produce the solutions.

We remark that when the teacher has good command of important concepts in a certain computer-based environment and good teaching capabilities aimed at exemplifying the possible modes of use of particular computer knowledge, they are generally sufficient to enable the above-average pupils of the class to easily assimilate the experiences matured by the teacher and the related conceptions of the device. The subsequent enhancing and strengthening activities generally enable several pupils to completely understand a computer-based scheme, allowing them to subsequently recall and use them in the solutions of new problems.

However, we note that the time spent with above-average pupils to develop them sufficiently to autonomously use certain computer-based structures is particularly long. Furthermore we remark that the below-average pupils of the class are generally left out of this learning process. The verifications and observations made lead us to believe that a gap is created between the teacher and the below-average pupils that is very difficult to fill through teaching activities of this kind.

If the pupils feel the knowledge of the teacher as close to their perception and experience it is very likely that a process of communication is initiated between pupil and teacher by means of which the teacher can gradually convey her/his own conceptions and knowledge.

What can also occur (especially at the lower end of the class) is that the communication process between teacher and pupil is not established because the difference between their two worlds of experience and knowledge is so big that it cannot be reduced by attempts of mediated teaching aimed at simplifying of streamlining the knowledge. The pupil therefore appears deaf to the words, examples and encouragements of the teacher; at the same time the teacher appears deaf to the pupils' world of representations, conceptions and
5.3.2 Evaluation of Pupils' and Teachers' Conceptions  

experiences. Hence what the teacher considers as a problem by the pupil and, vice versa, what the pupil perceives as a problem is not even taken into consideration by the teacher.

The reflection in our research group, in relation to the teachers' role in the process of teaching/learning the contents of mathematics and computer science fields and the analysis (still limited) of some results obtained in classes where some teachers begin to develop a different role, bring us to think another possible role, different from that of the "conveyor".

On the basis of our reflection we think that the teacher must, at first, undertake to develop a ground of experiences and common references [1] in the classroom connected with the operation of the computer.

We believe that this undertaking is functional for the purpose to evolve the pupils' conceptions and behaviours in the construction of a solution strategy by the computer.

In fact, as remarked earlier, the solution hypotheses thought by everyone depend upon the conceptions that he/she has developed on the operation of the device. These hypotheses may really advance a solution strategy for the computer, may be suitable for a pen and paper solution, but not for the computer, may be the expression of a thought which is conditioned and oriented by misconceptions of the device.

The below-average pupils of the class very often have great difficulty to develop the basic idea they have thought; in fact their reasoning is unable to advance a global solution strategy.

We believe that the evolution of the conceptions and behaviours of the below-average can be encouraged by social practice that will enable all pupils to compare their different solution hypotheses. In such a way the pupils may come into contact with the different ideas and points of view which are behind each hypothesis, with behaviours able to articulate such hypothesis and translate it into a draft solution for the computer, and with cognitive processes able to actuate verification tests on it.

We feel that in this way it is possible to create conditions such that the pupils who at the outset do not produce strategies suitable for the instrument can participate in the social game of testing the strategies produced by fellow pupils and understand why a strategy can be considered more or less suited to the computer. Moreover, by introducing their own hypotheses in the social test structure, these pupils can try out their own hypotheses which, very often, are an expression of an embryonic "intellectual production" [1] (because incorrectly directed by misconceptions of device operation), which can develop because these pupils are allowed to enter the game of hypotheses conducted in the class.

We feel that the social handling, in the classroom, of continued dialectics between the construction of an hypothesis advancing the solution strategy and the understanding and/or construction and/or recalling of formal structures able to make it suitable to the characteristics of the device available is essential to encourage the process of understanding a formal structure, above all in the weaker subjects.

In fact the experience of the refresher course has demonstrated that even in subjects with degree education, the command of a certain formalism is not by itself sufficient to guarantee its use in a new problem that does not simply require a stereotyped application of this formalism.

Fully understanding a certain computer science structure implies having an instrument with which to be able to subsequently develop one's own thought and construct new solution hypotheses.

We think that such dialectics can perform a crucial role to help the pupil to recognize, through the mediation of a teacher, that a certain structure logically incorporates the entire reasoning process which the pupil has developed in the earlier stages. In this way the formal structure acquires importance not only in relation to its internal logic but also to the specific semantic contents present in the solution hypothesis advanced by the pupil.

Furthermore, such dialectics can play a crucial role to help the pupils to attribute a unique meaning, in relation to the particular device available, to the sequence of instructions or commands used to solve a problem, recognizing not only the role of each instruction or command for the effect that each produces, but also the functional role for the entire problem which it contributes to solve.

We feel the comparison with a variety of models and cognitive styles with which the subject can, each time, identify herself/himself on the basis of an own judgement of utility and productivity (judgement that is influenced also by the manner in which the dialectic between the construction of hypotheses and the use of structures are handled in the class) can favour an overall maturity of the subject and the achievement of a systematic methodology in problem solution.

4. References


5.3 Fourth International Conference, "Children in the Information Age"

5.3.3 Implementation of Computer Use in Mathematics Instruction

By E. A. Friedman, L. V. Morris, K. F. Allum, USA

1. Abstract

Stevens Institute of Technology has been engaged since 1988 in a project to advance computer utilization in middle school and high school mathematics classes. The project focuses on in-service teacher training while addressing issues of school context and organization, student background and attitudes, and educational effectiveness of software strategies.

Assuming that mathematic teachers are familiar with computer technology and are competent in their curricula subject areas, they still face many obstacles as they attempt to integrate computers into instructional practice.

Since textbooks and curricula in the United States do not as yet assume the availability of computers as guides to teachers of mathematics, each teacher is faced with an overwhelming number of choices and decisions with regard to computer integration. The first critical choice is that of selecting strategic curriculum opportunities for computer use. Depending upon the availability of computer hardware, teachers must select from among hundreds of available software products that vary widely in quality, style and applicability to specific needs.

Independent of the specific topics in the curriculum, various courseware styles are possible. Furthermore, teachers must decide upon the instructional context in which they wish to pursue computer-based learning. Teachers also have flexibility in focusing their attention on various educational goals and outcomes.

Project experience is that in order for teachers to effectively utilize computers in secondary school classrooms, they must receive support from their school systems for the equipment, training and time that is required. They also must take initiatives in organizing and managing a computer-based classroom. The complex decision-making that is involved requires a strong sense of professionalism and the opportunity and willingness to work collaboratively with peers.

2. Project overview

Since October 1988, Stevens' Centre for Improved Engineering and Science Education (CIESE) has been working with five diverse New Jersey school districts in an effort to create model programs for computer integration into high school mathematics curricula.

Various studies indicate that computer technology has potential to significantly enhance the teaching/learning process in mathematics and science education. The National Council of Teachers of Mathematics in their recent Curriculum and Evaluation Standard in School Mathematics urge greater utilization of computer technology in mathematics instruction, especially at the high school level.

In spite of the widely held believe among educators that computer technology can provide educational benefits to the student, high school mathematics classes rarely utilize computer technology as an integral part of the instructional process. Unlike science classes, where computers can serve as part of a demonstration or experiment that is already included in the curriculum, introduction of computer-based material into a high-school mathematics class seems to require reorganization of curriculum materials and lesson plans. Studies by the Centre for Research on Schools at the John Hopkins University have observed this low level of computer use in high school mathematics classes. (Becker, 1988). CIESE meetings with both affluent suburban schools and disadvantaged urban schools have confirmed this phenomenon.

Computers can significantly enhance the teaching and learning of mathematics through various approaches. Computers can serve as expert assistants to teachers who can organize more individualized lessons and better play the role of coach. Computers provide rapid and accurate graphs and manipulations of geometric figures. Collaborative, self-paced, and exploratory learning can all be promoted through computer utilization. Students can do mathematics by exploring ideas and making conjectures. However, for all the computer's potential, its impact will be minimal unless teacher training and classroom implementation are carefully nurtured.

We have observed that computers are not being effectively utilized because there are too few models of effective integration into classroom instruction. Many implementation projects have not succeeded because they did not:
- continue for a sufficiently long time period
- involve school system-wide support
- treat teachers as professional collaborators in an undertaking which depends ultimately on their personal decisions, choices, and teaching styles.

We have tried to avoid these pitfalls in our endeavours. After three years of engagement in this process, we see significant progress, but find that there is still much to learn about successful implementation. Our
experience is consistent with the Bank Street Study, which found that it took teachers 3 to 5 years to become mature users of computers in the classroom (Sheingold, 1990).

3. Barriers and proposed solutions

Through interviews with teachers and administrators and personal observations, we have concluded that teachers face numerous problems in confronting computer integration. There are more than one thousand software packages being marketed for use in high school mathematics classes. Therefore teachers need assistance in identifying promising software. Once software is identified, it must be appropriately integrated into the instructional program. As a result, teachers need released time as well as assistance in implementing curriculum integration. Once implemented, the school systems and the teachers need assistance in the processes of assessment, evaluation and revision. Also, there is a lack of availability of computers for mathematics teachers. Though schools are usually equipped with computer labs, the demand on these labs is heavy from all departments; thus their availability for mathematics use is limited.

This lack of access is one reason why mathematics teachers at the secondary level have been reluctant to explore the possibilities of teaching with computers. The CIESE faculty and staff, with the cooperation and support of the administrations at each of the five school districts, are providing teachers in Grades 7 through 12 with needed assistance in approaches that utilize computers in instruction, advice on the purchase of equipment, the creation and implementation of lesson plans and, together with Educational Testing Service, evaluation of the impact and educational effectiveness of these efforts.

More specifically, some project approaches and developments are as follows:

- Almost every participating teacher has access to a computer connected to a projection device that they use as a resource in their classroom. By having the technology accessible, along with the support of the CIESE staff, the teachers are becoming comfortable with the technology and developing a repertoire of effective strategies for using the computer.

- There are many ways in which computers are used in schools. These range from drill and practice to exploration. CIESE seeks to help teachers find an approach that best meets their needs rather than authoritatively promote a "best" approach. CIESE interaction with teachers are conducted in an open-ended style during monthly visits to the schools and during a ten-day summer workshop.

- In preparation for work with schools, CIESE has emphasized the use of commercially available software. CIESE staff acquired a large software library based upon the recommendations of software review organizations like the Epie Institute and Microsoft, journals like Classroom Computer Learning, and books like Only the Best (Neill, 1990). The CIESE teachers found many of the programs useful. Some of the titles include: The Math Exploration Toolkit (WICAT/IBM), Discovery Learning in Trigonometry Conduit, The Suppose Series (Sunburst), Precalculus (True Basic), Equations I and II (Microcomputer Workshops Courseware/QUEUE).

- CIESE seeks software that is still under development at major educational research and development centres in the United States and abroad. These centres include the University of Chicago School Mathematics Project (UCSMP), Carnegie Mellon University, the National Educational Technology centre funded by the U.S. Department of Education at Harvard University, Bolt Baraneik and Newman Systems and Technologies Corporation, The Mental Models Group in London, England and the Artificial Intelligence Department of Edinburgh University in Scotland. We hope to incorporate the use of Geometry Tutor developed at CMU, the visual programming materials and Algebra Workbench of BBN and the Cellular Modelling System of the University of London.

- In many instances we have found that the commercial software is inadequate for certain applications that the teachers would like to use. CIESE has a staff of programmers familiar with a wide range of courseware, authoring tools and programming languages which make it possible for the development of a variety of teaching modules. The primary source of these programmers is Stevens graduate and undergraduate students. Stevens has one of the largest master's degree enrolments in the U.S. Under the supervision of an experienced CIESE faculty member, these graduate students can develop courseware modules that meet the specifications of the collaborating teacher. Once completed, such a package can be made available to other districts. During this past year, CIESE developed a flexible test and quiz generating program that will be piloted in the coming year.

- We will have high school students create computer programs (written in BASIC, Pascal or Logo) to solve simple mathematical problems and thereby illustrate and reinforce mathematical concepts. Despite the fact that at most high schools computer programming courses are taught by mathematics teachers, rarely are the skills taught in programming classes integrated into the mathematics classroom. Given the strategic position of mathematics teachers in this setting, CIESE will explore strategies of students integrating
5.3.3 Implementation of Computer Use in Mathematics Instruction  E. A. Friedman, L. V. Morris, K. F. Allum, USA

computer use into mathematics classes by writing small programs that further their mathematical studies.

4. Implementation context and variables

Computer integration in mathematics instruction in the U.S. secondary schools is in a nascent state of development. Models of exemplary utilization are rare, textbooks are generally uncoordinated with computer applications, and colleges of teacher provide limited guidance. To add the complexity of this situation, there is a vast amount of relevant software on the market and additional materials appear almost daily.

Not only is the hardware and software environment fluid, but the U.S. mathematics curriculum is being scrutinized with a view toward significant changes. The efforts of the National Council of Teachers of Mathematics being the most prominent in this regard.

Hence, as teachers approach computer integration in their classrooms, they are faced with many choices regarding topics, software, instructional context and style, as well as educational goals. What follows is an elaboration of some of these possibilities.

Independent of the specific topics in the curriculum, various courseware styles are available. Some of the possible styles include courseware which:
- provides visualization of mathematical objects and relationships
- manipulates mathematical objects or equations
- provides automated consultation or tutoring
- creates a microworld for open-ended exploration
- presents drill and practice material.

Teachers must also decide upon the instructional context in which they wish to pursue computer-based learning. Some possible contexts for technology include:
- expanding the repertoire of instructor activities
- providing students with alternative routes for learning
- providing a classroom information resource
- establishing a setting for collaborative learning
- creating opportunities for students to verbalize mathematical concepts.

Teachers select courseware styles structure instructional context for technology in the classroom based upon their desire to teach educational goals and outcomes. These goals and outcomes might include:
- enhanced understanding of a particular concept
- presentation of an alternative approach to reach students with varied learning styles
- desire to motivate students who are stimulated by interactive visual environments
- promotion of student interest as a consequence of their recognition that computer technology is a central component of the workplace.

This Stevens project with its long-term collaboration with five diverse school districts provides an opportunity to study this complex implementation process and to create models of effective computer use in middle school and high school mathematics classes. In the United States there are 16,000 independent school districts, each with great autonomy and freedom of action. The Stevens project includes school systems from widely diverse communities in terms of their racial and ethnic composition as well as their socioeconomic characteristics. Through the diversity of these schools, it is hoped that models for exemplary use can be developed that are relevant for a large number of these 16,000 districts.

Because organizational and social context is crucial in the implementation process, the project has created close working relationships with senior administrators, principals, and department heads in addition to teachers. there are 30 high school teachers from among the five schools who are active in the project, as well as 30 teachers from middle schools in these same communities.

Stevens faculty and staff visit these 60 teachers at least monthly at their individual locations. The teachers and administrators attend an annual conference at Stevens, and the participating teachers attend a ten day workshop each summer to evaluate software and to develop teaching modules. As teachers develop promising approaches to computer utilization in their classes, lesson plans are formulated which document these activities and, in some cases, video materials are also developed.

Stevens has established a partnership with Educational Testing Service (ETS) for evaluation and assessment of classroom materials and for study of the project's impact on school environments. The initial emphasis of these studies has been on teachers attitudes and behaviour and is now focusing closely on student reaction to computer use. Additional studies are being conducted by ETS and Stevens personnel on student learning of specific topics. Overall project organization and management is being evaluated by personnel from the Bank Street College of Education.

5.3 - 15
An additional research component was conducted by a sociology doctoral candidate at Princeton University. This work examined the receptivity of one of the high school mathematics departments to the introduction of technology-driven pedagogical innovation. This research utilized the other project schools as a frame of reference for examination of the target school.

5. Research observations

5.1 Summer workshop study

Based upon the summer workshop studies, it was found that, overall, the teachers felt their objectives were met and that the workshop was an invaluable experience. The following were of the more subtle ingredients that were essential in the success of the workshop.

Teachers pointed to time as one of the essential resources provided to them which made it possible to reach their goals. As the following quote suggest, time is hard to get during the school year: "The 10 days allowed undisturbed time to concentrate efforts on learning software that I would have had no other time to do. I became familiar with many types of software. During the school year the time is not available."

The workshop not only provided time to learn software but it also provided time for teachers from the same school to discuss the logistics and strategies to take to integrate the computers in their curricula. In the course of the school year, mathematics department meetings are hold once a month, if at all. Usually the content of the meetings centre around administrative details rather than substantive issues. Any other exchanges take place informally, such as in the halls or the lunch room. Teachers commented that these two weeks were the most time they ever spent with members in their own departments! Some schools held meetings throughout the workshops, many teachers from the same department wrote lessons together, and some ate lunch together. Strengthening the teacher’s bonds hopefully promotes cooperation between the teachers within the department. This cooperation seems imperative to develop a support system for the teachers when new technology is implemented.

Even more rare than spending time with fellow department members is the opportunity to interact with mathematics teachers from other schools on a prolonged basis. After the first days of the workshop, teachers from other schools interacted with each other. Teachers indicated that the exchanges with other teachers were stimulating and helpful when thinking about computer integration into their own departments. As one teacher commented: "Any collegial communication is beneficial. It was very helpful to have input from teachers from different districts teaching a different student population. Yet goals and strategies were the same."

Exchanges about issues aside from computer integration took place, such as school policies and contracts.

Teachers expressed their appreciation for being treated like professionals. The teachers viewed everything from being given a stipend, having lunch provided, to the treatment of suggestions and questions as indices of being treated professionally by professionals. In a society where high school teaching is often not viewed as a "real" profession, CIESE’s attitude toward the teachers was of utmost importance. Teachers are constantly flooded with "experts" telling them what should be done in the classroom. The teachers respect CIESE’s openness to hear their needs and suggestions. At the same time, when teachers did have questions, they felt they were attended to in a friendly, respectful manner. CIESE set a tone for open communication and corporation.

Finally, another contributing factor to the success of the workshop is flexibility. The workshop was loosely structured enabling the teachers to decide the best way to use their time. One teacher noted: "I liked everything about it, it’s laid back, the people are sincerely interested, they seem really sympathetic, making us as comfortable as possible, as loose as possible, the biggest strength may be that it is not too rigid. A lot of flexibility (was good about the workshop), openness to suggestion, accessibility to equipment before/after the workshop."

5.2 School-based study

In an in-depth case study which was conducted in one of the five school districts, it was seen that interactions among teachers with shared values and expectations led the entire mathematics department to support the proposed project. These shared values and expectations are embedded in a powerful framework of department self-identification associated with leadership in educational reform and innovation. Participation in the project offered teachers an opportunity to demonstrate their professional commitment to the department’s norms, while providing the department as a whole the opportunity to symbolically demonstrate its strengths which have remained dormant for several years. It was seen that innovation could, in turn, lead to increased levels of professionalization.

Key factors influencing teacher behaviour and enhancing the self-reinforcing interplay between innovation and professionalism include:
Preeminence of the Subject Matter - Teachers held the subject matter itself in high regard. One might say that the advancement of mathematical knowledge was a "sacred" value for these teachers. Since computers were viewed as advancing this mission, teacher participation in a technology-based innovation was enhanced.

Autonomy - Teachers rank classrooms autonomy as a highlight of professionalism. Since they were volunteering in this innovation and since computer use gave them additional flexibility in pursuit of their personal styles, autonomy was respected and enhanced by these activities.

Collaboration - Teachers view collaboration with peers as an indication of professional involvement and commitment. Through outside-of-class collaboration, they maintained classroom autonomy while gaining insight and expertise from others on classroom strategies, lesson plans and creative materials. Computer use in classroom instruction creates a dynamic in which teachers welcome review and comments from peers. They both learn from their peers while demonstrating their competence and professionalism.

Professional Development - The use of computer technology was found to enhance professional self-identity. The hardware and software are identified in society with prestigious pursuits. Also, mastery of these artifacts constitutes arcane knowledge which traditionally distinguishes professionals cadres. Teachers then are utilizing an advanced technology that is valued in society and separating themselves from laymen and less skilled teachers through acquisition of specialized knowledge.

Classroom Control and Student Achievement - Teachers pride themselves as professionals with respect to their ability to exercise classroom control and to further student achievement. They readily utilize computers in classes where these outcomes are enhanced. However, this aspect of teacher behaviour can lead to diminished use of technology in classrooms that have disciplinary problems. In order to overcome that impediment, teachers must be convinced that long-term learning enhancement justifies the challenge of dealing with disruptive students.

The single school study also brought out the importance of implementing computers as tools for teachers which enhance teacher effectiveness and consequently the importance of teacher presence in the classroom. A contrary mode of computer use, such as that with integrated learning systems, replaces teachers with technology. The first mode enhances professionalism while the latter mode leads to proletarianization.

In contrast with computer integration in instruction, we note that technologies which do not enhance the role of the teacher, such as remote teaching using teleconference technology, are strongly resisted by teachers.

Details of the observational and interview material supporting the conclusions of this single school study are found in the PhD dissertation of Keith F. Allum (Allum, 1991).

6. Conclusions

All of the studies conducted of teacher behaviour, attitudes, and performance lead to a consistent set of recommendations for successful computer integration into classroom instruction. Given the fluid nature of computer integration in secondary school mathematics classes, it is clear that opportunities to advance the educational process can best be obtained if school systems not only provide hardware and software support for teachers, but also encourage teacher continuing education, autonomy, collaboration, and time to develop and pursue individual initiatives. Teachers also need models of effective computer use and assistance with the assessment process.

Experience in this project has made us acutely aware of the complex network of variables that bear on computer integration in instruction. The viewpoint of the Stevens project, based upon these three years of experience, is that implementation efforts should facilitate the decision making role of the classroom teacher. This recommendation seeks to take advantage of the benefits that can be derived from enhanced teacher professionalism.

7. References


5.3 Fourth International Conference, "Children in the Information Age"

5.3.4 Psychological Impact of Computers on Children

By Sakamoto Takahshi, Zhao Li Jun & Sakamoto Akira, Japan

1. Problem

Information technology generated in the Information Society has a great deal of impact on daily human life. As one of the most important parts of our society, schools are also heavily influenced by information technology, such as computers and other electronic media. Computers were introduced in schools throughout the world during the 1980s.

In these situations, many arguments have been made in educational and academic fields. Most of these discussions were philosophical and general. Empirical research has not always been undertaken. A few studies have emphasized the effectiveness of computers on the development of intellectual abilities in children. For example, the comparative study of achievement scores between computer users and non users and the empirical study on the cognitive development by use of Logo on children were reported (OTA, 1988, Shwalb, B., Shwalb, D.W., & Azuma, H., 1986).

Most of the studies that have better conducted are concerned with the analysis of the state of computer use in schools. How many hardware and software are utilized, in schools and how these are utilized both by teachers and children have been the main topics of interest in the beginning of art.

However, recently two large international, comparative and crosscultural studies were initiated. One is the Comped (Computer in Education) by the IEA (International Association for the Evaluation of Educational Achievement). The project began in 1987 with the participation of 22 countries. The Japanese team found that 79% of 223 primary school principals whose schools are using computers perceived computers as effective tools and 78% considered themselves as able to teach things effectively from the teachers' viewpoint, and 81% regarded themselves as enhancing study motivation and 53 % felt themselves as enhancing creativity in children. These figures were greater than those of primary school principals whose schools did not use computers. Those figures were respectively 68%, 69%, 70% and 44 %. Based on these results, computers seem to be effective tools both for teachers and children.

Another international research project is the 1TEC (the Information Technology in Education of Children) which also began in 1987. Today 16 countries participate and investigate the impacts of computers on children's higher-level cognitive activity. In Phase I researchers in different cultural context observe children's cognitive behaviours in computer use situations. A great deal of impacts of computers on children's study behaviours have been found.

2. Purpose

The aim of this study is to investigate the computer experiences of children at home and in schools; to study the impact of computer use on children in such areas as attitude towards computers, and children's perception of effects on intellectual and conative abilities; and to study changes induced by computers on creativity, study motivation and empathy in children.

3. Method

The questionnaires composed of three parts were constructed for primary school children. Part One consisted of items asking children's experience with computers at home and in schools. The face sheet also asked children's gender and grade. Part Two consisted of items asking children directly for their attitude towards computers and effects of computers on children's study behaviours and abilities. Part Three consisted of items asking children about their psychological characteristics such as creativity, study motivation and empathy.

The questionnaire which included 30 items concerning attitude towards computers were constructed by translating a British original version into Japanese (Light, Colbourne, and Smith D., 1987). The 36 item questionnaire directly asking effects of computer use was constructed from items selected by experienced teachers discussion.

The questionnaire on creativity as constructed to elaborate and select suitable 37 items from items gained by experienced teachers' discussion and survey of advisers for invention clubs nationwide. The questionnaire concerning study motivation in children included the same 32 items used in previous research work (Sakamoto, Kimura, Muta H., Shimada, & Nagaoka, 1983; Sakamoto, 1985). The 20 item questionnaire on children's empathy also included the same items as those developed in the previous study by S. Sakurai (1986).

Three questionnairs concerning attitude towards computers, direct effects of computer use, and empathy were measured on a 2 point scale. The other two were 5 point scales.
The subjects were 762 children, of which there were 402 boys and 360 girls at 4th, 5th, and 6th grade in three different primary schools. As the questionnaire was delivered to the same children after four month intervals, the number of children in the second survey decreased to 679, from which 350 boys and 329 girls from two different schools.

4. Results

4.1. Computer Experience

Children's computer experiences were gained from the items asking to check one of the following items: a) "I use it everyday", b) "I sometimes use it", c) "I rarely use it", d) "I do not use it at all" and e) "There is no computer at home". Computer experiences in schools were also measured by the same items excluding e). We treated a) + b) as computer users and c) + d) as non computer users.

The results show a significant difference in computer experiences between boys and girls at home as well as in schools. The level of significance was less than 0.1 % in the data at home and at the first survey in schools and less than 1 % in the second survey. Boys used computers more frequently than girls did. (First survey: 26% of boys and 15% of girls use computers at school; Second survey: 43% of the boys and 33% of the girls).

The facts suggest serious problems from the viewpoint of educational equity.

4.2. Children's perception on impacts of computer use

As all questionnaires showed higher correlation coefficients between the first and second survey at more than 0.9 level, the data gained at the first questionnaire were subsequently utilized for statistical analysis.

The following were the highest five items in the questionnaire concerning children's attitude towards computers:

No. 17 I enjoy working with a computer (93%)
No. 3 Lessons where we use computers are worth looking forward to (92%)
No. 27 Computer games are great fun (90%)
No. 2 I really concentrate on computers when using them (84%)
No. 30 We don't get enough time on the computers in school (84%)

The least three items were as follows:

No. 8 Using a computer is mostly rather boring (8%)
No. 22 The computer is just a waste of time (11%)
No. 4 What we do with computers in school won't help us when we leave (12%)

Children seem to perceive computers as attractive and effective.

Concerning perception on the effects of computer use on children's intellectual and conative activity, 25 out of 36 items evaluated positive effects, but another 11 were negative. The following six items gained higher percentages:

No. 2 Motivated to study (68%)
No. 9 There are alternative ways of thinking (68%)
No. 5 Able to concentrate (67%)
No. 4 Able to memorize (64%)
No. 8 Cooperation works with friends (63%)

The following four negative items were eminent:

No. 26 Your eyes were tired (64%)
No. 33 Insomnia (11%)
No. 34 Forgetful of written Chinese characters (18%)
No. 36 Less able to calculate (19%)

Children perceived computers as effective for intellectual and conative activities.

4.3. Creativity, Study motivation and Empathy

Concerning these three scales, high correlations between each two surveys and also significant correlations between a score of one item and total score of other items in each item were found in each scale. Three factors were found by the principal component factor analysis and varimax rotation on creativity data: Initiative, Inquiry and Cooperation.
5. Impacts of computer experience

5.1. General remarks

We have here three different categories of data concerning: (1) computer experiences and gender of children, (2) children's attitude towards computers and perception of direct effects of computers on intellectual and conative processes, (3) psychological characteristics of children such as creativity, study motivation, and empathy.

One of our main objectives is to investigate the impacts of computer use on children. Therefore, correlation coefficients were calculated between the first category and other two categories. As a big difference was found in gender, correlations were shown in each gender in Table One. The coefficients were not so large, but some relations showed significance. Generally speaking boys showed more correlations than girls did. Interesting findings were significant correlations between computer experiences in schools and children's attitude and perception of computer use in both gender and also significant correlations between computer experiences and creativity with boys.

Table 1.
Significance correlation between Computer Use and Each Parameter in the First Survey.

<table>
<thead>
<tr>
<th></th>
<th>BOY</th>
<th>GIRL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Home</td>
<td>School</td>
</tr>
<tr>
<td>Attitude</td>
<td></td>
<td>0.2+++</td>
</tr>
<tr>
<td>Effect</td>
<td></td>
<td>0.2+++</td>
</tr>
<tr>
<td>Creativity</td>
<td>-0.1-</td>
<td>0.1+</td>
</tr>
<tr>
<td>Study Motivation</td>
<td>-0.1-</td>
<td></td>
</tr>
<tr>
<td>Empathy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of significance:</td>
<td>+ or - 5%</td>
<td>++ 1%</td>
</tr>
</tbody>
</table>

5.2. Attitude towards computers and creativity of computer users and nonusers

Concerning the attitude towards computers, twelve items showed significant differences between users and non-users in schools in percentages of children who answered yes in each item. Items indicating the difference at less than 0.1% level of significance are as follows:

No. 19 Using computers in school makes me want to find out more about them
No. 1 We learn a lot of interesting new things when we use computers
No. 13 Using a computer in school will help us get better jobs

and items showing less than 1% level are the following:

No. 2 I really concentrate on computers when using them
No. 29 Everybody should be given the chance to use a computer
No. 26 Computing is one of the most important things we do
No. 6 More of our teachers should use computers
No. 16 Writing programs helps us to understand about computers

In these items users got higher percentages than non users. However, non-users got higher percentages than users in the following two items at less than 0.1% level of significance:

No. 20 Computer programs hardly ever work properly
No. 8 Using a computer is mostly rather boring

Users seem to be more favourable to computers and find computers more useful than non-users. Concerning creativity, items showing the significant difference at less than 1% level were as follows:

No. 4 Conduct new experiments
5.3.4 Psychological Impact of Computers on Children

Sakamoto Takahshi, Zhao Li Jun & Sakamoto Akira, Japan

No. 17  Learn many things from friends
No. 8  Have logical perspectives in experimentation and handicraft work

In these items, users got higher percentages than non-users.

5.3. Impacts of Computer Experiences in the Computer-Use Increase Group

As we conducted two questionnaires at the four month interval, we are able to identify the group who increased the computer use experience during this period. The number of those children was 97 in home use and 80 in school use. On the other hand, the number of children who were non-users both in the first and second survey were 181 and 304.

Items showing the larger differences between the computer use experience and the non-user group were as follows:

No. 27  Computer games are great fun
No. 26  Computing is one of the most important things we do
No. 2  I really concentrate on computers when using them
No. 17  I enjoy working with a computer
No. 3  Lessons where we use computers are worth looking forward to

In these items, scores in the second survey were higher than those in the first survey and items showing the larger difference were as follows:

No. 8  Using a computer is mostly rather boring
No. 22  Computing is just a waste of time
No. 4  What we do with computers in school won't help us when we leave
No. 5  We don't get enough chance to think for ourselves when we use computers
No. 12  We don't get enough explanation about how to use the computer

Computer experiences seem to make children change to perceive computers as more attractive, more enjoyable, and more useful than before.

Items showing larger differences on creativity between the first and second survey in the computer use experience increase group were as follows:

No. 31  Present what I have done
No. 11  Formulate my own opinions, considering reasons
No. 23  Do things by myself without depending upon others
No. 3  Find alternatives when existing materials are not sufficient
No. 22  Take my own way without imitating methods of others
No. 6  Create a lot of unique products
No. 25  Apply things I've learned to daily life
No. 24  Confirm material learned by myself
No. 7  Make up my own mind about things to hear and see

In the questionnaire on children's attitude towards computers, we got three factors by factor analysis and calculated factor scores in each factor. The increase of factor scores from the first survey to the second survey in the computer use experience increase group were statistically tested by a test in case of paired items. The results showed that increases of factor scores by the school computer were significant on Initiative and Inquiry (5% level, increases of 0.21 and 0.17 respectively) and those by the home computer use were also significant on Cooperation factor (0.19), but negatively significant on Inquiry factor (-0.19, 5% level for both). As the significant differences on Cooperation factor scores between the two surveys were found even in the non-user group both in home and school use, these were not always due to the computer use experiences.

Computer use experience in schools seems to enhance children's Initiative and Inquiry abilities, but computer use at home does not always enhance Initiative and on the other hand is associated with a decrease children's Inquiry abilities.

5.4. Impacts of Different Computer Use

We divided computer use experiences into three categories: (1) game at home, (2) word processing at home, and (3) programming in school. Among computer users for word processing at home (30 boys) there were higher percentages on creativity (70%) and study motivation scales (65%) than were the scores of non-users (258 boys, 47% for each scale), but users of games (183 boys) got rather lower percentages on creativity, study motivation and empathy scales (47%, 47%, 45%, respectively) than did non-users (105 boys, scores of 55%, 57%, 60%, respectively). Moreover, we combined two different categories of computer use: word processing and programming. The combination for wordprocessing at home and programming in
schools got the highest percentages on the creativity measure (WP-home+Prog-School:87%; WP-Home: 62%; Prog-School:53%; No Computer Use: 45% on the creativity measure.)

Thus, when users only for wordprocessing at home and users only for programming in school got higher percentages in creativity than non-users, combined users both for wordprocessing at home and programming in schools got the multiplied effects.

However, when users only for wordprocessing at home got higher percentages (62%) than non-users for either wp or games (57%), users only for games at home got lower percentages (45%) than non-users (57%), and the combined users both for wordprocessing at home and game at home did not get the disturbed effects, but got the highest percentages (70%).

Thus, we are able to assume that computer use experiences for word processing at home and programming in schools and their combination were used for enhancing creativity, and also the use of computers for word processing at home would somewhat reverse the negative effects of using games at home to positive ones, when they were combined.

6. Conclusion

In order to investigate the psychological impacts of computers on children, we conducted three categories of questionnaires concerning:

1. computer use experiences and their differences in gender.
2. perception of direct impacts of computer use such as attitude towards computers and direct effects of computers on intellectual and conative processes in children.
3. impacts of computers on psychological characteristics such as creativity, study motivation and empathy in children.

We found the following results:

1. Boys had more computer use experiences than girls did.
2. Children perceived computer use as attractive, enjoyable and useful.

The authors express their thanks to Professor Sam Stern for his kind suggestion.

7. References

1. Introduction

Any activity in which humans participate is embedded in culture. Not to consider it distorts the facts in any study. On the other hand culture is such a complicated concept that to take into account requires the highest pattern recognition abilities of the human mind. Hence any statement made about it can only be tentative and heavily tainted with the points of view of the researcher in question. The previous statements do not, of course, mean that nothing can be said about it. Even such subjective things as beauty be talked about and many people will agree about them as long as they have something in common (cultural traits.)

Culture is preserved in a group, tribe or nation throughout education, whether formal or informal. When we try to introduce information technology into education one of the very first things we run into is culture. Since most of the modern information technology that we are interested in discussing here had its origin in English-speaking countries, in particular in the United States and the United Kingdom, much of it is tainted with that culture. To give a simple but important example, symbols used by the microcomputers used in education are coded in ASCII whose meaning is American Standard Code for Information Interchange. Being an American (that is, from the United States of America) code, it is completely oriented to the English Language and no consideration was given to the possibility of writing in other languages, even those very close to English such as German or French. There is no possibility of using diacritical signs such as accents, or letters that do not appear in English.

The extended ASCII code that is used by them IBM PC Computers attempts to emeliorate this situation and with its 256 symbol code introduces many special symbols used in other West European languages, but cannot be used in Greece or Russia where they use a completely different alphabet not to speak of Japan or China for which it is more appropriate to speak of ideograms, given the very large number of symbols used. Even in countries that do have an alphabet such as Israel a considerable amount of trouble arises from the fact that computers are designed to write from left to right while Hebrew is written from right to left.

The previous discussion gives a vivid indication that technology is not neutral as many claim but like any human endeavor is full of the culture of those that created it. Introducing information technology to groups of people whose culture differs from that of the originators of the technology is bound to encounter all sorts of difficulties that may not have been obvious at first. In this paper we discuss some of the difficulties.

2. The Language Question

Being one of the principal ingredients of culture, language stands out as one of the first things to consider when analyzing culture as context and determinant of educational uses of information technology. Not only is there the difficulty of writing with a computer using the proper symbols in the different languages, a problem that has been quite successfully solved for many of the popular languages of the world, but not so for languages spoken by some other few millions of people; we are now thinking of the dominance of the English language in all things that have to do with computers: error comments, commands, manuals, books, magazines and journals, databases, network protocols, and so forth. In many countries the dominance is so apparent that knowing English is a generally accepted part of so called "Computer Literacy". So many words such as "hardware" and "software", ROM, bug, CGA, debug, have been used untranslated in other languages for so many years that Language Academies that had attempted to introduce translations are giving up on them after a long fight. Even though many packages eventually get translated together with their documentation into other languages, because of the size of the markets of the English-speaking countries, the packages are originally developed for them.

Thus by the time a package gets translated the original programs are already in their second or third versions. Therefore we can see some countries in which popular packages such as dBASE are being marketed two versions behind those in the developed countries. The readers may not believe this, but in Mexico books on the IBM 1130 computer are still in the bookstore stands and are used by some teachers of computer programming who may or may not be aware of the number of years that such a machine has not been manufactured. People who want to be up to date (relatively speaking) have to do all their work directly in English, that is, using software in English; using manuals in English; using English keyboards; reading books, magazines and journals in English; and looking at videotapes in English. It is not only the undeveloped countries that are dominated by the English language. Industrially advanced countries such as Japan have to work in English as much as Paraguay or Morocco.

Some relief is provided by graphic oriented protocols such as those introduced by the Macintosh machines that use a mouse, buttons and icons. These are considerably more culturally transparent than...
3. The Colonization Question

Many governments are concerned about the ever growing cultural colonization of poor countries by the English-speaking countries. It is not only in the field of computers that such a colonization is very apparent. The colonization is very strong in music, science, engineering, TV, news and trade magazines, movies, scientific and technical books, videos, medicines, all sorts of machinery including automobiles, trucks, and airplanes and all the manuals that go with them, scientific journals and many other things including soft drinks and junk food. Educational software is just another step in this colonization process, but a very important step because it goes very deeply into the young minds of the children which are blank sheets of paper.

Systems of values different from the traditional one in a country can be transmitted very effectively through educational software (as was as early seen in text books) in a manner that is inconspicuous. The competitive attitude of capitalism and free market economics, as opposed to a collaborative attitude of some cultures where religion is all important, for example, are imbedded in the competitive games with heavy emphasis in scores that are developed in industrialized countries. The fear of some governments of this cultural colonization is such that lacking educational software developed for and by members of their culture, they prefer to wait until this software is available rather than using foreign software in their public schools. Here is a clear example of how culture may determine the use of information technology is education.

4. Curriculum Differences, Differences in Styles of Teaching, Social Organization and National Identity

Different cultures approach the teaching question in different ways. Americans, for example, in spite of their "factory model" of education [Ref. 1] have professed for many years a philosophy of education in which the students are welcome to search facts for themselves, question authority, look at things from different angles, and so forth. They believe that technology can help them make their educational system come closer to their educational philosophy. Not necessarily so with other cultures where power instead of coming from the people by democratic will comes from God or some other source. Given the role that Americans give to God and freedom of religion in their internal and foreign policy they would have to admit that authority coming from God is just as respectable as that coming from the people.

In spite of this they insisted after World War II that the Emperor of Japan publicly renounce any divine origin which previous to the war was a central item in their social organization. Westerners have considerable difficulty understanding the importance that Arabs give to the Islamic Religion both in their everyday life and in matters of international relations. In countries where the authority comes from God, it has to eventually filter down to the government, teachers and parents. In such cultures truth is not a matter of independent research or a result of voting.

Thus something is true because it was revealed by God through His representative on earth, which in the classroom are the teachers. Educational software of the kind in which a student discovers truth for himself are not well looked upon by such cultures. What is well looked upon is the tutorial type of software that first presents facts not open to question and then drills the students on those facts, there being only right and wrong answers. Naturally it is difficult to find cultures in which the described situation is as pure as presented here on other cultures. The main facts are that different cultures have intermediate attitudes towards this matter. But the degree of authoritarianism has a lot to do with the type of educational software that may be acceptable in a given culture. In many countries educational adventure games such as the Carmen Sandiego software, even if translated and adapted culturally, would not be considered educational, but rather as play, because the custom is to stick to the national official curriculum so closely that even the homework for the day is published nationally in officially newspapers, leaving the teachers almost no latitude to choose the manner in which to cover a topic.

In the developed nations many of the topics that are included in their curricula have been covered in various degrees by educational software developed within their culture. However, in undeveloped countries, many of the topics that are included in their curricula have not been covered either by them or by software
developers in industrial countries. Such is the case with topics having to do with local history, local forms of government, local literature and other topics not of general interest such as mathematics but of little interest except to the country in question. The reasons why these topics have not been covered by educational software generally have to do with economics. The most prevalent is a lack of an interesting profitable market. The economic situation of many of these countries in that the schools have no electricity, no budgets to buy even paper, books or chalk, thus installing computers is out of the question except possibly in some of the private schools which generally are a small minority.

In many of these countries the private schools are run by foreign communities that can get educational software from their countries of origin in the language of that country. Since in almost all instances the schools are bilingual there is a perfect excuse to use software in the other language as part of the bilinguality. However, this software is usually designed to cover the curricula of the country of origin and thus does not cover topics in the curricula mentioned above. This, of course, tends to increase the cultural colonialism of industrial countries. We thus find that in these bilingual schools, just to give an example, political leaders of the mother country may be better known by the students, particularly what they have done and what they stand for, than local political leaders, among other things because the educational materials (not only those computer connected) in the culture of the mother country are much better than the local ones.

This together with the monopoly of the communications industry particularly television by the advanced countries, creates a situation that many governments find very undesirable: loss of national identity. This fear is reflected in a rejection of the use of computers and other foreign technologies such as videotapes in education both for private and public schools.

5. Political, Economic and Trade Considerations

To provide each student in a country with a computer is something that even advanced countries have found too expensive to do. Average national ratios now stand at something between 20 to 30 students per computer in countries like the U.S.A. with interested groups recommending that by 1995 the ratios become 5 students per computer. In a country where computers are manufactured and there is a strong software development community the installation of many computers in the educational system benefits both the students and the local industry; it creates jobs and improves the economy.

Such benefits are not so clear in the case of countries where most or all the computers have to be imported using hard currency. The benefits to the students have to be so clear that seldom is the evidence strong enough to really convince the politicians that allocate the budgets. Additionally some countries have imposed trade restrictions on the export of certain technical equipment that may have military applications, such as computers. Such is the case of the U.S.A. and Cuba and until very recently with the former Communist Block.

Seen from the undeveloped countries' point of view, bringing in equipment which they do not have the technology to manufacture in order to help operate crucial national systems creates a dependency of the undeveloped countries on the suppliers that is politically very undesirable because it weakens the national sovereignty. There have been several instances where national government forbid their national companies to supply countries that they are pressuring politically or economically creating a very difficult situation in the undeveloped country. Although the educational system is not generally considered as a particularly vulnerable system in a country when compared with the financial, communications or food supply system, information technology has acquired the reputation of being one of the technologies that countries may use to pressure other countries with good leverage because of the dependency from it of such activities as banking, communications and transportation. Therefore, there are governments that are somewhat reluctant to have their educational system depend too much on computers and other equipment which are in the hands of foreign companies and that are not manufactured locally.

Local politics rather than international politics may also enter the picture. The microcomputer has given rise to, among other things, desktop publishing. Many regimes base their control of the population on the fact that they control the news and the communication systems and they do not look favourably on any breach of their monopoly on such items. In such countries a person having a mimeograph machine, a radio transmitter or a VCR is suspected of being reactionary and becomes a candidate for close surveillance and even imprisonment. Such countries are unlikely to be in favor of giving teachers personal computers for educational purposes, since they suspect the machines may be used for subversive activities. They will find all sorts of reasons to avoid the real introduction of computers in education. They may give lip service to the idea for international image purposes but more likely than not the introduction will be slowed down to a trickle and will flow only to the most politically trustworthy groups. Often a good excuse is the economic woes of the country, in spite of the fact that enormous sums of money are spent for political propaganda and personal image building by dictators.
6. Conclusions

The cultural aspects of introducing information technology in education is a very vast and complicated topic. A very short and incomplete discussion has been given with the limited goal of inviting the reader to reflect upon the topic. The question of how to characterize culture by the measurement of specific variables is left completely untouched. We believe the indicators used by international organizations are not sufficiently precise to base useful models for research on them. These indicators say nothing of how authoritarian a regime is, what is the degree of colonization of a country by others, what is the degree of national identity in a country, and other items mentioned in the article as important in the analysis of the use of computers in education. It is this researcher's position that this question of the role of culture in the use of computers in education has to be handled for the time being in as anecdotal manner as possible, as many things are involved in such a complicated process as education. Statistical indices such as the number of students per computer in a country are of very little significance if culture is not taken into consideration.

This author believes this is true even when speaking of the same country. Thus the educational benefits of introducing computers in urban Washington, DC would be very different from the ones that could be reaped in North Dakota because of the cultural environment. Facts such as living in a rural area with not that many social things to do because the next door neighbor lives 15 miles away, versus living in a ghetto area where peer pressure may be an overwhelming factor in the behaviour of a young person (who may be lured into drugs because it is the thing to do if one is really a macho man), can completely annull the significance of an indicator such as students/computers.

The conclusion of this paper is that it is urgent to do more research on the cultural aspects of the use of computers in education. The thesis also is that for the present we do not have good indicators to measure the cultural aspects that seem to really matter and that counting number of libraries per one thousand inhabitants is not nearly sufficient to build statistical models that make any sense in questions such as the subject of this paper. We will for some time have to do qualitative analysis of these matters rather than statistical quantitative analysis. This should not discourage us since we know that education and culture are extremely complex topics and we should not have expected them to yield with the same ease that some industrial problems have to mathematics and statistics.

7. References


2. M.A. Murray-Lasso, "Cultural and Social Constraints on Portability", Journal of Research on Computing in Education, Vol. 23, No. 2, Winter 1990, pp. 252-271. (The special issue in which this paper appears has several other papers dealing with cultural questions of the type discussed on this paper.)


5.3.5 Culture as a Context and Determinant of Educational uses of IT


17. Paula Polley & Richard D. Wenn, "Everything you need to know (but were afraid to ask kids) about computer learning: A guide for parents and teachers", Computer Learning Month, Palo Alto, CA, 1988.


21. M.A. Murray-Lasso, "The impact of Informatics on National Languages and National Cultures", presented at the International Congress: Education and Informatics—Strengthening International Cooperation, UNESCO, Paris, 1989. (In this Congress many topics of interest to the topic of the paper were discussed.)

5.3 Fourth International Conference, "Children in the Information Age"

5.3.6 Informatics Games for Developing Children's Thinking Ability

By Dr. F. Karoly, Dr. M. Körös-Mikis, Hungary

1. Introduction

Seven years have passed since we started teaching informatics - for the first time in Hungary - to small children in the first grade of the primary school. In our country children start learning in elementary school when they are 6 years old.

The preliminary experiments were introduced in a single class. Nowadays, our methods are widely spread in dozens of schools. We are teaching in an ascending system. Our original first group is already attending the sixth year (at the age of 12).

How do we teach it?

The great Hungarian mathematician Bolyai Janos, who constructed the non-Euclidian geometry, wrote in his famous book "Appendix":

"Excellent ideas are just like violets, they open at the same time everywhere when their time comes".

Well, we teach informatics like you who read this. Our methods have several similarities with one of Eduardo Calabrese from Italia, of Eirin Braende from Norway, of Alan Anov from Denmark etc. We could continue listing names of colleagues and friends.

Hereby however, we wish to indicate our most important experiences in the following theses.

2. Theses

Nr. 1. Teaching informatics is not only possible but desirable in all domains of public education. It is therefore necessary to teach it in the lower grades of primary schools, too. It would be advisable to start informatics education in the kindergarten.

Nr. 2. The most important factor in teaching informatics is the teacher. The presence of computer and/or other informatics media is not sufficient for starting.

Nr. 3. Informatics as a new subject is not only necessary but it is an essential part of basic education. In the lower grades one can teach informatics most conveniently during language, technics (arts and industries) and mathematics lessons.

Nr. 4. One of the possible methods of informatics education is "Education through informatics games" for small children, which we use.

Nr. 5. The most important methodological element of informatics education is "Informatics games".

Nr. 6. In the cognitive microculture of a LOGO-environment the Robot plays a more effective role than the Turtle.

Nr. 7. At present what is called small-LOGO is recommended - particularly for small children. Small-LOGO is characterized by native language instructions and by use of smaller numbers (Steps are larger on the screen).

Nr. 8. The translation of special informatics expressions is essential. Word by word translation should be eliminated as it is most often impossible.

Nr. 9. In the lower classes the demand for developing skills in reading and picture-reading will increase significantly.

Nr. 10. The capability of reading can be further developed at any age any level. Developing techniques of reading should be continually considered as a major pedagogical target along the course education. You must learn dynamic reading.

Nr. 11. The computer is one of the best media of teaching how to read, write and spell.
3. Comments on the theses

3.1 Nr. 1.

Of course we have to find and teach the most interesting and most useful fields of informatics for small children. These are the everyday informatics media and toys (for example TV, video-recorder, telephone, remote-control toys, electronic musical instruments, dictionaries etc.) i.e., all media that are in some way connected to data processing.

In the kindergarten we have to pay special attention to presenting these media and practice in the form of games, taking into consideration the psychological and ergonomic aspects.

Our experience shows that informatics games are perfectly suitable for developing small children's mental abilities like:
- precise and differentiated visual perception
- auditory perception
- coordinated arranged motion
- capability of connection visual and auditive information
- short-time visual-verbal memory
- directed attention, concentrated attention

One of the first toys in our experimental kindergarten is the compurobot. The children can try how to command the machine, how to use the robot. It is a pity nowadays these very useful toys are not being sold any more, but there are similar electronic toys which have a keyboard for commands on their back.

After the showing and using these toys we can start playing the games in which small children initiate these toys. In the kindergarten we use the electronic synthesizer too to help develop skills of music.

3.2 Nr. 2. - Nr. 3.

At the moment there is no informatics subject in the Hungarian primary schools. There is no plan to establish it. We have a subject called "Technika" which serves the development of technical ability and knowledge of children. Informatics education is done partly within the "Technika" subject and partly during native language and mathematics lessons. The teacher plays a decisive role in this. It is her/him on whom many things depend: whether or not she/he undertakes - in spite of poor conditions - doing informatics education, to what extent she/he is doing it, and particularly the ways she/he is doing that.

3.3 Nr. 4. - Nr. 6.

Our method is called "Education through informatics games". This is to emphasize that our most important aim is to adjust to a certain child, to the individual. We do not begin the course of practice using the computer. We had looked for and invented preparatory games which constitute the basis of the way of thinking and attitude which will be necessary for the use of informatics media (among others the use of computers).

These games are for example:

3.4 Play the robot!

The gist of the game is: a set of exercises to be done in the classroom, in the gymnasium, in the school-yard, practising the directions of left and right, estimating of distance and counting. We make use of the effect Papert called Syntony.

At first we give verbal instructions in Hungarian, later in some foreign language. The children must perform each move word after word, in an inverse way, with the eyes closed etc. They can play robots of different generations by responding in diverse ways to a false command:
- don't understand it and don't move
- say there are some problems
- try to correct the wrong command

The version of moving with eyes closed helps the teacher to see very well how the pupil thinks. We can play this game by giving several commands together and after the calling "robots" will execute them, thereby developing their memory.

These games not only prepare and consolidate the use of LOGO primitives, but increase the algorithmical ability too.
3.5 Feed the turtle!

This game is played on a field drawn on the floor or on the table, after in the activity book. Here is a part of our first grade informatics exercise book:

It is simple to make algorithms for moving to take the turtle (⇓) to his food (⇑). Once we have enough practice we start using the computer, since we have a software that can be used as an introduction to the screen and the keyboard.

3.6 Match-LOGO

We can draw the lane, the different turtle-moving, we can mark the steps and it is useful to mark the direction at every step. One way to solve this is to use or draw matches or arrows. When children take the small arrows made from paper they develop their manual skills.

3.7 LEGO-LOGO

Experts are quite familiar with describing the LEGO construction algorithms in the LOGO language.

Computer languages are designed so that they are useful for programming particular ranges of problems. Crawford Craig describes how a language was invented for use in one particular area of application, LEGO-LOGO. It is a special brand of 3-D turtle graphics, with a turtle moving around leaving LEGO-bricks as it goes, thus building any LEGO structure you wish.

The children are designing and building from small LEGO-bricks and in the meantime they recite and make notes on the algorithm of construction. This game is especially valuable as it is developing more abilities at the same time (manipulation, spatial vision, algorithm etc.) and elicits a psychological transfer effect.

We have set up a version of this game for computers, which is perfectly suitable for the demonstration of structured programming.

3.8 Floor turtle

Using the floor turtle, we got the keyboard separated from the toy. This play develops technical thinking mode also very well.

We use several kinds of floor turtles, made from LEGO elements, Fisher Technics elements, from elements of special Hungarian school kits. Of course pupils may make not only a turtle but many types of cars and other computer-controlled toys.

There is the other meaning of LEGO-LOGO. Enter LEGO-LOGO, brought to us by Papert and the crew of the MIT lab. This is an excellent integration of the abstract with the concrete. Children built whatever using colourful LEGO (or other similar) pieces, motors, wheels and other gears; hook up their machines via interfaces to the computer, and control the movements of the motorized constructions through computer programming.

3.9 Nr. 7. - Nr. 8.

Unfortunately, in Hungary the complete LOGO program is not worked out in Hungarian, in order to let all children communicate with the computer in their mother tongue. It was an absolute necessity to revise the English LOGO-primitives adjusting to the children's vocabulary (for example CLEARSCREEN is substituted by the Hungarian word SZIVACS means sponge, for cleaning the blackboard i.e. screen).
At the beginning in the case of children in the age group of 5-8 it is complicated to exceed the 100 figures, when we intend to change the direction of the turtle. Therefore, like imitating the clock we divided a circle into 12 parts; that is our compass. (So one quarter turn is equal to 3 units.) The measurement of the motion is different too: the length of the step of the turtle is 10 times more. We call this converted language: Small-LOGO.

3.10 Nr. 9. - Nr. 11.

In the first classes of primary schools the computer has proved to be the most useful aid in the teaching of reading and writing. According to our experience in the classes where the computer is regularly at disposal and the teacher is encouraging the pupils to read and write with the computer, the children will show fast progress in writing and reading with enthusiasm and success. They are practising less ordinary handwriting and yet their characters are not worse than those of schoolmates who are not using the computer. Moreover, they are more willing to put down longer handwritten texts.

We prepared a special program for the development of motoric reading-writing skills too [7]. It is among our work to construct a software package, which could process both pictogrammes and texts (words) for teaching.

4. Conclusion

The main goal is to teach children informatics without tears.

We think the direct experience is the most important in education. It is necessary to use not only a computer but a lot of other informatics tools too.

Our methods are no longer only in experimental schools, but 3 academic years ago the education of informatics games appeared in teacher training and post-gradual education too. At the Budapest Teachers Training College we are organizing courses for the teacher-to-be and the pedagogical institutes are offering post-gradual education to teachers.

We have published quite a few books, teacher handbooks and article to facilitate the job of our teachers.

5. References


5.3 Fourth International Conference, "Children in the Information Age"

5.3.7 Assessing Computer Use Impact within an Interactive Network of Variables: Assessing the Impact of Different Types of Computer Use in Mathematics Teaching at the Secondary Level

By P. Gabriel, France

Sample and Assessment Procedure

A preliminary survey allowed us to find 25 classes of three different grades, in 6 schools, noting nearby these classes' teachers, the types of IT previous integration, for the coming year, in the usual course of a mathematics teaching. Previous integration can be expressed in four categories:

1. Educational programming, mainly with Logo (PRO);
2. Drill and practice, with ready made software (DRI);
3. Mixed activities (i.e. programming and drill and practice - MIX);
4. No integration of IT, considered as control classes (NTT);

During the school year, for the classes concerned, the time allocated to IT was part of the usual course and the educational practices have been implemented by the teachers, apart from the evaluation saw as a "natural" observation.

1.1 Subjects

The considered grades are the first and the second grade of the middle school (respectively identified no.1 & 2) and one of the third grade of this same kind of school (identified no.3), a division which assembles low achievement pupils. The children are approximately eleven and twelve years old (1), twelve and thirteen years old (2), thirteen and fourteen years old (3).

The distribution of the pupils according to the grades and the type of IT integration (Table 1) shows that in the sample, the use of drill and practice software is essentially linked to the first grade and the educational programming to the other grades. On the other hand, the classes characterized by a mixed integration of IT and the control classes are associated to all grades.

Table 1

Description of the sample: Categories of the different types of IT integration in the usual course of mathematics teaching, grades and percentage of the pupils having participated in both of the tests

<table>
<thead>
<tr>
<th>Type of integration</th>
<th>IT</th>
<th>NIT</th>
<th>PRO</th>
<th>DRI</th>
<th>MIX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1 (6°)</td>
<td>35</td>
<td>-</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Grade 2 (5°)</td>
<td>22</td>
<td>6</td>
<td>-</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Grade 3 (4°a)</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

In fact, concerning the control classes, to offset the possible impact of the pupils' origin, they have been selected when it was feasible, with comparatively similar features according to the other classes (classes of the same level from the same school).

Two tests have been developed for the evaluation. They are common to the three levels and take national mathematics curriculum into account. The items composing them, relate on the one hand to the field of arithmetic (A) and on the other hand to the field of geometry (G).

In addition to that, we collected some more information concerning the children on the evaluation sheets (age, use of a computer in a club or at home, use of a computer the year before in mathematics teaching) and on the school register we have been allowed to get parents' activities.
The first approach we developed consists of integrating into a linear model the different variables observed.

2. The regression model

With the final mark as dependent variable, a multiple regression model has been constructed which integrates variables expressing the pupils' features themselves, the impact of the schooling context (including educational practices) and other aspects of children's computer use. This model explains nearly 46% of the variance (see Table 2). The results confirm some observations usual to this level of the secondary teaching (see, for example, Heuneman, 1985, Duru & Mingat, 1988) and bring some information about the sample itself.

The indicators are, classically, the value of the estimate parameter and the t-ratio associated to this parameter which is compared with its probability.

2.1 Pupil features as predictors

Concerning the pupil features, the sex has no significant effect unlike the age which, on the contrary, can be linked to a very significant impact: at the time of the first middle school year, the children with a normal age for this section ("6° & a76"), succeed better than the ones who are older, this effect disappearing later, in the second grade ("5° & a75"), but some trend occurs in the third grade ("4° & a73") in spite of the fact we took account of a repeating year in the past schooling of these pupils. In the present state of our knowledge, this phenomenon remains little described or studied. It is not the case of the familial culture influence, generally approached by the sociodemographic categorization (SDC) of the parents' occupational activities.

A three stratum categorization has been used. It appears that compared to the pupils gathered in the CSD (ie artisan, tradesman, firm director and intermediate occupations), the pupils whose parents are in the lower CSD (CSD INF.: employee or worker) have here, no different score; on the other hand, the impact linked to belonging to the upper CSD (CSD SUP.: executive or upper intellectual occupations) has a highly significant effect.

The scores at the first test, reflect of the initial level of the child in mathematics, have also a significant impact compared to the average child; According to this initial score, pupils have been gathered in seven categories: from "very weak" ("très faible") to "very strong" ("très forts"). We can observe that this impact and the t-ratio associated are increasing accordingly to the distance with the average score: the more the child is weak at the beginning of the year, the less he or she benefits by the teaching; and conversely, for the strongest children.

2.2 School context and educational practice as predictors

Concerning the schooling context and the educational practices, first, there is the influence linked to the grade; the second grade (5°), mainly, has a great and significant impact: a child in this class obtains two points more than a child in the first grade (the probability of the t-ratio is upper .001). Second, there is the variability between schools: compared to the school number 5, the other schools (Etablissement) are associated with significant better scores.

However, the structure of the sample allows us to reject the influence of a relationship between schools and grades: the pupils from 5o are in school number 5 (12% of the whole sample) and school number 5 (29,9% of the whole sample).

Concerning the educational practices, the results indicate a positive and significant impact of drill and practice software ("Didacticiels"); on the opposite side, the programming activities ("Programmation") and the mixed activities ("Act. mixtes") are linked to a penalizing impact on pupils mathematics acquisitions. r in the linear model: pupils from the PRO and DID groups have progressed, the last considerably more than the
first; on the opposite side, the mixed activities are linked to a penalizing effect: pupils initially above the average stand near the average after having studies with educational programming and drill and practice software. This result is all the more surprising that the pupils involved in programming activities are mainly in the second grade (see Table 1).

2.3 Computer use as a predictor

The other children computer use in the context of the previous schooling and in the field of mathematics has no effect while the out-of-school computer use (mainly, computer use at home & computer use in a club) seems to have a favourable, lightly significant impact.

Besides the elements of information given by this performance model some deeper analysis are required about our major concern: the assessment of IT educational practices. Actually, we can wonder how the pupils’ progress is set out, what the impact of the time allowed is, what is the relationship with the field of application, and what are the interindividual differences of reaction, considering these practices?

3. The difference in the practices impact

The progress in comparison with the group NIT of each of the three groups having used IT are envisaged from a distance indicator or effect measure. This ES (effect size) measure is defined as the distance between the average to a test of each IT group to the average of the non IT group at the same test divided by the control group standard deviation (Kulik, Kulik & Bangert-Downs, 1985). The ES take separately into account, the scores in arithmetic (A) and it geometry (G) as the seven class partition between pupils initial level of success (section 2, §1).

How to understand these observations (Table 2)? The ES indicator gives the distance between the average of each group to the control groups in terms of standard deviation; on the other hand, the standardized distributions of the values used to make them comparable allow them to obtain well-known Normal distributions: it means a particular number of class on the variable continuum in such a way that the number or the frequencies corresponding to each class be corresponding to the frequencies of the small-scale normal law, notably between the average and less a standard deviation and the average and a standard deviation there are 68.4% of the distribution frequency.

The kind of IT integration in the mathematics course indicates various effects of the educational practices according to the initial level of the pupils and the field of knowledge investigation: "A" vs. "G" (see Table 3). First, the impact of drill and practice software, appearing just as well in arithmetic and geometry, is mainly positive and concerns average pupils; thus 61% (instead of 50%) from "average" pupils of the DID group have, in arithmetic, a higher score than the average of the control group, they are 65% from the "average weak" and 94% from the "strong" group in comparison with the corresponding control group. In geometry, the trend relates to the strongest, "average strong" and "strong", with respectively 61 and 87% of the pupils from these groups exceeding the average of the control groups.

Secondly, the impact of programming activities is virtually non-existent in the field on geometry where these activities are considered as the more appropriate.
Linear regression table of the pupils’ standardized results at a test in mathematics at the end of the school year.

Dependent variable is: Final STD score

588 total cases of which 49 are missing

\( R = 44.5\% \) \( R(\text{adjusted}) = 41.9\% \)

\( s = 1,515 \) with \( 539 - 25 = 514 \) degrees of freedom

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
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<td>39.4</td>
<td>17.1</td>
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<td>Residual</td>
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<td>514</td>
<td>2.29801</td>
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<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
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<td>Constant</td>
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<td>0.3838</td>
<td>6.97</td>
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<td>Garçon</td>
<td>-0.0711021</td>
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<td>6 &amp;a76</td>
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<td>0.1918</td>
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<td>5 &amp;a75</td>
<td>0.190614</td>
<td>0.2285</td>
<td>0.833</td>
</tr>
<tr>
<td>4 &amp;73</td>
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<td>0.9982</td>
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<td>0.2193</td>
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<td>2.73</td>
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<td>1.35787</td>
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<td>50</td>
<td>2.13507</td>
<td>0.3279</td>
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<td>4 aménagées</td>
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<td>1. Etablissement</td>
<td>0.815623</td>
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<td>Act. mixtes</td>
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<td>0.1266</td>
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<td>AU0</td>
<td>0.267917</td>
<td>0.1599</td>
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</table>

Upper percentage points of the t-distribution, extracted for one-tailed tests of hypothesis:

<table>
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<tr>
<th>( v )</th>
<th>0.25</th>
<th>0.1</th>
<th>0.05</th>
<th>0.025</th>
<th>0.01</th>
<th>0.005</th>
<th>0.001</th>
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<td>1.645</td>
<td>1.960</td>
<td>2.326</td>
<td>2.5776</td>
<td>3.090</td>
</tr>
</tbody>
</table>

5.3.7 Assessing Computer Use in Mathematics Teaching

By P. Gabriel, France

Table 3

For the three groups IT (i.e. Programming activities—"PRO"; drill and practice—"DID"; & mixed activities—"MIX"), comparison with the groups NIT, concerning the distance the distance between initial and final score in arithmetic (A) and geometry (G), on different achievement level pupils (i.e. assess on the initial level from "very weak" - "très faibles" to "very strong" - "Très forts"), with from top to bottom in each situation: ES, Student t and probability associated.

<table>
<thead>
<tr>
<th></th>
<th>PRO.</th>
<th></th>
<th>DID.</th>
<th></th>
<th>MIX.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>G</td>
<td>A</td>
<td>G</td>
<td>A</td>
<td>G</td>
</tr>
<tr>
<td>Très faibles</td>
<td>.188</td>
<td>-.107</td>
<td>-</td>
<td>-</td>
<td>.298</td>
<td>-.426</td>
</tr>
<tr>
<td></td>
<td>0.482</td>
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<td>-</td>
<td>-</td>
<td>.932</td>
<td>1.528</td>
</tr>
<tr>
<td>p&gt;.4</td>
<td>p&gt;.4</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Faibles</td>
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<td></td>
<td>1.485</td>
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<td>.439</td>
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<tr>
<td>P&gt;.1</td>
<td>P&gt;.25</td>
<td>P&gt;.4</td>
<td>NS</td>
<td>p&gt;.25</td>
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<td>M. faibles</td>
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<td></td>
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<td>p&gt;0.4</td>
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<tr>
<td>Moyens</td>
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<td></td>
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</tr>
<tr>
<td>p&gt;.4</td>
<td>p&gt;.1</td>
<td>p&gt;.1</td>
<td>NS</td>
<td>p&gt;.4</td>
<td>p&gt;.1</td>
<td></td>
</tr>
<tr>
<td>Moy. forts</td>
<td>.614</td>
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<td>.35</td>
<td>.296</td>
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<td>-.134</td>
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<tr>
<td></td>
<td>1.572</td>
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<td>p&gt;.1</td>
<td>p&gt;.4</td>
<td>p&gt;.25</td>
<td>p&gt;.1</td>
<td>NS</td>
<td>p&gt;.4</td>
<td></td>
</tr>
<tr>
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<td>3.086</td>
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<td>p&gt;.25</td>
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<td>Très forts</td>
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<td>NS</td>
<td>p&gt;.25</td>
<td>p&gt;.005</td>
<td></td>
</tr>
</tbody>
</table>

4. The time allocated to computer use

During the school year and in this teaching context the time allocated to computer use has been the subject of a grouping together in three categories: length of time below 20 hours, "B20", between 20 and 40 (i.e. one hour per week for two terms or two hours per week for a term), "20-40", and above 40 hours, "A40". It appears that the ES observed from the distance between the standard scores of the first and the second test are not meaningful for the "20-40" and "A40" groups (respectively: ES = .066, t = .628 and ES = -.21, t = 1.146). Concerning the group "B20" the ES is negative (-.19) with a low level of significance (t: 1.562 & .10 < p < .05). This can give substance.

If the belonging to a particular school cannot be quoted to explain this result ("B20" groups belong to school 2 and 3), on the other hand, the relationship between grades and "B20" groups, is important: all the "B20" groups are first grade ("6°"). Furthermore, the "A40" are second grades only and belong to school 4, a school associated with a low level of performance, everything equal elsewhere.
In fact, things happen as if the time of computer use, on average, had no impact on pupils' mathematics acquisition, the trends observed translating into some interactions between IT and features of the context. In this respect, one of the major concerns of educational research relates to the relationship between pupils' features and educational practices. The achievement level of the pupils is, in this context, a worthwhile indicator as it reflects the schooling previous approach.
5.3 Fourth International Conference, "Children in the Information Age"

5.3.8. Metacognition and Strategic Use of Computers: A Study of Creative Writing with Grade Four Children

By L. Ollila, E. V. Schwartz, L. Francis, Canada

1. Introduction

Grade 4 students from Marigold Elementary School were chosen to be observed due to their participation in the Apple Discovery Program. The decision to use an ethnographic approach was based on the belief of the researchers that computers could enable students to develop individual working environments; this belief however makes it difficult to predetermine common characteristics of the student-computer interactions.

The programs that the students chiefly used were HyperCard, Clip Art, and MacWrite. HyperCard was used as an interactive multimedia programming environment, Clip Art was used for the animation of existing digitized graphics, and MacWrite was used as a word processor. The students were asked to work with each of the programs and to talk about what they were thinking while using the computer. The interview process took about 45 minutes, while the amount of time spent with each program was determined by the wishes of the students. During the observation time a series of questions that evolved from the various comments and nuances given by the students was developed. Thus, for the first student there were about 10 questions which were thought may be interesting to explore.

This is not to say that it was intended to dogmatically pursue the answer to the predetermined questions, rather, it was intended to use them as a template to help keep the flow of information coming from the student.

As more students were interviewed, questions were added and removed as seemed fit based on the following two main criteria: a) that the questions did not intrude on the students' personal lives, and (b) that the questions were prompted from the interaction between the students and the researcher. If questions did not arise consistently, or if they seemed irrelevant then they were dropped. As well, care was taken to ensure that the questions did not intrude on the interaction between the student and the computer; thus, in many cases, the questions were asked and answered at the end of the observation period rather than during it. At the end of the total interview process a total of 63 questions remained, of which 49 are used directly in this paper. The responses given by the students were then compiled by percentage into groups of common answers. The responses were then compared with personal notes and perceptions, and finally reflected upon based on relative importance, with the main discoveries brought forward in this discussion.

This paper contains five main sections: introduction, class physical environment, class interpersonal atmosphere, metacognitive processes, and discussion and future avenues. Class physical environment will focus on the layout of the computer-classroom. Class interpersonal atmosphere will concentrate on the human interactions. Metacognitive processes will focus on the impact of technology on students' writing skills; and discussion and future avenues will focus on the implications of the findings in this discussion.

2. Class Physical Environment

The basic layout of the computer class is rectangular, roughly 15 meters by 3 meters. There are two entrance ways at either side of the ends of the rectangle, with one entrance backing onto the library and the other opening into the hallway. In many respects the room resembles a hallway, although access through the back door to the library is limited. Computer workbenches run along both sides of the length of the room, with usually around 10 computers on both sides. Usually there is enough seating for 30 students.

Since there are very few computers in the students' regular classrooms, the computer room is in a constant state of flux with some classes or groups of students coming and going on a fairly regular basis. As well, there is a constant flow of teachers, staff, observers from other schools, interested computer users, and researchers. The presence of so many people in the lab at any given time results in the lab instructor constantly moving from student to teacher to staff to researcher to computer user to computer. The computers are all backed against the wall. This allows students to turn their backs on the buzzing activity when they wish to concentrate on their projects. If a problem is encountered by students, the many available computer-literate people are constantly able to help devise solutions. Hence, even though at first glance the classroom may seem to be chaotic, it is actually a productive and supportive learning environment.

3. Class Interpersonal Atmosphere

The three main interaction focuses are student interactions, teacher student interactions, and external interactions. Since the computer room at Marigold has so many "techy-gadgets" such as audio digitizers and video scanners, many computer-literate people from throughout the community come there. These people are
from all sorts of backgrounds, ranging from high school students and local teachers from technologically
deficient areas to school district administrators, university researchers, and computer hackers who just need to
use some of the equipment. As these people flow in and out, they serve as a resource for all, and ideas and
information are constantly being exchanged. The greatest impact that these external people seem to have is
their effect on the students’ perception of the relevance of what they are doing. That is, the students tend to
feel that they are not working in an isolated, information-deprived classroom; rather, they are part of a very
exciting, evolving world in which technology plays an essential role.

The teachers who are involved with implementing the computer-based learning environment are as
elated about using the computers as are the students. However, a struggle exists between their traditional role
of the teacher as a disseminator of a body of knowledge within a controlled environment, and the teacher as a
facilitator, that is, the determiner of how much structure is needed to enable the students to control their own
avenues of exploration without cramping their individual needs and styles. The general approach toward
structuring the learning environment has been to provide instruction in the regular classroom on new
techniques that may be used in different computer programs, providing goals for the students, then allowing
them to tackle their objectives in the computer room. Overall, such an approach seems to be quite effective.
Most students were able to quickly master and apply the new techniques.

While there has been success in empowering the students with the required skills needed to use the
computer effectively, there are constraints placed on the students’ creativity due to the environments of the
programs they have been using, and the solutions devised by the teacher to hold the class together. The
constraints imposed by the programs are due to the limitations of the programs and the technology. As an
example, students would imagine a picture they would like to create on the computer screen and discover that
it could not be drawn the way they wished. The causes for the students inability to draw the desired picture
usually stemmed from a lack of a high enough monitor resolution, a lack of animation capabilities of the
computer program, or a lack of authoring tools provided within the program package. Constraints placed on
the students by the teacher were primarily due to the apparent need to produce class projects. While the
students were allowed to work on their own projects, they were not necessarily part of the evaluation process,
and therefore did not play an essential role in providing parents and students with feedback.

The most evident constraint, that resulted from both the limitations of the technology and the desire for
a class project, appeared during the development of a class newspaper. The program chosen for the project
was Hypercard, and four main topics about which to write were chosen; people, science, sports, and tales.
The first letter of each topic formed the name of the paper PSST. Although in itself the process of making the
paper was not particularly constraining, problems arose with the amount of space allotted to each topic. The
average amount of space provided was 6 centimeters squared. This limited the students’ writing to about 20
words. Although this space was sufficient for students who did not particularly enjoy writing, the students
who did enjoy writing found it not big enough and tended to feel like they were obliged to complete a
frustrating task. Although this constraint was clearly not what the teacher had intended, it still existed. The
problem primarily stems from attempting to provide a working environment that is useful to an entire class,
rather than to an individual.

Despite the constraints, which were really quite few and possibly due to the lack of guidelines on how to
let students assume command of their own learning, students were definitely pleased with their experiences in
the computer room. Even though the lab instructor’s time was in constant demand by many people, thereby
disabling him from devoting a lot of time to individual student’s needs, the students were constantly busy. If
students were stuck on a problem they readily asked their friends or another person that they thought might
know how to solve the problem. If people in the room could not find a solution, which was very unlikely
especially over the long term, then 75% (Figure 1) of the students would either start working on a different
project or keep trying. Only 25% (Figure 1) of the students said they would give up entirely on those
occasions when there were no forthcoming answers.

Another key component in the interstudent interactions was the boot up time, or time it took for the
students to load a program and log onto the system. On average, it would take the entire class about 10
minutes to log on, with individuals taking from 30 seconds up to the full 10 minutes. The cause for the
variation was due to the nature of the system program, which requires each student to log on one at a time.
During the boot-up time, teachers actively promoted the reading of appropriate books, so as to not have the
children waste time. Student preference at these times was to socialize or just look around the room. Once
again, due to the activity level of the room, most students found it difficult to concentrate on their books.
However, once the computer was logged on they would enthusiastically start their work.

There are two probable explanations for why the students were able to concentrate while working on the
computers instead of reading. Perhaps the students simply wanted the boot-up period as a socializing time.
The idea of reading a book at that time was devised by the teacher, perhaps as an attempt to reduce an
apparent lack of productive activity. The students felt that the reading period was an inconvenience with 84%
(Figure 1) preferring to do something other than read. Another possible explanation, which learning theorists
have been suggesting, is that the new generation of children are more visually literate as compared to their
text literacy, whereas their parents are just text literate (Eriksson, 1988).
### 5.3 Fourth International Conference, "Children in the Information Age"

**Figure 1. Questions**

1) **What do you do/think about during boot up time?**

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing</td>
<td>28%</td>
</tr>
<tr>
<td>Think about what to do</td>
<td>24%</td>
</tr>
<tr>
<td>Read</td>
<td>24%</td>
</tr>
<tr>
<td>Talk</td>
<td>20%</td>
</tr>
<tr>
<td>Look at start-up screen</td>
<td>4%</td>
</tr>
</tbody>
</table>

2) **What would you like to do during boot up time?**

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talk</td>
<td>29%</td>
</tr>
<tr>
<td>Nothing</td>
<td>24%</td>
</tr>
<tr>
<td>Read</td>
<td>16%</td>
</tr>
<tr>
<td>Play a game</td>
<td>12%</td>
</tr>
<tr>
<td>Look at a screen</td>
<td>4%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>8%</td>
</tr>
<tr>
<td>Think</td>
<td>8%</td>
</tr>
<tr>
<td>Help others</td>
<td>4%</td>
</tr>
<tr>
<td>Does not know</td>
<td>4%</td>
</tr>
</tbody>
</table>

3) **Who do you normally learn your computer techniques from?**

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>40%</td>
</tr>
<tr>
<td>Students</td>
<td>8%</td>
</tr>
<tr>
<td>Self</td>
<td>4%</td>
</tr>
<tr>
<td>Lab Teacher</td>
<td>4%</td>
</tr>
<tr>
<td>Others</td>
<td>4%</td>
</tr>
<tr>
<td>Combinations of above</td>
<td>40%</td>
</tr>
</tbody>
</table>

4) **How do the different programs appear on the screen?**

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not know</td>
<td>100%</td>
</tr>
</tbody>
</table>

5) **When you can't figure out what to do, and there's no one to help, what do you do?**

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do something else</td>
<td>48%</td>
</tr>
<tr>
<td>Keep trying</td>
<td>28%</td>
</tr>
<tr>
<td>Quit</td>
<td>24%</td>
</tr>
</tbody>
</table>

### 4. Metacognitive Processes

#### 4.1 Visual Processes

One of the most interesting metacognitive processes evident in the students is their visual literacy. There is little doubt, based on the results of this study, that the students preferred working in a visually stimulating environment, as 92% (Figure 2) of the class liked doing animations. Although the animation skills were new to the students, 28% (Figure 2) said they were already making stories for their animations. Although 68% (Figure 2) said they were not plotting stories for their animations, it appeared as though they were, as most animations had themes.

For example, one girl who had said that she did not think she connected stories to her animations had created an animation of baby turtles emerging from their eggs, then moving to the sea. It is probable that many students did not think that their animations were stories because they did not fit the established definitions of story. When asked if one sentence could be a story, 76% (Figure 2) said no, with the following three key explanations: it would be too short, it would not say anything, or a story is not a sentence.

**Figure 2. Questions about Visual Effects**

1) **Could a story be just one sentence?**

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>20%</td>
</tr>
<tr>
<td>No</td>
<td>76%</td>
</tr>
<tr>
<td>Not sure</td>
<td>4%</td>
</tr>
</tbody>
</table>

2) **Why/why not?**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>It would be too short</td>
<td>44%</td>
</tr>
<tr>
<td>Depends on content</td>
<td>16%</td>
</tr>
<tr>
<td>It would not say anything</td>
<td>12%</td>
</tr>
<tr>
<td>A story is not a sentence</td>
<td>12%</td>
</tr>
<tr>
<td>Does not know</td>
<td>8%</td>
</tr>
</tbody>
</table>
5.3.8. Metacognition and Strategic Use of Computers

L. Ollila, E. V. Schwartz, L. Francis,
Canada

If the sentence had all the ideas it would be ok. 4%
3) Do you like doing animations?
Yes 92%
Sometimes 4%
Not Applicable 4%

4) Why/why not?
They are fun to do 92%
The product looks neat 4%
Not applicable 4%

5) Do you make up stories to make an animation for?
Yes 28%
No 68%
Not applicable 4%

6) Do you connect your written stories to your animation?
Yes 24%
No 72%
Not applicable 4%

4.2 Structure versus Creativity

The answers the students provided tended to be based on definitions that were provided them by adults. The limitations placed on what a story could be were indicative of the fact that the resource people involved with computers were very knowledgeable about computers, but, they also had specific boundaries of creativity within which they worked and made decisions. Thus, in people’s efforts to empower the students so they may take full advantage of the medium of the computer, they inadvertently created fences for the students’ creativity.

Other metacognitive processes the students were employing related to learning how to work creatively within the structure of the computer or certain software package and understanding how the computer and software work. A computer will only do what it is told to do, and, in order for this to occur some level of understanding how the machine works is invaluable. This leads to a major dilemma facing the teacher. Should a teacher spend time discussing the abstract workings of a computer, or get the students to start working immediately with the teacher filling in the gaps later? The method chosen at Marigold was the latter. It is probably the most effective approach, despite its limitations.

There is one prime limitation imposed by not understanding the system that had an impact on the students metacognitive processes. This is, the need to memorize series of events without knowing why those steps are being taken. For example, the steps involved in logging on followed by loading the appropriate program and then opening the desired file was usually a 10-step process. Memorizing 10 steps, which actually change depending upon where the program or file was stored (harddrive or internal drive), proved to be too much for 100% (Figure 3) of the students. Students consistently demonstrated varying degrees of frustration as they tried to open programs or locate their files. They usually had to resort to asking an instructor how to get their file. This was clearly due to a lack of understanding of how the system works. Yet, if a lot of time was spent on explaining how the system worked prior to using it, many students would probably lose interest and ignore the explanations.

The lack of student knowledge about computer systems could be seen in several ways. No one knew any of the physical processes required to enable the programs to appear on the screen. Ninety-two percent (Figure 3) could not explain what a computer system was, and 92% (Figure 3) did not know where software is stored when the computer is in use. It was almost as if the students were working in a “magical land” where things just happened. When asked if it mattered to them how the computer works, the students’ attitudes were probably similar to other people’s attitudes about cars with over half only being concerned that they know how to make the car work, while only 12% (Figure 3) thought it was important to understand how it works.

Figure 3: Questions about System Knowledge and Use
1) How long have you been using computers?
Less than one year 20%
One to two years 44%
5.3 Fourth International Conference, "Children in the Information Age"

Greater than two up to three 8%
Greater than three and up to four 8%
Greater than four up to five years 20%

2) Do you use them outside of class time?
Yes 64%
No 36%

3) When do you use them out of class?
At home 20%
After school 20%
Recess / lunch time 12%
No answer 32%
Not applicable 16%

4) Do you have a computer at home?
Yes 44%
No 56%

5) What is a computer system?
Does not know 92%
A tool 8%

6) Where are programs in the system?
Does not know 92%
Guessed a wrong answer 8%

7) Does it matter to you where programs come from?
Yes 44%
No 44%
Depends 8%
No answer 4%

7a) Why/why not?
Does not know 32%
Just as long as it works 24%
Concerned about getting computer viruses 20%
Just thinks it is important 12%
Reasons of integrity 8%
No answer 4%

8) How do the different programs appear on the screen?
Does not know 100%

4.3 The Writing Process

Despite the periodic moments of frustration, the students were very engrossed in what they were doing once they had opened their working file. Once within the "magical" world of the computer their enthusiasm for self expression through writing was clearly visible. The main reason the students enjoyed writing was due to the use of the computer to eliminate most of the tedious components of writing. Instead of the children focussing their efforts on the mechanics of how to print letters, the children were able to concentrate on the content of what they were writing.

There were essentially three ways that the computer made it easier for the students to write unimpeded: editing, spelling, and readability. The editing capabilities of the computer enabled the students to write freely without fear of mistakes that would require a lot of effort at the end to correct. Thus, students would happily type their stories with the knowledge that if they made a mistake, or felt like changing a component of their story after having written them, they could easily make the corrections and changes. It is likely that due to the apparent ease of these changes, 68% (Figure 4) of the students said they wrote to explore ideas, that 80% (Figure 4) said their stories evolved as they wrote rather than making up the story then writing it down, and that 68% (Figure 4) said they changed their stories. While editing features of the computer enhanced the students flexibility of story content, the spell checking feature helped students to overcome fear of using words they did not know how to spell.
Spelling words correctly was very important to 92% (Figure 4) of the students primarily because they were concerned that other people must be able to read their stories. Instead of stopping and pondering over the spelling of words, thereby interrupting their trains of thought, students would continue to type their stories. When they felt their stories were done, 80% (Figure 4) said completion was based on when they ran out of ideas and 80% (Figure 4) would then check for spelling errors. These spelling errors were easily corrected due to the editing features of the computer as well; 60% said it is easier to see misspelled words on the screen. Of the 64% (Figure 4) of the students who used the spell checking feature of the computer, 55% (Figure 4) felt it helped their own spelling primarily due to the computer's ability to show the correct spelling immediately. In comparison, to their own work however, some students felt the dictionary took too long, and that one had to know how to spell the word in the first place. Instantaneous answers to questions of mechanics prevented students from losing interest in editing, thereby, enabling them to produce very readable stories.

Figure 4. Questions about Writing

1) Do you think of a whole story first and then write, or do you write and think at the same time?
   - Write and make story 80%
   - Story first 12%
   - Both 8%

2) Do you allow yourself to write, to explore ideas?
   - Yes 68%
   - No 28%
   - Depends 4%

3) When do you feel your story is finished?
   - Run out of ideas 80%
   - Loses interest 8%
   - Mistakes are corrected 4%
   - Does not know 4%
   - When there is a lot written 4%

4) Do you think a story has to have an ending?
   - Yes 28%
   - No 72%

5) Do you check your work for mistakes?
   - Yes 88%
   - No 12%

6) When do you look for mistakes?
   - When finished the story 80%
   - During writing and when finished writing 20%

7) Why do you look for mistakes?
   - So others may read it clearly 52%
   - To avoid trouble with the teacher 12%
   - The story is not finished until mistakes are corrected 8%
   - Gets another student to check 4%
   - Likes to be able to spell 4%
   - No answer 20%

8) Do you change your story sometimes?
   - Yes 68%
   - No 28%
   - No answer 4%

9) Why do you change your story sometimes?
   - Sometimes the story does not sound right 40%
   - Get a new idea that fits 16%
   - Does not know 12%
   - Too many mistakes are made 8%
   - It's easy to change so why not 4%
   - Gets an urge 4%
5.3 Fourth International Conference, "Children in the Information Age"

Not applicable 8%
No answer 8%

10) When do you change your story?
While writing the story 48%
At the end of the story 12%
Not sure 12%
When using the computer 8%
Not applicable 8%
No answer 12%

11) Is it easier to see misspelled words on a computer, as compared to handwriting?
Yes 60%
No 28%
Neither 12%

11a) Why/why not?
Easier to see 56%
Does not know why 16%
No answer 16%
There is no real difference 8%
Catches mistakes by hand before making them 4%

12) Is spelling important to you?
Yes 92%
No 8%

12a) Why/why not?
So other people can read it 60%
Miscellaneous 28%
Does not know 12%

13) Do you check your spelling?
Yes 88%
No 4%
Sometimes 8%

13a) If so when?
At end of writing 60%
At end of and during writing 24%
If it looks really bad 4%
No answer 8%

14) Do you use a spell checker?
Yes 64%
No 36%

14) Why/why not?
It shows mistakes 40%
No, answer 24%
Easier than dictionary 12%
Does not know how to use it 12%
It is fast 4%
Does know why/why not 4%
It does not work 4%

15) If you use a spell checker, do you think it helps in your own spelling?
Yes 40%
No 16%
Not applicable 28%
Depends 8%
No answer 8%

15a) Why/why not?
It shows errors immediately 32%
Does not know 16%
Students felt that the increased readability of their written works would enable others to read their stories without being slowed down by poor handwriting. Story readability contributed greatly to the high result of 80% (Figure 5) of the students enjoying reading other students' stories and 76% (Figure 5) enjoying reading their stories to others. Hence, as a result of the computer's capacity to make editing, spelling correction, and readability assessment easier, students felt more confident in writing, more readily willing to show their effort to others, and more able to concentrate on content.

The main inhibitor for many students is the keyboard interface. The one area that slowed students down in their ability to write was their typing skills. Sixty-eight percent of the students felt they got more work done on the computer as compared to handwriting. However, of the 32% (Figure 5) that felt they got less work done, 50% (Figure 5) said they were faster at handwriting and 50% (Figure 5) believed that the computer makes mistakes. In all instances it was not computer error, rather, that the students would press the wrong key. In order for students to become significantly unimpeded by the keyboard interface, thus enabling them to concentrate even further on their story content, basic keyboard skills need to be developed. This is not to suggest that the students need to become touch typists. Based on experience, typing levels of around 20 to 30 words a minute would probably be sufficient to enable the students to communicate with the computer in a manner such that their creative flow is not interrupted.

Figure 5. Questions about Communicating
1) Do you change your story on a computer more often than when writing?
   Yes 48%
   No 48%
   No answer 4%
2) Why do you change your story more often on a computer versus a pen and paper?
   Computer is easier 56%
   Not applicable 12%
   Applicable to reverse question 12%
   No answer 12%
   Does not know 4%
   Teachers forces student to change with the computer 4%
3) Do you put all your ideas into one your story, or do you sometimes leave them out?
   All in 32%
   Leave out 68%
   3a) Why/ why not?
   Would not make sense to leave all in 32%
   Miscellaneous answers 28%
   Does not sound right 16%
   Does not know 16%
4) Do you like what you have written when you done?
   Yes 80%
   Depends 20%
   4a) Why/why not?
   Just likes it without reason 72%
   It is finished 8%
   Does not know 8%
   An accomplishment 8%
   Likes writing 4%
5) Do you feel you get more done working on the computer?
   More 68%
   Less 32%
   5a) Why/why not?
   Faster at handwriting 20%
   Computer errors are too frequent 20%
   Computer is faster 16%
The computer is less tiring 12%
It just seems like the computer is faster 12%
Does not know 8%
Easy to read from computer screen 8%
Easier to correct mistakes 4%

6) Do you make more mistakes on the computer than doing things by hand?
Yes 36%
No 52%
Depends on what is being done 12%

5. Discussion and Future Avenues

The events that are happening in Marigold school appear to harbour great promise for future students and educators. The diversity of activities that are found in a computer-classroom environment make it impossible for the teacher to be aware of what all the students are doing in their individual computer based efforts; which suggests that individual curricula may be the next logical step in the computer-classroom evolution. Such a direction may be desirable when one considers some of the metacognitive advantages that are associated with a computer-classroom.

The computers’ power, of freeing the students from the relatively labour intensive editing processes of using a pen and paper, greatly enhances the writing process. Students develop a greater sense of freedom to change their original stories, which encourages them to spend more time concentrating on higher level thought processes.

It is important to note that the level of activity found in the classroom would most likely diminish significantly if all schools had the equipment that is available at Marigold. The number of researchers and computer hackers and other interested people would drop off, which may have an impact on the level of the students’ enthusiasm for their projects. The true impact of the novelty of the computer center can only be determined over time. It is quite conceivable that after a few years of computer use, interest could wane and the computer would become just another tool. Much of the students’ enthusiasm for the computer is based on the perception that they are working on their own projects, thus it seems reasonable to suggest that in order to maintain the students’ level of interest flexibility of computer use will have to be maintained.

As students become more computer literate and start delving into some of the more powerful potentials of computers such as accessing databases, classrooms may be transferred into a highly stimulating, interactive and information rich environment. Based on the experiences in Marigold Elementary School, the development of such a classroom environment would be dependent on several steps. Three key steps would be: a) to promote the concept of having teachers act as facilitators rather than front of the room presentators; b) to provide students with access to a greater variety of equipment such as modems and databases, and c) to alter the current perception of the need for a common curriculum and a common system of evaluation.

6. References


5.3 Fourth International Conference, "Children in the Information Age"

5.3.9 Study on Development of Programming Ability and Cognitive Skills of Junior High School Students

By Hong Liu, Qi Chen, China

1. Abstract

This paper investigated the relationships between learning Logo programming course and developing cognitive skills in junior high school. Our study focused on two issues as follows:

1. Whether students need some cognitive prerequisites for learning Logo programming?
2. Can learning Logo programming instruction enhance students' cognitive skills?

It is concluded that Logo programming instruction has a positive influence on developing students' cognitive skills and higher-order thinking skills. However, how teachers make good use of the Logo to provide more effective instructional environment and direct teaching guidance for transfer should be further studied.

2. Introduction

Programming is a very complicated skill involving some important higher cognitive abilities, specially, planning, debugging and reasoning. Psychologists, computer programming can be a powerful vehicle of enhancing thinking and the development of good problem-solving skills in children in addition to being a powerful method for teaching students fundamental concepts in mathematics, physics, and logistics. Preliminary studies have offered confused results.

One area where transfer has been extensively is in response to learning Logo. Seymour Papert [1], one of the creators of the computer language Logo and a leading exponent of the use of computer programming to expand children's intellectual power, based his ideas on the theories of Piaget. He offered case studies and claimed that Logo was a well-designed symbol system for programming as an environment in which children could explore through discovery learning and develop problem-solving skills that would spontaneously transfer beyond the practices of programming. Similarly, one study was done by Seidman in which he studied the effects of learning the Logo programming language on the logical reasoning abilities of fifth graders [5].

He found a significant relationship between learning Logo's IF-THEN construct and the use of conditions in formal logic tasks. On the other hand, a number of studies indicate that students who learn Logo fail to generalize this learning to other task. Pes and Kurland failed to find, even after two years of instruction, there were no significant differences between the experimental and control groups for any specific complex cognitive skills [3,4,5]. Students had difficulty with exhaustive and accurate procedural reasoning, understanding special programming construct such as recursive routines and variables and programming skills. He pointed out that Trial-and-error generation of screen effects neither engaged high level thinking skills nor supported increased mastery of the language. Therefore, we need to rethink the critical aim of computer programming instruction and to develop more effective instructional designs, more explicit instructional guidance and more time for transfer.

Preliminary studies involving Basic have also yielded mixed results. Marcia C. Linn described an ideal chain of cognitive accomplishment from programming [6,7]. The chain has three main links: (b) single language features, (b) design skills; and (C) general problem-solving skills. Design skills including templates and procedural skills which are the group of techniques used to combine language features to form a program that solves new problems. Such skills are essential in order for students to write computer programs of any complexity. The third link on the chain consists of problem-solving skills useful for learning new formal systems. Students need experience with language features and design skills before they acquire general problem-solving skills. Programming is a very demanding task which requires certain kinds of high-order cognitive skills (including formal reasoning skills and planning skills) and develops new conceptual mental models. Instruction strongly influences outcomes from programming classes. Linn demonstrated that it was necessary to consider how to provide, styles of instruction which are appropriate for a wide variety of learners.

Does learning a programming language need some cognitive skills or can enhance some cognitive skills in domains beyond programming in order to more closely examine the effects of novices' initial learning of Logo on their cognitive skills, we conducted a study using 33 computer-naive junior high school students who took a 3-hour course in Logo. Our aim in designing the Logo curriculum was to help students develop a richer mental model of Logo and foster some cognitive skills such as spatial skills and planning skills. Thus, programming instruction was carefully designed in order to insure that students understand the importance of planning and have the opportunity to practice it.

Our study focused on two issues as follows:

1. Whether students need some cognitive prerequisites for learning Logo programming?
2. Can Logo programming instruction enhance students' some cognitive skills such as planning and spatial skills?

3. Method

The subjects were 66 (11-13 years of age) students from a junior high school in Beijing, China. None of them had any previous programming experience.

4. Apparatus

The apparatus consisted of 94 Apple IIe computer systems, with each system including 64K memory and a single disk drive. Students worked in groups of two persons and each group with a microcomputer.

5. Instructional Methods

Logo was selected for two reasons. Firstly, "Turtle Geometry" is a very charming natural programming language for children. Children draw by directing the movements of a Graphic "turtle". A small triangular pointer that can move around the display screen, will leave traces of its path on the computer screen in response to the messages sent by the programmer. Children can understand the social relationships within the commands by playing "turtle" and discover their own mistakes by observing the movements of turtle and then correct them instantly. What children learn from correcting their own mistakes is an important part or learning. Secondly, Logo is a computer language designed to be accessible to children. It is developmentally appropriate for young children and is interactive. According to the theories of Piaget [8], all the children pass through four stages of cognitive development, and the children at the concrete operational stage will be concerned with the aspects of a given situation. During this period children grow in their abilities to perform mental operations and to understand spatial and numerical relationships.

6. Instruments

A brief review of the tasks is provided below.

Pretests — the pretests were divided into three types as follows:

1. Raven's Standard Progressive Matrices (SPM) (J.C. Raven, 1938), as a measure of general intellectual ability.
2. Spatial Test, as a measure of spatial skill.
3. Math Test, as designed to evaluate one's mathematical achievement.

Post-tests — the battery of post-test is included as follows:

1. Duplicate Figure Test and Spatial Test, as a measure to determine one's spatial skills.
2. Map Test. Several analyzes of the cognitive components of programming isolate planning as a central activity, so we chose Map Test as a measure of planning skill.
3. Math Test, as a measure of one's mathematical achievement.
4. Logo Test, as a measure of programming skill.

7. Procedure

All groups of students receive all the pre- and post-tests measures with the exception of the measures of programming. The Logo Test was only administered to the experimental group.

8. Results

The means and standard deviations for all the pretests' scores are shown in Table 1. There are no significant differences between groups on any of the measures of pretests and so we can compare groups directly on the post-tests.

9. Post-test Results

Table 2 shows that there are significant differences between groups on all of the measures of post-tests. As indicated, the Logo group gain a significantly more than the comparison group on the two specific component cognitive skills: spatial skill (as measured by Spatial Test and Figure Test) and Planning skills (as measured by Map Test). For example, Spatial Test, t(64) = 3.247, P < 0.01; Figure Test, t(64) = 7.25, P < 0.01; Map Test, t(64) = 9.33, P < 0.001. The results encourage the idea that learning Logo programming language may result in changes in some cognitive skills.
Table 1.
Performance on Pretest

<table>
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<th></th>
<th>Mean</th>
<th>SD</th>
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<tr>
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<td>CG (N=33)</td>
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<td>3.92</td>
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<td>CG</td>
<td>8.03</td>
<td>3.82</td>
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<tr>
<td>CG</td>
<td>65.45</td>
<td>14.92</td>
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EG -- Experimental group
CG -- Control Group

Table 2.
Performance on Post-test

<table>
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<td>7.25***</td>
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<tr>
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<td>3.247**</td>
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<tr>
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<td>01.77*</td>
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<tr>
<td>CG</td>
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* P<0.05  ** P<0.01  *** P<0.001
Table 3.
Correlations of Performance on Logo Test with Performance on Pre- and Post-tests
(Experimental Group) (N=33)

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<th>Logo scores</th>
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<td>0.59**</td>
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</table>

<table>
<thead>
<tr>
<th>Post-tests</th>
<th>Logo scores</th>
</tr>
</thead>
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<td>Figure</td>
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</tr>
<tr>
<td>Map</td>
<td>0.48**</td>
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<tr>
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<tr>
<td>Math</td>
<td>0.44**</td>
</tr>
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</table>

* P<0.05  ** P<0.01

On the other hand, the Logo group did not show significantly more statistical gains than the comparison group on the Math Test. On the contrary, the control group did a little bit better than the Logo group on the Math Test, t(64) = -1.77, P<0.05. One important reason may be that the conditions between the groups were not equally matched. For example, the mathematics teacher of the experimental groups were not equally matched.

was much less proficient on teaching and management that the other one on the control group. Therefore, further investigation should be conducted in schools in order to meet exactly the equal conditions for two groups.

10. Correlation of Pre- and Post-tests with Logo Programming Test

Table 3 summarizes the correlations between Logo Programming Test and Pre- and Post-tests. The figure that emerges from this work is that success in learning a language such as Logo may depend on such specific cognitive skills as spatial skill and mathematical skill. It is significant that the most highly predictive cognitive skills are logically related to Logo programming. Similarly, Webb [9] found that the best predictor of success in learning Logo was spatial ability. Unexpected, success in learning Logo was not related to general intellectual ability. A recent study by Coombs, Gibson and Alty was reported that learning styles is a more significant factor than general intellectual ability in determine how much students will benefit from programming instruction [10]. These styles may not reflect differences in general ability but, rather, differences in response to instruction. One striking finding for teaching is that alternate models for instruction should be available for student with different learning styles.

11. Discussion

The study investigated the effects of computer programming inn Logo on children's cognitive skills (spatial skills, planning skills and arithmetical skills). The main results may be summarized as follows.

1. After 30-hour long Logo programming instruction, students develop their planning skills and spatial skills in some degree.

The Logo programming group significantly outperformed the control group on Figure Test, Spatial Test, and MapTest. These results encourage the idea that learning Logo programming can have positive effects on spatial skills and planning skills that are directly related to Logo. Two reasons may account for these results.

Firstly, programming is primarily a planning task and thus demands that people develop new conceptual models and organize their cognitive activities much more carefully and systematically than in other domains. Logo is procedural-problems which can be divided into small pieces which Papert calls "mind-size bites", and a separate procedure written for each piece. In this way, children can divide and conquer problems as they begin to see, if a concrete fashion, how tasks can be broken down into procedures, how procedures can be combined to form superprocedures, and how procedures interact. They usually need a plan for combining language features and templates to solve a programming problem.
5.3.9 Study on Development of Programming Ability

By Hong Liu, Qi Chen, China

Secondly, since Logo programming involves giving explicit spatial commands. It is reasonable that spatial skill was the most important skill for knowledge of basic Logo commands and generating graphics problems because both components involve the placement and the movement of the Logo turtle on the screen. Based on this explanation, we would also expect spatial skill to play a large part in interpreting graphics problems.

2. Learning Logo programming course needs spatial skills and mathematics achievements as cognitive prerequisites for students in junior high school.

Although measures of spatial skills and mathematics achievements are positively related to Logo programming, it is clear that cognitive requirements depend on the type and purpose of the instruction. Logical relations programming seems to require mathematics ability, whereas graphical programming seems to depend on spatial ability. Performance on one kind of ability measure (e.g. mathematics) is not enough to predict learning of all aspects of computer programming.

In summary, the present study shows that learning Logo programming can successfully enhance students' spatial skills and planning skills. Since our study focused only on 30-hour long instruction, further research is needed to determine whether the results will generalize to long term instruction and to more representative student population.

12. Conclusion

The most central finding of this study is that instruction strongly influences outcomes in Logo introductory programming class. The results show that:

1. Learning Logo programming course needs spatial skills as cognitive prerequisites for students in junior high school.
2. After 30-hour long Logo programming instruction students develop spatial skills and planning skills in some degree.

Besides, how teachers make good use of the potential advantages of Logo to provide more effective instructional environment and direct teaching guidance for transfer should be further studied.

13. References

5.3 Fourth International Conference, "Children in the Information Age"

5.3.10 Computer-related Attitudes of Primary School Students in Japan and the U.S.A.: First Year Longitudinal Results
By G. Knezek, Texas, K. Miyashita, Japan.

1. Abstract

This paper reports on an exploratory cross-cultural study of the attitudes of first and second grade students toward the use of microcomputers in instruction. Questionnaire responses were compared among three groups: Japanese students in Tokyo, Japan; American students in Sanger, Texas; and Japanese students attending a special school for Japanese dependents in Dallas, Texas. Attitudinal differences among the three groups were explored using factor analysis, analysis of variance and discriminant analysis. Identifiable differences were found in the areas of Attitudes Toward Computers, Study Habits and Empathy. No significant differences were found in the areas of Motivation or Creativity.

2. Introduction

Computers can now be found in the United States in virtually every school, at all levels of K-12 education (QED, 1989). The use of microcomputers is widely endorsed beginning as early as the first grade (Bruder, 1990). In Japan, however, the situation has been quite different. There has been very little public school utilization of microcomputers with elementary school students in Japan throughout the 1980s (Knezek, Miyashita, & Sakamoto, 1990).

National educational reform documents in Japan provide a partial rationale for Japan’s contemplative approach to the introduction of microcomputers into elementary school education (Ministry of Education, 1986, 1987a, 1987b). These documents have urged increased awareness of the potential "dark side" of information technology—such as possible loss of touch with reality, decreased socialization skills, and reduced creative thinking abilities—while Japan concurrently proceeds with what is termed the “informationalization” (preparation for the information age; Sakamoto & Nishinosono, 1990) of its society.

This "informationalization" of Japanese society can be expected to rapidly accelerate with the massive infusion of computing technology into the Japanese educational system beginning in 1992 (Sakamoto & Nishinosono, 1990). Such a nationwide, large scale change provides an opportunity to study the good and bad effects of introducing this technology, especially by contrasting any measured changes in Japan with the time-synchronized changes in a country like the United States, where the large scale introduction of instructional information technology is already well underway.

3. The Study

This study is intended as a first step in planned longitudinal cross-cultural research on the long term effects of information technology on society. The attitudinal values reported here are intended to serve as a baseline for data gathered in Japan and the U.S. in future years.

3.1 YCCI Development

The Young Children’s Computer Inventory was used to gather data for the study. This instrument was derived from a questionnaire originally developed by Dr. Takashi Sakamoto of the Tokyo Institute of Technology for use in a recent UNESCO study (the ITEC Project) at the fourth grade level (Sakamoto, personal communication, 1990). Sakamoto’s questionnaire consisted of 155 items on the following five subscales: Attitudes Toward Computers, Psychological Effects of Computers, Creativity, Motivation to Study, and Empathy. The subscales of Creativity and Motivation to Study were previously used in a 1985 international comparison of the student study skills (Sakamoto, 1985a, 1985b).

The YCCI was produced for the target audience of first graders by removing the subscale Psychological Effects of Computers and reducing the number the number of items on each of the remaining four subscales to 10 and 15 items for the U.S. and Japanese versions, respectively. Several of the items retained were also reworded to make them more understandable for first graders. Finally, the number of Likert-type choice categories was a reduced from the original five to the three-point scale of "No" (disagree), "I don't know" (Undecided), and "Yes" (agree). Only the ten items from each subscale which were used at all three sites were employed for the current research.

3.2 Administration

A 40 item English-language version of the YCCI was administered to 112 first grade students at the Chisholm Trail Elementary School in the northern Texas community of Sanger during May, 1990. 52% of the students were male, and 9% were members of an ethnic minority (Hispanic or Black). All students had received two, 50-minute periods of computer laboratory instruction per week throughout the academic year.
Each of six first grade teachers read the questions with their classes and aided students with brief interpretations of questions, as necessary. This procedure required 20-40 minutes per class. The completion rate was 100%.

A 60 item Japanese-language version of the YCCI was administered to 99 first and second grade students in the Todoroki Elementary School, Tokyo, Japan, during September 1990. 56% of the students were male, and fewer than 1% were members of an ethnic minority. As was typical for Japanese public schools at this level throughout the 1980s (Knezek, Miyashita & Sakamoto, 1990), none of the students had received hands-on computer laboratory instruction during the academic year. Children were asked to answer each item with their parents at home, then return the completed instrument to their teachers at school. This procedure required approximately 20 minutes for each student. The return rate was 100%.

Approximately one week after the Tokyo administration, the same 60 item version of the YCCI was administered to all 60 first grade and second grade students attending the (Saturday only) Japanese Advanced School in Dallas for the dependants living abroad. (These Japanese students attend normal U.S. schools Monday-Friday, with varying amounts of exposure to computers at school.) 50% of the students were male, and approximately 3% were of mixed racial ancestry. As with the Tokyo site, students in Dallas were asked to answer each item with their parents at home, then return the completed instrument to their teacher at school. 51 of the 60 students (85%) completed and returned the questionnaire.

3.3 Data Analysis

Three methods of factor analysis (Unweighed Least Squares, Generalized Least Squares, Maximum Likelihood; Norusis, 1985) and two methods of factor rotation (Varimax, Oblimin) were performed on the combined 262-subject data set to confirm the existence of the hypothesized subscales in the questionnaire. Next, one-way analyses of variance were performed on the subjects' factor scores (constructed responses to hypothesized items representing each factor) to determine if students at the Tokyo, Dallas and Sanger sites differed in their attitudes.

Factor scores (ULS, Varimax) for the three least correlated subscales of the Attitudes Toward Computers, Creativity and Empathy were also entered into the program MacSpin (Donoho, Kerrick & Olson, 1990) to enable rotation in simulated three-dimensional space.

In addition, a discriminant function analysis (Norusis, 1985) was performed on the combined 262-subject data set to determine if differences in responses on the 40 questionnaire items could successfully predict whether the responses were American (Sanger site), Japanese living in America (Dallas site), or Japanese living in Japan (Tokyo site).

4. Results

4.1 General Trends in Data

Table 1 contains means and standard deviations for each of the three sites on the 40 questionnaire items. Responses were coded as 1 = disagree, 2 = undecided, and 3 = agree. In general, responses were quite high, with item averages ranging from 1.98 to 2.89 at the Sanger site, from 1.59 to 2.94 at the Dallas site, and 1.32 to 2.95 at the Tokyo site. Response averages across all items were 2.60 for Sanger, 2.46 for Dallas, and 2.35 for Tokyo. Item 23 (I feel happy to see a friend smiling; overall mean = 2.82), item 24 (I feel sad to see an animal wounded; mean = 2.86), and item 37 (I invent games and play them with friends; reflected mean = 2.86) were rated relatively high by students at all three sites. Item 5 (I would like to study from teachers rather than from computers; reflected mean = 1.78) was rated relatively low at all three sites, indicating students tend to prefer human teachers over computers.

4.2 Factor Analysis

A scree plot of the factor analysis eigenvalues (plot of variance explained by each factor, Dunn-Rankin, 1983) indicated that five factors probably exist in the data. Therefore, the researchers ran a five-factor solution (Generalized Least Squares, Oblimin rotation), which indicated that the subscale Motivation to Study is actually a composite of Study Habits (items 12, 13, 14, 16, 17) and a kind of Motivation related to persistence or "drive" (items 15, 18, 19, 20). Study Habits and Motivation/Persistence/Drive are correlated with each other (r = .14), but each is correlated even more strongly with Attitudes Toward Computers (r = .26 and .19, respectively) and Creativity (r = .18 and .22). Surprisingly, item 4 (I think computers are very easy to use) is also strongly correlated (r = .57) with good study habits. These and other results are presented in Table 2.

4.3 Factor Score ANOVAs

As can be seen in Table 3, factor score differences were highly significant for Attitudes Toward Computers, Study Habits, and Empathy. Texas students (Sanger site) were more positive than Tokyo students in their Attitudes Toward Computers and their Study Habits, but scored lower on Empathy than their Tokyo counterparts. No significant differences were found in the areas of Motivation/Persistence or Creativity.
Table 1. Descriptive Statistics

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean Sanger, Texas</th>
<th>SD</th>
<th>Mean Dallas/Japanese School</th>
<th>SD</th>
<th>Mean Tokyo, Japan</th>
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* Scores for these negatively-worded items have been reversed.

Table 2. Factor Analysis Results

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5.3 - 54
B. Factor Loadings (Pattern Matrix)

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C. Factor Correlations

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Table 3. Analysis of Variance (Factor Scores)

A. Attitudes Towards Computer

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5.3 Fourth International Conference, "Children in the Information Age"

B. Motivation/Persistence

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4.4 Factor Score Graphical Displays

Results of exploring graphical representations of the factor analysis through the MacSpin (Donoho, Kerrick, & Olson, 1990) simulated three-dimensional display program were also examined. The subscales of Attitudes Toward Computers, Creativity, and Empathy were used as X, Y, and Z axes for plotting subjects in three-dimensional space. A one-third (approximate) sample rate was chosen for each group to make the output more legible when printed.

The examination shows that Tokyo and Texas students are reasonably well separated along the dimensions of 1) Attitudes Toward Computers and 3) Empathy, but not with respect to 2) Creativity.

The Japanese students living in Dallas are more widely dispersed in this three-dimensional space, with several lying in the same "neighbourhood" as Tokyo students, and some quite similar to Sanger (Texas) students. Nevertheless, it is possible to graph the three-dimensional centroid of the Japanese students living in Dallas, and to see that (as a group) they lie between Tokyo students and traditional Texas students.

4.5 Discriminant Analysis

Results of the discriminant function analysis are shown in Table 4. 19 of the 40 items were selected in a stepwise procedure. A two-function solution correctly classified 91% of the Sanger students, 86% of the Tokyo students, and 42% of the Dallas students.

Table 4. Discriminant Analysis Results

A. Classification Results

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<th>No. Case</th>
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<th>Membership</th>
<th>Predicted Group</th>
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5.3 - 56
5.3.10 Computer-related Attitudes of Primary School Students

B. Summary

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C. Canonical Discriminant Function

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<td>14.02</td>
<td>0.49</td>
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D. Standardized Canonical Discriminant Function Coefficients

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<th>Item</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
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<td>-.22</td>
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<td>Item 2</td>
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<td>Item 5</td>
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<td>Item 12</td>
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<td>Item 14</td>
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<td>Item 15</td>
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<td>Item 37</td>
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6. Discussion

Further analysis of individual items from significantly different subscales pinpointed additional differences between sites. The following observations are based upon one-way analysis of variance tests for individual items, using Scheffe's multiple range test with alpha set at .01:

1. Sanger students think computers are easy to use, relative to Dallas and Tokyo students (item 4, f=42.5). Hypothesized reason: Greater use increases perception of ease to use.
2. Sanger students more strongly agree that computers provide opportunities to learn new things (item 8, $f=21.6$). Hypothesized reason: Longer exposure increases awareness of educational possibilities.

3. Sanger and Dallas-based students enjoy lessons on the computer more than Tokyo students (item 2, $f=21.4$). Hypothesized reason: Students who use computers in school have greater opportunities to enjoy computer-based lessons.

4. Sanger students, compared to Tokyo students, believe they will enjoy school more if teachers use computers (item 9, $f=10.6$). Hypothesized reason: Any positive educational experience can be amplified by teachers.

5. Sanger students believe more strongly than Tokyo students that it is more important to learn how to use a computer (item 6, $f=10.0$). Hypothesized reason: U.S. cultural characteristic.

6. Sanger students believe more strongly that they will get a good job if they learn how to use a computer (item 7, $f=5.2$). Hypothesized reason: U.S. cultural characteristic.

7. Dallas-based Japanese students do not tend to review their lessons each day (item 12, $f=43.8$). Hypothesized reason: Dallas students receive weekly Japanese instruction, rather than daily.

8. Tokyo students do not like to ask the teacher questions (item 14, $f=18.8$). Hypothesized reason: Japanese cultural characteristic.

9. Sanger students study without anyone forcing them (item 17, $f=18.3$). Hypothesized reason: U.S. cultural characteristic stressing individuality.

10. Sanger students try to finish whatever they begin (item 16, $f=12.7$). Hypothesized reason: Sanger school stresses task completion.

11. Sanger students, more than Tokyo students, like to work out applied problems (item 13, $f=10.5$). Hypothesized reason: U.S. emphasizes problem-solving skills in education.

12. Tokyo students more strongly empathize with children lacking friends than do Sanger students (item 25, $f=9.1$). Hypothesized reason: Japanese culture stresses value of friends.

13. Sanger students tend to think about alternative ways of solving a problem more so than do Tokyo students (item 34, $f=6.5$). Hypothesized reason: U.S. emphasizes problem-solving skills in education.

14. Tokyo students tend to invent games to play with their friends (item 37, $f=5.4$). Hypothesized reason: Japanese culture encourages group play.

15. Sanger students, more than Tokyo students, tend to find new things to play with or study about on their own (item 33, $f=5.6$). Hypothesized reason: U.S. culture stresses individuality.

An explanation of the general trends among these items is also in order. Sanger students obtained the highest mean score for each item selected in the area of Attitudes Towards Computers. Every mean score for Dallas students fell between Sanger and Tokyo student means. Therefore, the general hypotheses for this area is that children experienced with computers have more positive attitudes towards computers than do children who have had few or no experiences with them. Moreover, children who have had some computer experience at school have had increased opportunities to feel that computer experiences are enjoyable.

In some cases, the mean scores for Dallas students were similar to the means for Tokyo students. For example, neither Tokyo nor Dallas students felt strongly that computers were an important tool for learning or helping them to obtain solid careers in the future. This can be explained in two possible ways: (1) Because Japanese children had few or no experience compared to Texas students, they learned relatively few things on a computer, or (2) Because Japanese people tend to think that entering a good university is most important for getting a good job, and because knowledge of computer use is not directly related to their future careers.

Three subscales, Study Habits, Empathy, and Creativity, seem to be highly related to cultural differences, as evidenced by the fact that most of the mean scores obtained by Dallas students and Tokyo students were similar, compared to the mean scores obtained by Sanger students. For example, Sanger students study independently and prefer problem solving tasks. On the other hand, Both Dallas and Tokyo students are more often encouraged to study by others. The same situation exists in other areas, such as play. Sanger students tend to play without any help, whereas Tokyo students tend to cooperate with their friends. Both Dallas and Tokyo students value friends more strongly than Sanger students.
5.3.10 Computer-related Attitudes of Primary School Students

G. Knezek, Texas, K. Miyashita, Japan

7. Summary

262 first and second grade students from Sanger, Texas, Tokyo, Japan and a Saturday-only Japanese school in Dallas completed the Young Children’s Inventory between May and September, 1990. An analysis of variance of the factor scores for this area determined Sanger students to be more positive than Tokyo students in Attitudes Towards Computers, less positive than Tokyo students in Empathy, and more positive than Tokyo students with respect to Study Habits. No significant differences were found in the areas of Motivation or Creativity. A discriminant function analysis was able to identify survey respondents, by site, with the following accuracy: 1) Sanger = 91% correct, 2) Dallas = 42% correct, and 3) Tokyo = 86% correct. Graphical and tabular representations of the data confirmed that Dallas-based Japanese students typically lie between Tokyo students and traditional Texas students on the attributes measured.

8. References


"Computer Corners" as a stimulus for students' activity at mathematics classes.

By B. Lazarov, M. Bekyarova, Bulgaria

1. Introduction

In this paper, like those of [1] K. Bankov, and [2] E. Sendova, we try to answer the question: "How to teach maths in school?" In each of these papers the answer is researched by means of the project "Learning and doing mathematics".

We will mention the basic idea on which has grounded the formation of this project:

- every student is able to use maths, moreover, every student can love maths and the mathematical way of thinking;
- maths ought to cultivate a special style of thinking developing the skills of classifications, of doing parents, of finding the connections between different kind of things, the art to make decisions.

Realizing this strategy the authors of the project keep in mind that maths is not learned by itself. They keep the living bond between the other subjects and the math wherever it is possible. The everyday problems are included especially wide as math situations.

By the way, some of these situations have lost their actuality. Lately life has left behind a great deal of the problems we had only two years ago. This makes the conclusion: a teaching experience is easier done in a quiet life!

Our theme: to reach the above strategical purpose the authors of the project have used different tactics.

First: We have made a math textbook which is separated in several booklets. Everyone of the booklets cover a topic of the curriculum (At this moment the booklets for the 5th grade are published, these for 6th grade are in manuscripts).

Second: the form of giving the matter is relieved by: funny pictures, illustrations, diagrams, games. In some problems different manipulatives as: domino, chess, calculators, colour pencils are used.

Here we will consider the use of computer as a tool in the project "Learning and Doing Mathematics". The idea to introduce computers in math lessons is not new. Both problems and lessons in which the central place is taken by the computer are an usual unit in the secondary school course (8th - 10th grades). However, we do not know any kind of practice related to the use of computer in maths lessons in 5th - 7th grade curriculum. That's why we will consider briefly the ideas we put in the ground of our work.

2. Computer Corner

We call Computer Corner (briefly CC) this part of the lesson where the solving of problems is recommended to be done by the computer. Some more details:

1. CC is a part of maths lesson;
2. CC is not a separate unit;
3. CC is not a key unit of the lesson, i.e. one can miss the CC without any consequences on the following;
4. The problems in the CC might be solved without a computer;
5. There is at most one CC in one math lesson (this does not mean that there is only one problem in the lesson solved with the help of a computer).

These necessary conditions lay the groundwork of our work over the CC. Let us give some motivations:

- we would not double the informatics lessons. That is why the part of the computer is reduced to a second-hand tool.
- being an expensive thing, the computer is not so widely available at our schools. So if there are not enough computers in the school it is better to miss the CC.
- it is a good characteristic for the pupil if he can deal with any kind of problems using things at hand. If the pupil has a computer, let he use it, else let he do what he can.

If we think for the points 1 - 5 as somewhat negative boundaries let us tell something about the positive boundaries:
3. Problems

What kind of problems are included as CC in view of communication pupil—computer? For example, it can be:

- problems for writing procedures, connected with a single question, which is discussed during the lesson. The pupils are allowed to use only the programming language Logo;
- problems for creating procedures, using already done block structures (procedures);
- problems that use a ready made program (software).

What is the desired aim as a result of using the computer, i.e. what thing is the communication computer — pupil about?

- to build up an illustration more flexible than a picture;
- practical effect—an answer of a standing problem;
- demonstration of a phenomena.

In the experimental schools of the RGE, Logo is studied one or two hours per week from the 5th grade. Logo used as a tool in mathematics gives the students the opportunity to explore a rich variety of mathematical topics, including geometry, probability, arithmetics. The possibilities to use Logo in mathematics increase in the 7th grade when the students know almost all the Logo commands and operations.

In the experimental schools Logo is studied in Informatics, in Mathematics we only use it. Here are some examples for CC in the 5th and the 6th grade booklets, that have been experimented with in two schools in Sofia (2nd and 119th schools) the last 2 years.

3.1 Example 1.

The students can define themselves a procedure that fills a given percent of a circle. Here is a student's solution:

```
To fill :percent
draw hideturtle
penup left 90 forward 50 right 90 pendown
repeat 36 (right 5 forward 2*3. 14*50/36 right 90)
penuo right 90 forward 50 left 90 pendown
repeat :percent (forward 50 back 50 right 360/100)
End
```

This procedure gives the students the opportunity to understand clearer what part of the whole is the given percent. There are examples with 25%, 50%, 30% in the booklet. The students can get the wrong impression that there are not 37% or 53% for example.

After running the procedure with different inputs, the teacher can help the students to find out if it is correct, for instance, for 1% - the students will understand that we need two turtle moves for this.

The students have to edit the procedure. For the students good in mathematics and informatics the teacher can propose to fill the circle more closely.

This was the first CC, included in the first booklet. As the students begin to learn Logo in the 5th grade, and Logo begins with the commands for drawing with the turtle, we had to use only those commands. Despite of the minimal set of Logo commands, the computer has been used. There are problems for filling a given percent of squares and rectangles in the booklets.
3.2 Example 2.

This example is intended to make a graphic illustration of the greatest common divisor of two integers. It is interesting, but the students cannot define the procedures themselves, as they need more Logo skills. That's why the program is recorded on every diskette.

This program saves much work to the teacher. And further - if the teacher tries to make the same thing on the blackboard, the effect will not be the same - the teacher will work slower, and despite of this - he can make a wrong diagram. Here the procedures that the students can load from the diskette:

To start :A :B
    draw .aspect 1
    penup sixty -135 (-50) pendown
    problem :A :B
End

To problem :A :B
    rectangle :A :B
    squares :B
    problem :B :A
End

To rectangle :A :B  (A > B)
    remember "X1 "Y1
    forward :B right 90
    forward :A right 90
    forward :B right 90
    remember "X2 "Y2
    forward :A right 90
End

To remember :X :Y
    make :X Xcor
    make :Y Ycor
End

To squares :B
    if equal? :A :B then square :A toplevel
    if :A<:B then sixty :X2 :Y2 weth towards :X1 :Y1 stop
    square :B
    remember "X1 "Y1
    make "A distance :X1 :Y1 :X2 :Y2
    squares :B
End

To equal? :A :B
    output (abs :A-:B) < 0.001
End

To square :A
    repeat 3 (forward :A right 90)
    right 90
End

To distance :X1 :Y1 :X2 :Y2
    output SQRT (:X1-:X2)*(:X1-:X2) + (:Y1-:Y2)*(:Y1-:Y2)
End

To abs :number
    if :number <0 then output -:number
    output :number
End

The students can run this program with different inputs. It will be better if the teacher gives them some "good" inputs. For example, with the instruction

start 250 110

the students can see that the GCD of 250 and 110 is the biggest square that can cover the rectangle (See Figure 1):
3.3 Example 3.

When the students study Euclidian algorithm for calculating the greatest common divisor of 2 integers, they can write Logo procedures for the same thing:

```
To GCD :A :B
  if remainder :A :B = 0 then output :B
  output GCD :B remainder :A :B
End
```

They can make this procedure in informatics class too, but to comment on it in mathematics. So the students look at the algorithm from another point of view and they can understand it better. There are some other procedures connected with this topic - least common multiple of 2 integers, GCD and LCM of 3 or more integers. There are many mathematics problems to solve with them too. The students can try to write a procedure for GCD with other algorithm also with subtraction, for example.

3.4 Example 4.

This is the example that we like very much. It shows a CC using ready made Logo procedure for solving mathematics problems. We have seen it made with Basic, but we like more the Logo program. This is the simulation program of the well-known game of "the frog and the lizard"

This is a maths game, we can play without a computer, but only with a dice. If the dice shows 3, the frog wins. If the number of the dice is not 3, the lizard receives a point (makes a jump). If in 6 tries the dice does not show 3, the lizard has 6 points (it has made 6 jumps) and it is the winner - it eats the frog.

Can you predict who is more likely to win - the frog or the lizard? This is an interesting question for the students too. They can play 10 games with dice and see what happens. How the computer can help us (or the students)?

One of its advantages is that we can play a game faster than with a dice. If we want to play more games the computer will count for us how many times the lizard wins and how many times the frog does.

The students with Logo skills they have, can write an operation, playing the role of a "dice" -it gives as a result a random number between 1 and 6:

```
To dice
  output 1 + random 6
End
```

It is not difficult for students to write the next procedures too. But this is a problem for the informatics class, in maths class they can load and use the procedures for solving maths problems. The program below is a simple simulation, giving the students the opportunity to predict the results of a large number of games and to change the rules in order to see what will happen. Here are the procedures:
5.3 Fourth International Conference, "Children in the Information Age"

To start :N
   make "lizard.wins 0
   make frog.wins 0
End

To games :n
   repeat :N (make "lizard.points 0 lizard.and.frog)
   (print (frog wins) :frog.wins) (print (lizard wins) :lizard'wins)
End

To lizard.and.frog
   make "number dice
   if :number = 3 then make "frog.wins :frog.wins + 1
   stop else make "lizard.points :lizard.points + 1
   if :lizard.points = 6 then make "lizard.wins
   :lizard.wins + 1 stop else lizard.and.frog
End

The procedure start gives some initial data. The procedure games has a parameter for the number of games we want to play. The procedure lizard.and.frog counts how many times the lizard wins and how many times the frog wins, after this it prints the results on the screen. If we use another version of Logo (for example Logo Writer) the game can be made with some kind of animation - for representing the lizard and the frog we can use different shapes of the turtles. We have tried to make this with 6th grade students (in informatics classes) and it was fun.

Here are some maths problems for the students. They can solve them with the help of the program. The students run the procedure 20, 100, 1000 times and to see who wins more often. After that they can make decimal fraction:

$$D = \frac{\text{lizard.wins}}{\text{number of games}}$$

They can try to find out how the value changes with increasing the number of games. Some of the students can edit the procedure lizard.and.frog - to print out the searching decimal fractions.

If the students work on 10 computers and they have played 1000 games on everyone, they can count the lizard wins and the frog wins for 10000 games played. The probability of the lizard winning is equal to the 6th degree of the decimal fraction 5/6, i.e. 0.333. We approach this value, when the number of games increases.

Let's suppose that the lizard wins when it has 4 points. Who is most likely to win now?

The students can edit the program lizard.and.frog to see if they are right.

The teacher can offer the students to try to think out their own games changing the rules, to make a Logo simulation of their own games and to see the chances for the lizard to be the winner. They can make a game with 3 animals, or something else. This is only a challenge for the best students because they cannot make their own games in this class - they have not enough time. But they can solve the problem in the informatics class because they will have much more time (the students in the experimental schools have informatics classes twice a week).

The students could think and try to find many other things - when is more likely to win the frog, if there are a number of lizard points for which the chances for the two animals are equal.

4. Conclusion

Those were only some of the CC included in the booklets to give some idea of the different kind of CCs and of the way to use them. We haven't touched the use of Logo in geometry, because it is traditional to use Logo in geometry, and there are many examples for this.

One more thing - a part of the informatics lessons is appropriate for CC in the math lessons too. In our first Logo textbooks (4, 5) we can find everything - music, drawing, mathematics. We use these textbooks now too, that's why many mathematics topics are included here, not in the booklets. The mathematics teacher is often an informatics teacher as well; it is up to him to decide where to use procedures written in informatics classes. For example, the procedures for drawing regular polygons and for converting one number from one to another positional system and so on. Often one CC can be continued in informatics classes too.

A continuation of the project "Learning and doing Mathematics" is currently underway. We will test mathematics students using Logo, and students not using Logo to find out the difference between them. We hope there is a difference.

5.3 - 64
5.3.11 "Computer Corners" as a stimulus for students' activity B. Lazarov, M. Bekyarova, Bulgaria

5. References


1. Introduction

1.1 The Communication Revolution and Social Change

We are living in an age which many claim is witnessing a new technological or social revolution. In most cases these dramatic statements do not withstand serious scrutiny. The changes brought about by the "revolution" turn out to be relatively minor. However, we believe that the claim that modern society is undergoing a communications revolution of awe-inspiring scope is one that is well founded. Our own everyday experiences and also our reading of a number of social theorists convince us that the "third wave" society (Tomer, 1980) in which we live is profoundly different from the worlds that preceded it. Moreover this difference is large a result of developments in communication, or better yet, "communication" technology.

1.2 Changes at Three Levels

The communications revolution has created changes at three different levels. First, we have technological changes that have altered the process of communication itself: Today access to and storage of information is far easier than previously; information is transmitted from one point to another at great speed; this enables linkage throughout the world practically simultaneously, allowing us all to tune into many communication channels and information sources or, in other words, to belong to a continually increasing number of communication networks whose geographical scope is practically unlimited; television has created the possibility of mass transmission of visual images rather than symbolic transmission through words.

Second, there are changes in the dominant ontology of the modern mind which result from changes in the nature of communication. The world relevant to us is becoming increasingly an artificial one which we view through the TV screen: a world of artificial figures viewed passively and two-dimensionally and presented to us in a reality made up of discrete "flashes". This is a world in which the dividing line between reality and fiction becomes blurred: fictional myths become reality (as when Paul Eddington from the British TV show "Yes, Prime Minister" travels the world and meets with real prime ministers!).

Third, there are psychological and social changes in our society that also derive from changes in the nature of communication. We live in a world where we are continually bombarded through the media with news of changes, a world which is not mediated by written symbols but impinges on us in all its immediacy. This is a world whose concept of time is far more flexible than previously was the case. Increasingly the individual can structure his/her own time frame, collapsing the distinction between day and night as the possibilities increase of being involved in work, consumerism and leisure at any time during 24 hours of the day, either at home or in other places. Our world is becoming a far more open one with regards to the possibilities available to us.

Modern mass media and computer technology have also blurred distinction between childhood and adulthood with children being exposed to information previously available to adults only (Meyerowitz, 1974) and also showing, in the cases of computer proficiency, that adults have no advantage over them.

The communication revolution created what McLuhan (1965) calls the "global village", but is a village in which people are far more separated physically than ever before. We are now not so much part of a "lonely crowd" (Reisman 1961) but rather part of a "lonely tribe" in a world-wide village of isolated units.

2. Social Change and Education

As open systems, schools are linked to social change in two primary ways. First, social change impacts upon the school in such a way that the school must adjust to such inputs as different technological demands, new machines for inter-school communication, a demand to teach children how to use computers, etc. In this way the school reacts to some extent in a passive manner to social change, and as such aspires to minimize the negative effects of the changes wrought by the communications revolution.

The school, however, also has a responsibility to prepare students to function in the new era as creative, responsible, participatory citizens and in this way the school in fact helps to create the new age, infusing new norms of behaviour and new standards of judgment accordingly.

The school, thus, has a dual purpose in this communication era: to help students minimize the detrimental effects of communications change, and in a more positive manner, to help shape the potentials of the communication era by developing responsible, socially committed, creative users of the new technology.
3. The needs of the Communications Revolution Age: Social Capabilities

3.1 Autonomy

The world in the age of the present communications revolution demands of its members far greater autonomy than ever before - autonomy in J.S. Mill's sense of authenticity and self-direction. According to Mill, authenticity is the capacity of the individual to identify his/her true wishes and desires and his/her willingness to line according to them. Self-direction is the capacity of the individual to form rational life-plans to serve the realization of his/her wishes, taking into account external circumstances and his/her abilities to follow these plans. The new age presents the individual with so many choices and possibilities for change, in a most persuasive and penetrating media (cf. McLuhan, 1965), such that only an autonomous individual can avoid being continuously swayed by the wills and whims of others that are communicated to him/her.

Further the isolation of the individual vis-a-vis the contemporary communications instruments (computer, television, telephone) demands independent capabilities for action and decision-making, which are best served by the capabilities of the autonomous individual.

In times like ours of swift and intensive changes in all aspects of life, an extensive range of individual autonomy is a sine-qua-non of both the ability of the individual to lead a healthy fulfilling life and the ability of the democratic structure of society to retain its vitality.

3.2 The need to communicate and work with others

Because the new media allows people to work apart from each other, there is much less face-to-face interaction. Instead of using their free time to play with other children, for instance, more and more children spend their time alone, watching television or using a computer. This cuts down their opportunities to communicate with other children, reduces their potential communication and impedes the ability to communicate and work with others (Noble, 1975).

On the other hand, many tasks in modern society demand cooperation, working in teams and different kinds of group interaction. It is especially important for interdisciplinary groups whose mission is to create something new by working together, e.g. a committee of several different types of professionals whose task is to prevent the use of drugs in school, or teams of different types of scientists planning to send a new missile into space.

Society needs a socialization agent to teach these skills to the new generation. It is only natural that this task be responsibility of schools where many children come together in face-to-face interaction. Schools must create opportunities for children to meet and cooperate and learn how to communicate effectively with one another.

3.3 Technical Training

The dominance of technology presents certain challenges in the post-industrial society (cf. Bell, 1976). Only people who know how to use the equipment offered by modern technology can enjoy and benefit from it. Those who feel threatened by this equipment may find it difficult to adapt and function in such a society. It is important to know how to activate and use technology as well as how to discover and deal with small technical problems. Children must be taught how to control this part of their world, so that they will not be afraid of and avoid new machines, and so that they can control their surroundings in the best way possible.

While television can teach many things, it cannot teach technical abilities, especially those that need repetitive exercises, on one hand, and human supervision and correction on the other hand. Such abilities must be taught in a different way, such as through school. The teacher can supervise, control and correct students as needed; can give students a feeling of security and control while using different equipment, especially those connected with communication. Thus students will be able to benefit from all new advances in technology without being threatened by their lack of knowledge.

4. The Failure of the Present School Paradigm to Address these Needs

Israeli schools have not ignored communications changes. Surveying the current programs offered, we found that there are programs in five major areas: (1) mass communication; (2) critical consumerism of communication media; (3) interpersonal communication; (4) video-making; (5) computer communication, including electronic mail linkages abroad.

Most schools, however, do not teach all of the subjects mentioned, but concentrate on only one or two of the subjects. Further, the method of teaching keeps the unity of time, place and group. Study hours are usually in the morning, at schools in classrooms in which the ages are homogeneous. This way of learning does not leave the option of choosing the time and place in which the student can study best, nor is the pace flexible except in rare cases of individualized-learning policies.

Further, the teacher's role has not changed. Teachers remain the experts rather than the advisors or experts who lead the student to use his access to knowledge through the new communications' media as a tool...
for his studies; not do they act as tutors developing the students' ability of work individually with his best
learning style. Little team-work is emphasized.

Thus, some schools have made efforts to meet the needs for new skills in the new communications era,
but these efforts do not restructure the schools to meet the more challenging social and psychological needs
induced by the communication changes, nor are they on a comprehensive scale to meet all of the needs under
one umbrella.

5. The New Model of School As COMMUNICATIONS CENTRE

5.1 Principles and Purposes

The structure of the school as a communications centre we propose is the result of a process of our
attempt to discover the structure that will best serve the central aims of education in the era characterized by
the computer and communications revolutions.

We believe that the educational system in developed democratic societies has four major aims: (1) the
enhancement of learning; (2) the development of learning capabilities; (3) the development and enhancement
of autonomy; and (4) the enhancement of social commitment among the students. We believe that all four
aims will best be served within a flexible school structure, i.e. within a school not exclusively based on the
principle of unity of time, place and group. According to the "unity principle" all students have to follow their
primary study within the same place (the classroom and the school building), within the limits of the same
time (usually the morning and early afternoon hours, which are divided into "lessons"), and usually with the
same group of students, often identified or classified by age. This principle is now exclusively dominant in the
education system. We believe that this principle interferes with the full realisation of the four major
educational aims, because it limits the learning situations to particular times and places in a way which is no
longer necessary. A more open and flexible school structure will allow students so desiring to study part of
their program at home, at hours convenient for them, in the light and temporal conditions of their choice,
from the medium and in the way preferred by them.

In other words, our proposed school will cater in a much improved way to students' learning styles.
There is a great deal of evidence that: (1) individuals differ from each other on the cognitive (e.g., inductive
vs. deductive learners; field-dependent vs. field-independent learners), physiological (form the perspectives of
desired light, background sound, temperature, or body-position, for example), and affective (e.g., impulsive
vs. reflective learners) levels; (2) individuals have more motivation to learn when the learning situation suits
their learning style; and (3) the effectiveness of the learning process in increased by the adaption of the
learning situation to the learners.

Given the body of evidence, we have no doubt that the first aim of the educational process would be
much better served by a flexible school structure. It is easy to see how such a school would also cater to the
development of learning capacity and the enhancement of autonomy. the development of learning capacity and
the result of the development of meta-cognition, which cannot be developed without the individual's
awareness of his/her learning styles. The experimentation in learning style facilitated by the flexible structure
will serve this aim. It will also enhance autonomy: Mill suggested that the best way for autonomy to develop
is through active engagement in "experiments-in-living", wherein the individual forms tentative life-plans in
any aspect of life and attempts to follow them, thus actively learning what way best suits him/her. Further, the proposed
school structure requires an individual responsibility and active participation in the learning process which
fosters autonomy.

The fourth aim, the enhancement of social commitment, will also be served by making the school
structure more flexible. This will enable students to become familiar with the typical social structure in post-
modern, post-industrial society, which is characterized by flexible channels of distance, on-line and off-line
communication. They will become familiar with the advantages of these channels (the ability to cooperate
with individuals who share the same interest and line thousands of miles away, for example), and to recognize
the disadvantages associated with them (e.g., the often sterile and one-dimensional character of electronic
communication). Along with their awareness, they will be encouraged to learn to make the most of the
advantages and to minimalize and cope with the disadvantages so as to become fully contributing members of
the post-modern era.

It follows from the above that the reduction of the impact of the unity principle in the school system, and
increased flexibility of flexibility of the school structure are necessary conditions for the efficient achievement
of the four central educational aims in the electronic age. A satisfactory fulfilment of these aims requires, in
addition and parallel to theses structural changes a change in the content of the curriculum. The necessity of
such a change stems from the need to supply students with programs and courses intended to assist them in
taking advantage of the structural changes in light of the four educational aims. Thus is will be necessary to
supply students with courses about learning styles and their identification and frameworks supplying constant

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1 As opposed to "secondary study", which consists of "homework" or reinforcement of what has already been learned within
the primary process.
feedback and guidance in this regard. It will further be necessary to supply them with feedback and guidance in this regard. It will further be necessary to supply them with courses and other programs aimed at helping them to live as autonomously as possible in the electronic age, including being able to use the new electronic instruments technically and to maximize the benefits derived from them. Finally, it will be necessary to supply students with planned social activities and opportunities for spontaneous social meetings in order to help them cope with implications for human relationships in this electronic era.

In conclusion, the "school as a communication center" aims at the formation of the best educational environment to fulfill the four most important educational aims as we understand them today. It consists of two changes vis-a-vis the prevailing school: increasing the flexibility of the school structure, and the introduction of new educational programs into the curriculum which will focus on learning styles, technical abilities to use electronic instruments, and inter-personal skill adapted to these altered social conditions.

5.2 The Time and Place of Teaching and Learning

In all schools, study occurs at three different sites: (1) in the school building itself (standard classes); (2) at home (home work, etc.); (3) other places outside the school (field trips to museums etc.). In our model these sites continue to exist. The difference is in the responsibility placed on the students for choosing a suitable site for a particular learning assignment, in the relative weights given to the various sites, and in the time frameworks allocated to each site.

We believe that students should have the maximum freedom in choosing where and when to learn. This is suited to the capabilities of contemporary communications technology; it develops the autonomy of the student; and it maximizes the learning possibilities according to individual learning style and pace.

Therefore, with regards to the relative weights of sites, we propose that formal time at the school site be drastically reduced (to approximately two school days a week) and that the "freed" time be distributed primarily between the other two sites. The time spent at the school will be devoted mainly to: (1) social activities to develop interactive skills; (2) learning the technical and cognitive skills needed to function efficiently as a student at the home learning site; (3) workshops for creative work in film making etc; (4) "academic" study of communication designed to develop critical consumerism in this area; and (5) regular meetings with a tutor/advisor on an individual basis.

The time spent outside the school and home will be devoted mainly to aspects of research projects which require on-site observation in various places in the city or local area.

5.3 What is to be taught?

Because of the possibilities introduced in the new communications age, there are a number of skills and subjects which must be taught which are not currently emphasized.

5.3.1. Accessing Information

First, students must be taught how to access information independently (connecting to data bases, using computerized library catalogues etc.). Once they are able to access information in order to select those useful for their own purposes, how to sort and classify this information, and organize it in creative and efficient ways. This includes a need for enhanced problem-solving and decision-making skills as well as more sophisticated abstract-thinking abilities.

5.3.2. Technical training

Students must be given technical skills to use new technologies, for both routine and creative purposes (such as filming videos).

5.3.3. Critical Consumerism

Given the pervasive and extensive penetration of the new communications media, students must be taught to be critical consumers, learning to discern fact from fiction (including in news broadcasts), bias from objectivity, comparing sources of information to get to a closer approximation of "the truth". Students must be taught responsible ways to make choices among the many alternatives presented them, and to withstand the temptation for immediate gratification pressured by modern-day media. These skills will allow the schools to be the institution which provides a check on the commercial mass media, which may otherwise have too much (unchecked) influence for a healthy democratic society.

5.3.4. Social Skills

Interpersonal communication and the ability to work in teams must be stressed, as these skills which will otherwise not be developed in independent learning.

5.3.5. Enhancing the "Regular" Curriculum

While much of the content of learning will remain the same in our school, but will be enhanced by new technological possibilities (such as computerized learning programs), extending the teaching of literature to
include the visual and oral arts, etc. Further the stress will be less on rote learning than on ways of thinking and problem solving within each of the disciplines.

5.4 How it Will be Taught

5.4.1. Distance Learning

We will make use of the possibilities of computerized learning in terms of distance learning from homes, including simultaneous interactive learning from many sites, computerized "bulletin board" possibilities with multiple access, on-line conferencing, peer and teacher-student interaction at flexible times and places.

5.4.2. Training the Learner as a Creative Multimedia User:

Each assignment should reinforce multiple skills in the learner. Since technology is involved, every student has to gradually master the necessary technological skills, such as keeping records of several inquiries that he/she has made, creating computer files or video documents, communicating via networks, etc.

5.4.3. Developing autonomy

In each discipline the thrust will be to develop independent learning skills and personal responsibility to make plans and carry them out, beginning gradually with smaller assignments and a few disciplines and developing them into larger and larger assignments and participatory planning of the learning process, and gradually extending into more and more areas of the curriculum.

5.4.4. Simulation

Extensive use will be made of computer and non-computer simulations which will present real-life problems and situations with which students will learn to cope and to apply the new possibilities in creative manners.

5.5 Roles in the Learning Arena

5.5.1 The teacher as a Tutor

Since learning time and space are flexible, the teacher will not exercise direct control over the learning process. His/her role will be to create an environment which will replace the traditional classroom context (or culture) and help the learner to develop work habits suited to a "remote control" situation. The teacher will serve as initiator or challenger stimulating the initial interest of the student in a given task and then move on to advising, reinforcing and evaluating the learning process and its products. Rather than directly "controlling" the learning environment, the teacher's role changes to that of advising and channelling.

Given the accumulation of specialized and a constantly growing body of knowledge in almost every subject, the teacher can no longer be seen as the ultimate or expert source of knowledge on any particular subject, but must convey to the student the necessary tools to access major information centres in order to find the most up-to-date and complete information. This loss of teachers' expertise power will thus be replaced by the power which comes from the ability to access information.

5.5.2 Boundary Spanning Roles

Because of the greater contact with the home and the wider society, there is need for more extensive boundary-spanning roles, e.g., supervision of home-based activities, contact with community facilities. These will be covered by redefining priorities of existing positions, such as that of the principal and vice-principal(s), enhancing the role of the school counsellor, and that of the teacher.

5.5.3 Technical Services

The school will need access to a full-time technical specialist to assist in problems associated with the new technology (including computers, modems, faxes, etc.).

5.6 Facilities

Apart from the facilities required in any well equipped modern school, our model places special emphasis on the following:

(1) A library that becomes a resource and information center in which it will be possible to link up with larger databases in universities (national and international), other schools and information processing organizations. This center must also link up with computers in the students' homes and must contain not only books and computer-stored information but also video, CD and cassette tape collections.

(2) Technical laboratories, including extensive computer laboratories and a studio for film and videod production.

(3) An extensive cafeteria or club where students (and teachers) can interact in informal, relaxed surroundings.
6. The Application of the Model

Since our proposed school presents a radical change from current school practice, opposition is anticipated both from within the school and from the community. The first part of the project is therefore to prepare the population both within the school and surroundings it to be prepared for the changes and understand the need for them, and contributes to their formulation.

6.1 Students:

The long-range success of this new node of learning depends of the perseverance and self-discipline of the students. We will thus begin to gradually prepare the students for independent learning with small assignment and few disciplines, gradually extending the approach to large assignments and more disciplines.

6.2 Support from the home:

The idea is basically dependent on a solid home support prerequisite to intelligent and flexible use of independent and distance learning. Parent conferences and material support from the school and project will help to alleviate foreseeable problems.

6.3 Cost:

The technical infrastructure required is extensive and will be supported by the Ministry of Education. But the price of the project is higher than the cost of the technical infrastructure. Teachers have to be paid for flexible working hours, a large variety of learning materials have to be produced, operating costs (telephone, commuting, supplies, etc.) will burden a limited school budget. The budget is therefore being planned carefully in order to avoid unforeseen stumbling blocks. In the long run, national support and allocation of funds for these new modes of learning will have to be provided by the state. The exact scope and the degree of change in the school system according to this radical model will have to be considered carefully in order to avoid misapplication or waste of energies.

6.4 Language

The language barrier precludes use of computer programs already developed and available in other languages (primarily English). Our solution is dual: to develop more programs in Hebrew - which is very time-consuming and costly- and simultaneously to focus on intensive English training so that more use can be made of already available software in various subjects.

6.5 Teachers

The main obstacle as we see it is stimulating the teacher to try a radical way of teaching. Much efforts has to be devoted to convince and train teachers to operate within the demands of the new environment. Teachers will be involved from the beginning in the formulation of the project along with administration and university faculty in an advisory capacity. The will have an intensive training session in the summer prior to the beginning of the project, and workshops throughout the preparatory year. These workshops will be to get them familiar with the technology they will be using and in tune with the learning climate the new school proposes.

7. Safeguards

7.1 Awareness

Some of the problems mentioned can be solved by being aware if their existence. For instance, involving the community, especially the parents, from the very beginning of the project may serve as a possible safeguard against later resistance. Teachers must get sufficient support in cases of crisis of difficulties.

7.2 Evaluation

Evaluation of each student is necessary to avoid side-tracking and provide her/him with mechanisms and discipline to return to the task. Frequent reports to the tutor, dissemination of materials to other students for peer review, and whole-class presentation of the acquired knowledge are some examples of ways to monitor the progress.

8. Current Process of the Project
We have presented our proposal to the wider educational community in Israel and are currently meeting with number of schools which have shown unusual interest in the approach. Concurrently we are negotiating with the Ministry of Education for the appropriate budgetary framework. We intend to select at least one school to be our "flagship" and begin intensive preparatory work with it during the coming academic year. Actual programs will then begin in the academic year of 1992-1993.

9. References

The Young Children's Computer Inventory (YCCI) is a Likert-type survey instrument designed for use by first grade students at home or in schools. This paper addresses the historical antecedents of the instrument, reports construct validity and reliability based upon pilot tests in the U.S.A. and Japan, and provides recommendations for the practitioner with respect to appropriate questionnaire format and administration procedures.

1. Introduction

Computer technology is rapidly being introduced into educational environments. In the United States, 94.9% of all schools, elementary and secondary, were using computers by the fall of 1987 (QED, 1989). Recent U.S. studies show that teachers favor early introduction of microcomputers into schools; specifically, 41% favor introducing computers no later than the first grade (Bruder, 1990). Many nations other than the U.S. have also introduced computer technology into their educational fields. However, little research has been conducted relative to computers' effects on the instructional process at the primary school level (Heller & Key, 1990). The following sections describe the development of a new instrument for assessing young persons' attitudes toward computers in instructional environments.

2. UNESCO Derivative

The Young Children's Computer Inventory was derived from the English edition of a questionnaire originally developed by Dr. Takashi Sakamoto of the Tokyo Institute of Technology, consisting of 155 items on the following five subscales: Attitudes toward Computers, Psychological Effects of Computers, Creativity, Motivation to Study, and Empathy. This questionnaire was designed for use by fourth-grade children in the ITEC Project (the UNESCO study which is the focus of this Final Report; Sakamoto, personal communication, July 11, 1990). Two subscales of the original questionnaire, Creativity and Motivation to Study, were derived from Professor Sakamoto's earlier study, "An international comparison of student study skills" (Sakamoto, Matsuda, & Muta, 1985).

Several modifications were made in the YCCI. One subscale, Psychological Effects of Computers, was removed because of the abstract nature of the statements. Other items on the remaining four subscales were revised with simpler wordings for the first grade level. Because of the short attention span of young children, the total number of items was also reduced. This reduction procedure is summarized in Table 1.

Table 1. UNESCO Derivation of YCCI Items

<table>
<thead>
<tr>
<th>Scale</th>
<th>UNESCO</th>
<th>YCCI version 1</th>
<th>YCCI version 2</th>
<th>YCCI version 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes Toward Computers</td>
<td>30</td>
<td>10</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Psychological Effects of Computers</td>
<td>36</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Motivation to Study</td>
<td>32</td>
<td>10</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>Empathy</td>
<td>20</td>
<td>10</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Creativity</td>
<td>37</td>
<td>10</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>TOTAL Items</td>
<td>155</td>
<td>40</td>
<td>60</td>
<td>48</td>
</tr>
</tbody>
</table>

Version 1 of Young Children's Computer Inventory consisted of following four subscales: Attitudes Toward Computers, Motivation to Study, Empathy, and Creativity. Each subscale contained ten items written in English.

3. Texas Pilot Test

During May, 1990, Version 1 of the Young Children's Computer Inventory (the 40 item questionnaire) was administered to 112 first grade students in the Sanger Independent School District, located near Dallas in Northern Texas, U.S.A. The items were then submitted to a factor analysis (ULS, oblimin rotation) to assess construct validity for the four subscales. Twenty items which had their strongest
loadings on the anticipated factors (subscales) were retained; the remainder were eliminated. A post-hoc internal consistency reliability analysis was then conducted on each of the four subscales, using only the items from each subscale with confirmed construct (factor) validity. Cronbach's Alpha (SPSS, 1986) for Attitudes Towards Computers was .74 with six confirmed items; for Motivation to Study, for Motivation to Study, .53 with five confirmed items; for Empathy, .10 with two confirmed items; and for Creativity, .79 with seven confirmed items.

The reliability of the subscale Empathy (.10) was judged to be so low as to make it unusable in the two-item form analyzed. Reliabilities for the remaining three subscales were judged as acceptable. Overall reliability for the 18 items confirmed for the three subscales of Attitudes Toward Computers, Motivation to Study, and Creativity, was .77.

4. Japan Pilot Test

A second version of the Young Children's Computer Inventory was developed for pilot testing in Japan during September, 1990. This version was constructed using the same four subscales included in Version 1, but 15 items on each subscale were selected from the original UNESCO instrument for this version. Thus a total of 60 items were backtranslated (Baker, Matsura, & Fukumora, 1990; Spielberger & Diaz-Guerrero, 1982) into Japanese, from English, to form version 2 of the YCCI.

Ninety-nine first and second grade students in the Todoroki Elementary School in Setagaya-ku, Tokyo, Japan, completed Version 2 of the inventory during mid-September 1990. These items were also submitted to a factor analysis (ULS, varimax rotation) to assess construct validity for the four subscales. Seventeen items which did not produce strong (r>=.20) factor loadings on the anticipated subscale were removed; the remaining 43 were retained. The top eight items for each subscale were then selected for post-hoc reliability analysis using the program SPSS (1986). Cronbach's Alpha for Attitudes Toward Computers was .79; for Motivation to Study, .69; for Empathy, .55; and for Creativity, .68. Overall reliability for the 32 items was .78.


The Japanese Advancement School of Dallas, Texas, U.S.A. was selected as a third pilot test site. This is a private, Saturday "Japanese School" for children of families from Japan stationed in the Dallas area. During the last week of September, 1990, 51 first and second-grade students in Dallas completed the same Japanese version of the inventory which had been administered one week earlier in Tokyo, Japan.

6. Recommended Form for Cross-Cultural Studies.

Combined data from the initial Texas public school pilot test site, the Tokyo public school test site, and the Texas-based weekend school for Japanese dependents, was factor analyzed to reaffirm construct validity for the YCCI. A scree plot of the initial results indicated five factors, rather than four, existed in the data. Additional analysis verified that the subscale Motivation to Study is actually a composite of two factors: a) Motivation/Persistence, and b) Study Habits.

Selected subsets of items were then recombined, based upon their factor loadings, and subjected to a series of post-hoc internal consistency reliability analyses to determine final recommendations for YCCI subscales. The iterative procedure began with only those items having high (r >= 3) loadings on the anticipated factor. Subscale reliabilities for these were calculated as baseline data. Then, the next-highest loading item on each factor was added to the baseline subscale, and the reliabilities were recalculated. This procedure was repeated until: a) adding a new item failed to raise the subscale reliability, or b) there were no remaining items significantly contributing (p >= .01) to the subscale. As a final check, each collection of subscale items was reviewed for content validity. Two items ("I think about many ways to solve a difficult problem and I never give up," and "I try to finish whatever I begin") were removed from the subscale Empathy at this stage. One item "Computers are very easy to use") was removed from the subscale Study Habits.

The five recommended subscales, in terms of the items listed in the Appendix, are

- Attitudes Toward Computers (reliability =.75): Items 8, 12, 9, 10, 6, 11, 3, 5;
- Motivation/Persistence (reliability =.66); Items 39, 21, 16, 23, 6, 24, 46, 15;
- Empathy (reliability =.50); Items 29, 30, 32, 28, 34, 45, 35;
- Study Habits (reliability =.65); Items 18, 15, 25, 19, 24, 22; and
- Creativity (reliability =.66); Items 42, 44, 37, 45, 47, 48, 39, 46, 43.

Note that items 6, 15, 24, 39, 45 and 46 contribute to two subscales.
5.3.13 "The Young Children's Computer Inventory: K. Miyashita, Japan and G. Knezek, U.S.A.

Table 2 lists the factor loadings (strength of relationship between item and factor) for the 32 items confirmed for the five subscales.

Table 2.

Factor Loadings for YCCI Version 3 Attitudes Towards Computers

"Attitudes Towards Computers"
8. I know that computers give me opportunities to learn many new things. (.73)
12. I believe that it is very important for me to learn how to use a computer. (.60)
9. I can learn many things when I use a computer. (.56)
10. I enjoy lessons on the computer. (.53)
6. I would work harder if I could use computers more often. (.43)
11. I believe that the more often teachers use computers, the more I will enjoy schol. (.43)
3. I will be able to get a good job if I learn how to use a computer. (.41)
5. I enjoy computer games very much. (.27)

"Motivation" (Persistence)
39. I tend to consider various ways of thinking. (.56)
21. I enjoy working on a difficult problem. (.55)
16. If I do not understand a problem, I will not stop working on it. (.50)
23. I never forget to do my homework. (.45)
6. I would work harder if I could use computers more often. (.28)
24. I like to work out problems which I can use in my life every day. (.29)
46. I invent new methods when one way does not work. (.25)
15. I study by myself without anyone forcing me to study. (.25)

"Empathy"
29. I feel sad when I see old people alone. (.49)
30. I worry when I see a sad friend. (.49)
28. I get angry when I see a friend who is treated badly. (.36)
34. Children who have no friends sometimes do not want a friend. (.30)
45. I invent games and play them with friends. (.29)
35. I feel happy when I see a friend smiling. (.23)

"Motivation" (Study Habits)
18. I review my lessons every day. (.63)
15. I study by myself without anyone forcing me to study. (.47)
25. If I do not understand my teacher, I ask him/her questions. (.42)
19. I try to finish whatever I g\begin{. (.41)
24. I like to work out problems which I can use in my life every day. (.38)
22. I think about many ways to solve a difficult problem and I never give up. (.21)

"Creativity"
42. I find different kinds of materials when the ones I have do not work or are not enough. (.58)
44. I make a plan before I start to solve a problem. (.53)
37. I find new things to play with or to study, without any help. (.45)
45. I invent games and play them with friends. (.44)
47. I choose my own way without imitating methods of others. (.38)
48. I tend to think about the future. (.30)
39. I tend to consider various ways of thinking. (.24)
46. I invent new methods when one way does not work. (.22)
43. I examine unknown issues to try to understand them. (.21)

7. Cross-Cultural Differences

As shown in Table 3, overall internal consistency reliability for the 32 factor-validated items, using combined data from the U.S.A., Japan, and the U.S.-based Japanese school, is .81. Reliabilities for the individual groups of Japanese students or U.S.A. students, each taken alone, are .74 and .83, respectively. Sixteen additional items (see Table 4) have been included in YCCI Version 3, in hopes of further improving the overall reliability for future administrations, especially in the area of Empathy. Fourteen of these sixteen items produced significant ($r > .2, p <= .01$) factor loadings in a separate analysis restricted to the Japan data gathered from the 60-item edition of YCCI Version 2. Seven of the sixteen items are believed to measure Empathy. Additional analysis based on new data will be required to confirm the utility of these items.
Table 3. Internal consistency Reliability for the YCCI

<table>
<thead>
<tr>
<th></th>
<th>Items</th>
<th>All groups</th>
<th>Japan</th>
<th>United states</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes Toward Computers</td>
<td>8</td>
<td>.75</td>
<td>.68</td>
<td>.70</td>
</tr>
<tr>
<td>Motivation/Persistence</td>
<td>8</td>
<td>.66</td>
<td>.61</td>
<td>.74</td>
</tr>
<tr>
<td>Empathy</td>
<td>7</td>
<td>.50</td>
<td>.41</td>
<td>.50</td>
</tr>
<tr>
<td>Study Habits</td>
<td>6</td>
<td>.65</td>
<td>.66</td>
<td>.55</td>
</tr>
<tr>
<td>Creativity</td>
<td>9</td>
<td>.66</td>
<td>.56</td>
<td>.77</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>.81</td>
<td>.74</td>
<td>.83</td>
</tr>
</tbody>
</table>

Table 4. YCCI Version 3: Non-Validated Items

1. I enjoy doing jobs which use a computer.
2. I am tired of using a computer.
4. I concentrate on a computer when I use one.
7. I think that it takes a long time to finish when I use a computer.
13. I think that computers very easy to use. (labeled Item 4 in analysis and on YCCI Version 1)
14. I would like to study with a teacher rather than using a computer. (labeled Item 5 in analysis and on YCCI Version 1)
17. When I don't understand something, I keep on working until I find the answer.
18. I review my lessons every day.
20. Sometimes, I change my study habits.
26. I feel sad when I see a child crying.
27. I sometimes cry when I see a sad play or movie.
29. I feel sad when I see old people alone.
30. I worry when I see a sad friend.
31. I feel very happy when I listen to a song I like.
32. I do not like to see a child play alone, without a friend.
33. I feel sad when I see an animal hurt.
36. I examine unusualy things.
38. When I think of a new thing, I apply what I have learned before.
40. I create many unique things.
41. I do things by myself without depending on others.

Two of the items listed in the Appendix and Table 4 (Items 13 and 14) were retained from pilot test administrations with Versions 1 and 2 and carried forward to Version 3, even though they were not confirmed as belonging to a subscale by the procedures described above. This is because they have been found to be strong individual indicators of differences between the U.S.A. and Japan in the pilot test data, and are hypothesized to carry the same importance for differences between other computer-intensive and non-intensive educational environments.

Versions 1 and 2 of the YCCI both contained Likert scales with just three choices (Disagree, Undecided, Agree) in order to make completion easier for young children. However, there was a tendency at the U.S. public school pilot test site for almost all children to make the highest rating possible in "Attitudes Towards Computers". Such a high rating would be especially detrimental if a researcher wished to use the YCCI for measuring pretest-to-posttest changes. As a result, four choice categories (1=No, 2= Maybe No, 3=Maybe Yes, and 4=Yes) have been included in YCCI Version 3. Pilot testing is currently underway to determine if coloring "happy face" symbols would be preferable to having young children circle words or numbers when making a response.

Optimal administration procedures for the YCCI may be culture bound. For example, in the Japanese pilot test, the YCCI was administered by sending a questionnaire home with each student, to be completed under parental guidance, and returned to the teacher at school. The return rate for this procedure was 100%. In the U.S. pilot site, each teacher had all students complete the questionnaire during class time because teachers believed only a small percentage would be returned if the students carried them home. Since previous checks had shown parental supervision yields slightly more reliable data in the U.S.A., the U.S. administration procedure sacrificed a certain degree of internal consistency reliability in order to assure a high completion rate. Such tradeoffs may be necessary in other cultural environments as well.

References
5.3.13 "The Young Children's Computer Inventory: K. Miyashita, Japan and G. Knezek, U.S.A.


Appendix

Recommended YCCI Items

1. I enjoy doing jobs which use a computer.
2. I am tired of using a computer.
3. I will be able to get a good job if I learn how to use a computer.
4. I concentrate on a computer when I use one.
5. I enjoy computer games very much.
6. I would work harder if I could use computers more often.
7. I think that it takes a long time to finish when I use a computer.
8. I know that computers give me opportunities to learn many new things.
9. I can learn many things when I use a computer.
10. I enjoy lessons on the computer.
11. I believe that the more often teachers use computers, the more I will enjoy school.
12. I think that it is very important for me to learn how to use a computer.
13. I think that computers very easy to use. (labeled Item 4 in analysis and on YCCI Version 1)
14. I would like to study with a teacher rather than using a computer. (labeled Item 5 in analysis and on YCCI Version 1)
15. I study by myself without anyone forcing me to study.
16. If I do not understand something, I keep on working until I find the answer.
17. I review my lessons every day.
18. I try to finish whatever I begin.
19. Sometimes, I change my study habits.
20. I enjoy working on a difficult problem.
21. I think about many ways to solve a difficult problem and I never give up.
22. I never forget to do my homework.
23. I like to work out problems which I can use in my life every day.
24. If I do not understand my teacher, I ask him/her questions.
25. I feel sad when I see a child crying.
26. I sometimes cry when I see a sad play or movie.
27. I get angry when I see a friend who is treated badly.
28. I feel sad when I see old people alone.
29. I worry when I see a sad friend.
30. I feel very happy when I listen to a song I like.
31. I do not like to see a child play alone, without a friend.
32. I feel sad when I see an animal hurt.
33. Children who have no friends sometimes do not want a friend.
34. I feel happy when I see a friend smiling.
35. I examine unusual things.
36. I find new things to play with or to study, without any help.
37. When I think of a new thing, I apply what I have learned before.
38. I tend to consider various ways of thinking.
39. I create many unique things.
40. I do things by myself without depending on others.
41. I find different kinds of materials when the ones I have do not work or are not enough.
42. I examine unknown issues to try to understand them.
43. I make a plan before I start to solve a problem.
44. I invent games and play them with friends.
46. I choose my own way without imitating methods of others.
47. I invent new methods when one way does not work.
48. I tend to think about the future.
APPENDICES
Final Report Phase 1 ITEC Project

Appendix A. Archives of ITEC Phase 1: Project Documentation 1988-1991

Appendix B. Original List of Proposed ITEC Variables, May 1988

Appendix C. Names and Addresses of Researchers, Principals, and Teachers Participating in ITEC Phase 1

Appendix A. Archives of ITEC Phase 1: Project Documentation 1988-1991

In this document, an overview is given in point form of the major "deliverables" of the ITEC project with their authors, dates, titles, numbers of pages, and other descriptive information. These documents are available at UNIVERSITY OF TWENTE, MS. COLLIS as the ITEC Document Archives. Many of the documents are described in this Final Report. There have been many other documents received by the project over its history; this is a selection of items felt to show some major aspect of the study.


These documents are available from UNIVERSITY OF TWENTE, MS. COLLIS, Division of Higher Education and Research, Paris.

ITEC Document Number:


2. "Responses to the Proposal, 'Pre-project for a Longitudinal, Comparative and Cross-cultural Study of the Effects of Computer Technology on Child Development'", Dr. Betty Collis (then at the University of Victoria, Canada); Dr. Mihaly Csako, Budapest, Hungary; and Dr. Erich Neuwirth, University of Vienna, Austria; April-May 1988 (15 pages).

3. "Summary Report and Recommendations, The ITEC Project", Dr. Betty Collis, (then at the University of Victoria, Canada); 28 May 1988; (21 pages).

4. "ITEC Preliminary Working Papers" (September 1988) consisting of:
   - "Vigotsky's Theory as a Methodological Basis for a Cross-cultural Study on the Impact of Information Technology in Education on Child Psychological Development", Prof. O. K. Tikhomirov, Department of Psychology, Moscow University, USSR (15 pages);
   - "Genetic and Modelling Method and its Usage for Studying Cognitive Development in Cross-Cultural Research", Prof. V. V. Rubtsov, Institute of General and Pedagogical Psychology, Moscow, USSR; (18 pages);
   - "Aspects of Process Measurement", Dr. Paul Light, The Open University, Milton Keynes, UK, and Prof. Janine Rogalski, University Paris V, France; (5 pages);
   - "Some Methodological Issues about Introduction of Computers in the Classroom", Prof. Janine Rogalski, University Paris V, France (6 pages);
   - "Observations and Interviewing Combined as Assessment Techniques for Family Variables", Dr. Mihaly Csako, Budapest, Hungary (5 pages);
   - "Assessment Procedures for Family and Home Environment", Dr. Toma Tomov, Medical Academy, Sofia, Bulgaria (2 pages);
   - "Developing a Scoring Procedure for 'Frequency of Computer Use'", Dr. Betty Collis, University of Twente, Netherlands (8 pages);
   - "In-service Training", Mrs. Birgitta Lindahl, Stockholm Institute of Education, Sweden, (5 pages);
APPENDICES

- "Evaluation of Behaviour in Computerized Classrooms: Concepts, Instruments", Dr. Zimra Peled, Dr. Elad Peled, Dr. Gad Alexander, Ben-Gurion University of the Negev, Beer-Sheva, Israel, (24 pages; also five instruments developed for the "Comptown Project" by the authors);

- "Specification of Information Technology in Education", Dr. Elad Peled, Dr. Zimra Peled, Dr. Gad Alexander, Ben-Gurion University of the Negev, Beer-Sheva, Israel (14 pages).


11. "Detailed Procedures, Instruments, and Other Information for Phase 1 Participation in ITEC", Dr. Betty Collis, Netherlands, 30 November 1989 (44 pages).

12. "ITEC Participants, Phase 1: Overview of Schools, Teachers, and Classes" (March 1990) including:
   - Form A Summary, 17 countries, 23 schools
   - Names and addresses of teachers participating in Phase 1
   - "Profile of Participating Classes, Phase 1, ITEC Project", Dr. Betty Collis, University of Twente, Netherlands, 6 March 1990 (8 pages).

13. "Revised Project Documents: Phase 1, ITEC Project", Dr. Betty Collis, University of Twente, Netherlands:
   - 20 February 1990 (7 pages),
   - 6 March 1990 (23 pages).

14. "First Summary of Contextual Descriptions" (April 1990) including:
   - Summary description of participating schools (Form B, 14 pages)
   - Extra information about the two Costa Rica schools, the USA school, and the Swedish school (14 pages),
   - Summary of interviews with principals (Form C, 50 pages),
   - Summary of student characteristics (Form D, 2 pages),
   - Summary of teacher interviews and teachers characteristics (Form E, 25 pages),
   - Summary of descriptive videos, (Form F, 34 pages).


16. "Planning for Analysis: Phase 1" including:
   - Letter, 3 April 1990
   - Short summary, "The ITEC Project", August 1990
   - "ITEC: An International Study of Computer Use and Cognitive Functioning", Dr. Betty Collis, University of Twente, Netherlands, October 1990 (14 pages).
Appendix A. Archives of ITEC Phase 1: Project Documentation 1988-1991


18. "Summary Reports, ITEC Phase 1" including:
   - National Summaries (as of the end of 1991):
     - Bulgaria, Dr. V. Tsonceva and others, (83 pages),
     - Canada, Dr. L. Francis and Dr. L. Ollila, University of Victoria, BC, (7 pages),
     - China, Prof. Hou-can Zhang, Department of Psychology, Beijing University, (3 pages),
     - Costa Rica, Dr. Clotilde Fonseca, Rocio Murillo, Rosalina Chacon, Aurea Alvarad, and Magaly Zuniga, Omar Dengo Foundation, San Jose, Costa Rica (10 pages),
     - France, Mr. Philippe Gabriel, IREDU, Dijon, France (13 pages),
     - Hungary, Dr. Mihaly Czako, Lorand Eotvos University, Budapest & Dr. Gustav M. Habermann, National Institute for Education (13 pages); and Dr. Gustav Habermann, National Institute for Education (4 pages),
     - Japan, Prof. Takashi Sakamoto, Tokyo Institute of Technology, (9 pages),
     - Mexico, Dr. Marco Murray-Lasso, Mexican Academy of Science, Mexico City (12 pages, two submissions),
     - New Zealand, Dr. Kwok-Wing Lai, University of Otago, (5 pages),
     - Romania, Dr. Ian Diamandi, Research Institute for Computers, Anca Costin, Centre for Improving Educational Activity in Informatics, and Eugen Noveanu, National Institute for Educational Sciences, (20 pages); and Dr. Ian Diamandi, Research Institute for Computers, (8 pages, second submission, on "The LOGO Experiments and Children’s Cognitive Capacities"),
     - USA, Dr. Arie Pilz, Dr. Gladys Levis-Pilz, and Dr. Paul Resta, University of New Mexico, Albuquerque, USA (6 pages); and Dr. Gladys Levis Pilz, Mrs. Sylvia Mills, Mrs. Elizabeth Paak, Dr. Arie Pilz, and Dr. Paul Resta, University of New Mexico, USA (2 pages),
     - Russia, Prof. V. V. Rubtsov and Dr. V. N. Kaptelinin, USSR Academy of Pedagogical Sciences and USSR National Committee for UNESCO Affairs, Moscow, USSR (13 pages).

19. Overall Descriptive Summaries:
   - "ITEC Project, Analysis of the Answers to Form C (Views of the Principals of the Schools") Dr. Clotilde Fonseca, and Rocio Murillo, Omar Dengo Foundation, San Jose, Costa Rica (23 pages), and
     Dr. Lloyd Ollila, Dr. Leslie Francis, and Mr. Erich Schwartz, University of Victoria, Canada (13 pages)
   - "Summary Information for ITEC", Mr. Ion Diamandi, Research Institute for Computers, (25 pages).
   - "Contexts of computer use in elementary school learning processes: Some sample characteristics", Dr. G. M. Habermann, & Dr. M. Csako, (48 pages).
   - "Trends in software use at school", V. Tsonceva, (pp. 3-7).
   - "Trends in the use of software in schools", Mr. Ph. Gabriel, (7 pages).

20. Video Tapes (Available with B. Collis —numbers refer to coding of composite tapes):
   - Bulgaria, Descriptive (Tape 6); Computer-use observation #1 (Tape 5)
APPENDICES

- Canada, Computer-use observations 1 and 3 (Tape 10); also overview of primary grades and computer use in British Columbia (Tape 10)
- China, Descriptive and Computer-use Observation 1 (Tape 2)
- Costa Rica (two schools), Descriptive (both schools), (Tape 1),
- France (two schools), Descriptive (Petit Bernard School—Tape 7), Computer-use observations 1 and 2 (both schools, Tape 5); also overview of Project Meeting, October 1990 in British Columbia (Tape 10)
- Hungary, Descriptive (Tape 7), Computer-use observations 1, 2, and 3 (Tape 5)
- Israel, Descriptive (Tape 7), Computer-use observations 1, 2, and 3 (Tape 5)
- Japan, Descriptive (Tape 2), and Computer-use observations 1, 2, and 3 (Tape 2); also interview with school principal (Tape 2)
- Mexico (four schools), Descriptive (Col. Madrid, Tape 8); Descriptive (all four schools, Tape 9), Computer-use observations 1, 2, and 3 (Vista Hermosa, Tape 3)
- The Netherlands, Descriptive (Tape 7, repeated, Tape 5), Computer-use observations 1, 2, and 3 (Tape 11, Observation 3 repeated on Tape 5)
- New Zealand, Descriptive (Tape 7), Computer-use observations 1, 2, and 3 (Tape 11)
- Romania (two schools), Descriptive (both schools, Tape 6, repeated, Tape 7), Computer-use observations (both schools, Observation 1—Tape 11)
- Sweden, Descriptive (Tape 6)
- USA, Descriptive (Tape 10)
- Russia, Descriptive (Tape 6), Computer-use observations 1, 2, and 3 (Tape 4)
- Zimbabwe, Descriptive (Tape 6, repeated, Tape 5)

(Note: Unfortunately, tapes from Romania, Zimbabwe and the USA have been lost in the mail).
Appendix B. Original List of Proposed ITEC Variables, May 1988

I. Child-centered variables

With respect to variables associated with the child, we first discussed some general categorization schemes for outcome measures. Two general frameworks emerged:

1. Social versus technological ("thing-oriented")
2. Cognitive and metacognitive versus communicative and metacommunicative

Following this, we elaborated the following list of generally stated dependent variables:

1. Goal setting
2. Problem solving
3. Decoding and encoding social cues
4. Adjusting behaviour in response to social cues
5. Cognitive skills
6. Metacognitive skills
7. Communicative skills
8. Metacommunicative skills
9. Learning strategies
10. Learning achievement
   - relative to curriculum-related content
   - relative to process variables, such as inquiry skills, skills in the organization, synthesis, and evaluation of data, etc.
11. Motivation
12. Inferential thinking
13. Language-related variables (as opposed to cognitive variables)
14. Affective variables
   - attitude towards learning in general
   - attitude towards subject matter
   - attitude about oneself as a learner
   - attitude towards computer use
15. Neuropsychological variables related to maturation

We also discussed salient independent variables related to the child. Age and gender were seen as the most productive independent variables. Some mention was also made of sibship position and of socio-economic level. With respect to age, it was agreed that two cohorts would be selected. Various criteria for the selection of age ranges for these cohorts were discussed. We agreed that pragmatic considerations would influence our choice of age groups relative to school organization features and the projected length of our longitudinal study. Having overlap between the age groups during the latter years of the study (i.e., that the younger group would end up at the same age bracket as the older group had been at when the study started) was also seen as a promising strategy. Selected initial age groups were discussed, with some consensus forming around 7-8 years for the younger group and 10-12 years for the older group. There was also some discussion about the desirability of having a third cohort, this one being at about 15-17. This would allow the examination of the impact of more sophisticated computer applications and also the inclusion of students in vocational education streams.

As a final suggestion, some comment was made about "special needs" students—handicapped or learning disabled—as levels of a student-characteristic variable. It was suggested that this focus might be a module for individual countries to include rather than being an independent variable for the study as a whole.

II. Teacher/school variables

Teacher and school-related variables were seen as critical dimensions underlying child performance on the dependent variables in our study. We began our discussion of teacher variables by considering various aspects of the role of the teacher, such as motivation, selection and management of learning activities, functional activity and knowledge level. From this, we identified two main groupings of "teacher" variables—those related to personal characteristics of the teacher and those related to the teacher's decisions with regard to the integration of computer use with the larger lesson and with aspects of classroom organization and management.

Annex - 5
Some of the variables we discussed were:

Personal Variables Relating to Teacher:
1. Conception of teaching, with regard to function, philosophy, and teacher-student relationship
2. Expectation held towards students as learners
3. Competency level
   - With regard to subject area
   - With regard to computer use
   - With regard to computer applications in the teacher's own subject area
4. Attitudes
   - Toward computers
   - Toward computer use in the teacher's own subject area
   - With regard to self-confidence as a computer user
5. Prior experience with computers; extent of this prior experience, type, duration, and recency of training
6. Subject area of teacher
7. Teacher's tendency towards creative thinking
8. Teacher's preferred teaching style
9. Teacher's preferred organizational style for classroom management
10. Teacher's planning ability
11. Teacher's mental and physical health related to stress and tension

Variables Concerning Choice of Instructional Strategies:

Discussions also occurred concerning the teacher's decisions with respect to the integration of computer-based material into the on-going lesson or unit or study. It was observed that the variables relating to the teacher's choice of instructional strategies in which computer use is embedded are critical components of the overall system influencing outcomes relative to cognition and communication. These strategies should be considered in at least the following ways:

1. Relevancy of computer use to the other material student is learning and to student's prior knowledge in the area
2. Social aspects of instructional strategy, i.e. students working in groups or individually
3. Teacher guidance with regard to computer use
4. Teacher follow-up and feedback on concepts involved in computer use

School Variables:

Finally, school variables were discussed. The following list summarizes the discussions:

1. Student selection and "streaming" procedures
2. Single-sex or coed schools
3. Rural or urban areas
4. Socio-economic class
5. Organization of computer access, such as laboratories versus within-classroom use
6. General pedagogical climate in the school
7. Support of administration

III. Family variables

Various independent variables relating to the family were discussed as being potentially salient in influencing the impact of computer use on child development. Some of these variables are:

1. Family interest profile
2. Family interest in education
Appendix B. Original List of Proposed ITEC Variables, May 1988

3. Parents' level of education
4. Overall family characteristics (perhaps 'Home Environment Assessment Scale'?)
5. Attitudes to computers/technology
6. Developmental stage of the family
7. Number of children
8. Structural characteristics (nuclear, complete, etc.)
9. Coping strategies typical in family
10. "Technological culture" of the family
11. Availability of home computer
12. Economic indices; also, who supports the family
13. Interactional styles between family members
14. Level of home media use
15. General family expectations about appropriate behaviours for children; aspirations towards future for children
16. Social characteristics of family
17. Is the child working?
18. Overcrowding, density
19. Age of parents
20. Networks:
   - Social network of the family
   - Technical network available to child
   - Computer subculture available to child
21. Family interpersonal relationships

IV. Variables relating to computer use

It is obvious that variables relating to type and characteristics of computer use will be critical independent variables in the impact of such use on the child. We discussed computer use variables from a number of different perspectives. Our first concern was what to call this overall cluster of variables, as "CAI" is connotative of only a subset of the different types of computer use which we may wish to examine. Two of the suggestions were "CAL" (computer-augmented learning) and "NIT" (learning with new information technologies). Both of these designations are used in Europe while only "CAL" is used in North America. Following this, the following scheme was presented as one framework for categorizing computer use in learning and in school:

1. Computers used in support of teaching and learning in existing curriculum areas. Within the existing curriculum these uses may be further categorized as:
   - Drill and practice
   - Tutorials
   - Simulations
   - Instructional games
   - "Open" tools
   - Applications software (word processing, data base management software, spreadsheets, graphing software, desktop publishing, etc.)
   - Data capturing tools for the science laboratory
   - Less structured simulations
   - Less structured games
   - Authoring languages

(The use of computers to add to or otherwise extend existing curricula was also noted, as, for example, could occur with the creation of new teaching units on information processing.)

2. Computers used for administrative purposes (not considered salient for the current study)

3. Computers as the object of study (having taken or not taken some kind of computer-oriented course)
In addition to this categorization, a variety of other considerations were discussed:

1. Is there a hierarchy of cognitive demand embedded within the different categories of computer use? (It was felt that this depends on various other aspects of the usage situation, so a hierarchy is not appropriate)

2. Should we make a distinction between producing, consuming and manipulating knowledge?

3. Is it relevant to consider the degree of teacher dependence or independence involved in the use of the computer application?

V. Culture-related variables

Finally, we discussed variables pertinent to the culture in which the child and his computer use are embedded. We identified many different potentially pertinent variables, first relevant to the larger cultural context:

1. Type of skills and knowledge valued in a culture
2. Culture’s attitude towards modernity
3. Culture’s concept of focus on control (in higher authority or in the individual)
4. Development level

and second, to the local culture:

1. Languages used
2. Level of industrialization
3. Size of community, centralized or dispersed
4. Homogeneity or heterogeneity of community
5. Dominant mode of symbolic representation in the community
6. "Cosmology" indices, general beliefs about life
7. Wealth and its distribution

It was noted that a social anthropologist should be added to the overall project design team in order to more effectively deal with the delineation and assessment of cultural variables such as the ones listed above. Therefore, we decided not to focus specific attention on this cluster of variables at the present moment but instead to wait for the contributions of someone trained in the area.
APPENDIX C. NAMES AND ADDRESSES OF RESEARCHERS, PRINCIPALS, AND TEACHERS PARTICIPATING IN ITEC PHASE 1

Researchers:

Bulgaria

Dr. Assen Jablensky

President, Bulgarian Medical Academy
D. Nestorov 15
1431, Sofia
Bulgaria

Dr. Violeta Tsoneva

Bulgarian Medical Academy
Dr. Nestorov 15
1431, Sofia
Bulgaria

Canada

Dr. Lloyd Ollila

Faculty of Education
University of Victoria
P.O. Box 1700
Victoria, British Columbia
Canada, V8W, 2Y2
Tel: 09-1-604-721-7826
Fax: 09-1-604-721-7767

China

Prof. Hou-can Zhang

Beijing Normal University
Department of Psychology
Beijing 100031
China

Costa Rica

Dr. Clotilde Fonseca de Pachero

Omar Dengo Foundation, Executive Director
Apdo 1032-2050
San José
Costa Rica
Tel: 09-22-1144
Fax: 506-22-1654

France

M. Philippe Gabriel and
M. Francois Orivel

IREDU, Faculté des Sciences Mirande
B.P. 138
21004 Dijon Cedex
France
Tel: 09-80-355450
Fax: 09-30-80-395-069

Hungary

Dr. Milhaly Csako

Budapest, VII
Dohany u. 16-18
Hungary, 1077
Dr. Gustav Haberman

Project Director
National Institute of Public Education
P.O.B. PF. 65
Budapest 13
Hungary

Israel
Dr. Gad Alexander,
Dr. Elad Peled, and
Dr. Zimra Peled

Ben Gurion University of the Negev
Department of Education
Post Office 653
84105, Beer-Sheva
Israel
Tel: 09-972-57-1371
Fax: 09-972-57-31340

Japan
Prof. Takashi Sakamoto

Tokyo Institute of Technology
Graduate School Nagatsuta
Nagatsuta, Midoriku
4259, Yokohama 227
Japan
Tel: 09-81-45-922-1111 ext. 2654
Fax: 09-81-45-921-1485

Mexico
Dr. Marco Murray-Lasso

Mexican Academy of Science
Rembrandt 53
D.F. 03910
Mexico, 19
Mexico
Tel: 09-525-563-37400
Fax: 09-525-548-8213

The Netherlands
Dr. Betty A. Collis, and
Dr. Jef Moonen

University of Twente
Department of Education
P.O. Box 217
7500 AE Enschede
The Netherlands
Tel: 053-893611
Fax: 053-356531

New Zealand
Dr. Kwok-Wing Lai

Department of Education
University of Otago
P.O. Box 56
Dunedin
New Zealand
Tel: 09-64-024-791-100
Fax: 09-64-024-741-607
<table>
<thead>
<tr>
<th>Country</th>
<th>Name</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Romania</td>
<td>Dr. Ion Diamandi</td>
<td>Research Institute of Computer, Technique en Informatics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calea Floreasca, nr. 167</td>
</tr>
<tr>
<td></td>
<td></td>
<td>72321, Bucharest, Romania</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: 09-40-079-7140</td>
</tr>
<tr>
<td>Russia</td>
<td>Prof. Vitaly Rubtsov</td>
<td>Institute of General and Pedagogic Psychology</td>
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<td>Marx 20 &quot;B&quot;</td>
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<tr>
<td></td>
<td></td>
<td>K.9, Moscow, USSR (GOS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: 09-7095-229-5637</td>
</tr>
<tr>
<td>Sweden</td>
<td>Mr. Bengt Bengtsson</td>
<td>Göteborgs Skolforvaltning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P.O. Box 5428, Göteborg, Sweden</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: 09-46-31-373500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax: 09-46-31-832-452</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Dr. Joao Oliveira</td>
<td>I.L.O. Office 9-112</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Route des Morrions</td>
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<tr>
<td></td>
<td></td>
<td>CH-1211, Geneva, Switzerland</td>
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<tr>
<td></td>
<td></td>
<td>Tel: 09-41-22-799-6610</td>
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<tr>
<td></td>
<td></td>
<td>Fax: 09-41-22-798-8685</td>
</tr>
<tr>
<td>U.K.</td>
<td>Dr. Alistair Mundy-Castle</td>
<td>Ealing College of Higher Education</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Department of Humanities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>St. Mary's Road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W5, 5RF, Ealing, London, London, United Kingdom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: 09-01-579-4111</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>Dr. Paul Resta</td>
<td>University of Texas, Director Learning Resource</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Education Building</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Austin, Texas, U.S.A.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tel: 09-1-512-471-4019</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax: 09-1-512-471-4607</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>Mr. David Wilson</td>
<td>Department of Psychology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>University of Zimbabwe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe</td>
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<tr>
<td></td>
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<td>Tel: 09-303-211</td>
</tr>
</tbody>
</table>

Annex - 11
APPENDICES

Principals and Teachers, ITEC Phase 1, 1990-1991

Bulgaria
Mrs. Miroslava Bekyarova, Teacher
Assoc. Prof. Lyudmil Vatskichev, Principal

119 School "VI, Bashev,"
11 Latinka Str.
1113 Sofia
Bulgaria

Canada
Mr. David Allen, Principal
Mr. Steve Hambleton, Teacher
Marigold Elementary School
3751 Grange Road
Victoria, British Columbia
Canada, V8Z 4T2

China
Mr. Yao Shang-Zhi, Principal
Mr. Zhang-Xuejun, Teacher
The Second Experimental Primary School of Beijing
18 Xidan-Shoupa-Hutong,
West City District
Beijing 100031
China

Costa Rica
Mrs. Azalea Varela Morales, Principal
Mrs. Mayela Herrera Vargas, Teacher

Jorge Debravo School
Hatillo 8,
San José
Costa Rica

Mrs. Maria Antonieta Pernudi, Principal
Mrs. Victoria, Vargas, Teacher

Escuela Republica de Panamà
San Antonio de Desanparados
San José
Costa Rica

France
Mr. M. Jean Pierre Chaix, Teacher
M. M. N. Krug, Principal

Ecole Chevreul
Rue Joseph Milsand
21000 Dijon
France

Mr. Yves Seguin, Teacher
M. Vallenet, Principal

Ecole Mixte Petit Bernard
E.M. Petit Bernard
3, Rue Petit Bernard
21000 Dijon
France
Appendix C. Names and Addresses of Researchers, Principals, and Teachers Participating in ITEC Phase 1

Hungary
Ms. Zsuzsanna Mozes, Principal
Mrs. Katalin Kiss and Mrs. Fekete, Teachers
Hikádé Aladár utcai Alralános Iskola
Hikádé Aladár utca 14
Budapest XIX
H-1195 Hungary

Israel
Mrs. Miriam Aharon, Principal and Teacher
Chalamish Elementary School
21 Sheizaf Str.
Chalamish, Arad
Israel

Japan:
Mr. Eisho Kamiyama, Principal
Mr. Sato and Mr. Someya, Teachers
Shimura Dai-Ni Primary School
1-7-1, Shimura
Itabusiki-Ku
Tokyo,
Japan

Mexico
Dr. Jose Antonio Chamizo, Principal
Profa. Leticia Rojas Calvo, Teacher
Colegio Madrid A.C.
Calle Puente Numero 224
Ejidos de Huipulco
C.P. 14380 Mexico, D.F.
Mexico

Profa. Patricia Diaz Covarrubias, Teacher
Mr. Alfredo Hubenic Hicke, Principal
Colegio Vista Hermosa
Av. Loma de Vista Hermosa
#221 Fraccionamiento Vista Hermosa
Mexico 11000, D.F.
Mexico

Mr. Raul Mena Gutierrez, Principal
Profa. Yolanda Rico Porras, Teacher
Esc. Prim. 31-553-67-VI-x
Profr. Simitrio Ramirez Hernandez
Av. San Bernabe y Ojo de Agua s/n
Col. Sanbernabe Ocotepec
C.P. 10300. Mexico D.F.
Mexico

Profa. Alicia Goycoolea Inchaustegui, Teacher
Prof. Octavio Herrera Orozco, Principal
Escuela de Educacion Especial Numero 17
Grupos Integrados Especificos
Para Hipoacuscios
Francisco Marquez 144
Colonía Condesa
Mexico, D.F.
Mexico

Annex - 13
APPENDICES

The Netherlands
Dhr. R. Veldink, Teacher
Dhr. W. Terenk, Principal
Basisschool Park Stokhorst
Hoge Boekelerweg 135
Enschede
The Netherlands

New Zealand
Mr. John Jensen, Principal
Mr. Nigel Wilson, Teacher
Wakari School
150 Helensburgh Road
Wakari, Dunedin
New Zealand

Romania
Mrs. Cristina Atomei, Teacher
Mrs. Mineva Buzila, Principal
School No. 17
Str. Alexandru Petoffi nr. 16
cod. 71306, Sector 1
Bucuresti
Romania

Paunescu Aurelia, Principal
Ionescu Titana, Teacher
School No. 56
Bulevardul Republicii Nr. 209
Sector 2, Bucharest, Cod. 7321
Romania

Russia
Mrs. Inna Ierofeevnna Zabrodina, Principal
Mrs. Natalja Lazarevna, Tabachnikova, Teacher
Moscow School 91
Vorovskogo Str. 14/16,
Moscow 121069,
Russia

Sweden
Mr. Hakan Edman, Principal
Mr. Martin Engstrom, Teacher
Rannebergen Centrumskola
Fjällblomman 7
42449 Angered
Sweden

U.S.A.
Mrs. Sylvia Mills, Teacher
Mrs. Beth Park, Principal
Zuni Elementary Magnet School
6300 Claremont N.E.
Albuquerque, New Mexico 87110
U.S.A.

Zimbabwe
Ms. Ophelia Chihambakwe, Teacher
Mr. Allen James Mayger, Principal
Highlands School
P.O. Highlands
Harare
Zimbabwe

Annex - 14