

Chapter 2

Three Multinational Studies

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In chapter 1, Collis and Sakamoto explored characteristics of information technology (IT) societies and examined several common rationales for using computers in schools. In chapter 2, we introduce studies that have gathered evidence from many cultures about the effects of IT on students' cognitive and affective development. Two major themes are also introduced in chapter 2: How does one best come to understand the complex phenomenon of children interacting with IT? What "results" or findings are emerging across cultures and settings? This chapter sets the stage for the findings and their implications presented later in the book.

VIEWS ACROSS MANY CULTURES

Three multinational studies form the foundation of this book: the International Association for the Evaluation of Educational Achievement Computers in Education Project (IEA CompEd), the Information Technology in Education and Children Project (ITEC), and the Young Children's Computer Inventory Project (YCCI). Taken together, these projects span elementary, middle school (lower secondary), and secondary education. Their findings about the psychological impact of school computer use are based on data gathered in 19, 16, and 3 nations, respectively.

The studies present three complimentary views of the effects of computer use in school environments. IEA is at the most global level, looking at school systems, with their many different aspects—policy, practice, teachers, and principals. ITEC is at the next, more focused level—selected classrooms form the research units, with a more detailed study of the “ecosystems” that include children and IT. YCCI looks most specifically at the children themselves and how IT might be affecting their ways of thinking about themselves. An overview of each of the studies is provided in the sections that follow.

IEA COMPED

This international comparative survey of computers in education (CompEd) ran from 1987 until 1994. It was conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA).

The IEA

The IEA is a nongovernmental international organization of professional educational research centers from more than 50 national educational systems (Hayes, 1993). The organization has been in existence for more than 30 years. IEA researchers undertake international comparative research projects in core school subjects like mathematics, science, and native language mastery (mother tongue).

The history of IEA dates back to late 1958, when representatives from approximately 12 countries concluded at a UNESCO meeting in Hamburg that there was a strong need to conduct empirically oriented international comparative research in order to study problems common to many educational systems. The first feasibility study (conducted in 12 countries for a population of 13-year-old students) involved testing in reading comprehension, mathematics, science, geography and nonverbal ability. It proved to be successful (Foshay, 1962).

Since 1962, a large number of studies have been carried out. The First Mathematics Study was conducted in 1964 in 12 countries on national probability samples of 13-year-old and preuniversity students (Husen, 1967). The Six-Subject study was administered in 1970 in 21 countries and included the following subjects: science, reading comprehension, literature, French as foreign language, English as foreign language, and civic education (Carroll, 1975; Comber & Keeves, 1973; Lewis & Massad, 1975; Purves, 1973; Thorndike, 1973; Torney, Oppenheim, & Farnen, 1976). This study identified the following three populations of students: students ages 10 and 14 and students in the final year of full-time secondary education. Twenty countries participated in the Second International Mathematics Study, for which data were collected in 1981 (Robitaille & Garden, 1989; Travers & Westbury, 1989). Other studies in the 1980s were the Second International Science Study, Written Composition, and the Preprimary Study. Increasing numbers of countries participated in more recent studies: 32 in the Reading Literacy Study (Elley, 1992) and more than 40 in the Third International Mathematics and Science Study scheduled for completion in 1997.

In general, the design of IEA studies involves collecting data at different levels of the school system (country, school, teacher and student), taking national representative samples typically from three populations of students: (a) students near the end of primary education, (b) students in the first stage of secondary education, and (c) students in the second stage of secondary education. As can be learned from IEA reports, the publications are aimed at various audiences; the general goal is to promote the understanding of the functioning of education in order to contribute to its improvement (Husen & Postlethwaite, 1985; Passow, Noah, Eckstein, & Mallea, 1976). In this way, IEA studies serve two purposes: (a) to provide policymakers and educational practitioners with information about the quality of their educational systems in relation to relevant reference groups in similar nations, and (b) to assist researchers and policymakers in understanding the reasons for observed differences among educational systems.

The CompEd Study

The IEA CompEd was conceived as a two-stage investigation. The first stage (1987–1990) was aimed at describing the worldwide situation with regard to computer use in terms of many variables. Items measured included how computers were used, the extent and availability of computers in schools, the nature of instruction about computers, and estimates of the effects that computers are having on students, the curriculum, and the school as an institution (Pelgrum & Plomp, 1991, 1993). Data were collected in the participating educational systems from a representative sample of schools and teachers at the primary, lower secondary and upper secondary levels in the participating countries. Computer education teachers, and computer-using as well as nonusing teachers in mathematics, science, and mother tongue were asked about the current state of computers in education. Quite extensive analyses were also conducted in order to explore causal linkages between the different variables.

Data collection for Stage 2 of the CompEd study commenced in 1992, after 2 years of preparation. This stage consisted of two parts, the first of which was a repetition of the survey conducted in Stage 1. Data were gathered through questionnaires distributed to principals, computer resource coordinators, and teachers, with the form and content of the questionnaires closely related to those used in Stage 1. In this way, it was possible to determine the rate of development of computers in education over time.

The second purpose of Stage 2 was to study variables at the student level. Issues addressed included the extent to which students had access to computers, ways in which computers were used in schools and outside schools, the extent of student IT competencies, and student attitudes toward and perceptions of computers. Students were surveyed at three age/grade levels:

Population 1: students in the grade in which the modal age is 10 years.

Population 2: students in the grade in which the modal age is 13 years.

Population 3: students in the penultimate (next-to-last) year of secondary education.

Participating Educational Systems

Because some countries operate more than one educational system, IEA prefers to use the word *system* instead of country. Table 2.1 lists the systems that were participating in the CompEd Study.

TABLE 2.1
Overview of Project Characteristics: IEA-CompEd

	Years of Data Collection	
	1989	1992
Participating countries	Austria, Belgium-Flemish, Belgium-French, Canada-BC, China, France, Germany, Greece, Hungary, India, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Poland, Portugal, Slovenia, Switzerland, U.S.	Austria, Bulgaria, Germany, Greece, India, Israel, Japan, Latvia, Netherlands, Slovenia, Thailand, U.S.
School types	Elementary education Lower secondary education Upper secondary education	Elementary education Lower secondary education Upper secondary education
Respondents	School principals Computer coordinators Computer education teachers Teachers of mathematics Teachers of science Teachers of mother tongue	School principals Computer coordinators Teachers of professional computer education students
Research type	Survey	Survey
Instruments	Questionnaires	Questionnaires Multiple-choice tests Performance tests
Samples	National representative	National representative
Supported by	International Association for the Evaluation of Educational Achievement	International Association for the Evaluation of Educational Achievement

Snapshot of Major Findings

Some of the major conclusions from the survey in 1989 were:

- There were large differences between countries in access to computers.
- There was not enough hardware or software.
- Teachers were insufficiently trained.
- Extent of integration of instructional tool software was strongly related to availability.

Some major findings from the 1992 survey were:

- A greater number of schools were equipped with computers than in 1989.
- More hardware was available in schools.
- Hardware quality was improving, but slowly.
- There was more instructional software available.
- There was somewhat more integration, but not in all countries.
- There were fewer complaints about hardware/software shortages among educational practitioners.
- Not all students used computers.
- There were large differences within and among countries in computer-related knowledge among students.
- Students learn much about computers outside school.
- Boys knew more about computers than girls.
- Boys liked working with computers more than girls.

These and other findings are discussed in detail in chapter 3.

ITEC

ITEC stands for Information Technology in Education and Children and is the name of a long-term international research project associated with UNESCO and many other organizations. Phase I began in 1988 and was completed in 1992. It involved over its 4-year span more than 30 researchers in 25 countries. A brief overview of the ITEC Project is provided in Table 2.2.

Purpose

The central research question of ITEC can be stated succinctly:

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?

TABLE 2.2
Overview of Project Characteristics: ITEC

	Years of Data Collection
	1987-1992
Participating countries (through full term of the project)	Bulgaria Canada China Costa Rica France Hungary Israel Japan Mexico Netherlands New Zealand Romania Sweden U.S. (then) U.S.S.R. Zimbabwe
School type	Elementary education (ages 9-10)
Participants (throughout the project)	26 researchers, 18 school principals, 24 teachers, 660-680 children
Research type	Multiple case study, with mixed qualitative/quantitative methods.
Instruments and procedures	Observations of classrooms, interviews, questionnaires, analysis of videotapes of classrooms, and of children in more than 40 lessons involving intensive computer activities, inventories, and other aspects of case-study development and analysis.
Sampling	Teachers nominated as having a reputation in their countries as doing "good things with computers" in classroom lessons with 9-year-old children.
Supported by	UNESCO and various national research agencies in participating countries.

Preliminary questions were also developed for the first phase of the study:

- 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 indicators of “higher level cognitive functioning” is not too great, can a reliable methodology, usable in countries around the world, be found to measure the appearance and change of these indicators over time and in the complex context of the computer-use setting?

The 32 experts from 14 nations participating in the planning meeting held in Bulgaria, in May 1988, concluded that these kinds of questions were important to pursue:

The ITEC Project has the potential to make a strong contribution to both research and practice in the application of IT 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 IT in education. We have the opportunity to make a significant contribution, on behalf of the child, to the eventual recommendation of uses of IT in education most likely to be of positive impact to him and his development. (Collis, 1993, p. 7)

Method

The ITEC research was based on classrooms as research unit *ecosystems*, using Vygotskian theoretical foundations and mixed qualitative–quantitative research methods. It was decided to seek out existing classrooms in participating countries where teachers of students ages 9 to 10 were known to be doing “good things” in terms of computer-use instructional settings. Interviews were administered to principals at participating schools, and researchers in the participating countries completed observation checklists and interviews within 23 selected classrooms from 16 countries where computer use was already established with 9- and 10-year-old children and where the teachers had a reputation of working successfully with computers in their classrooms. Videotape footage was taken at many sites for later analysis by a team of researchers. This decision was made in order to maximize the chance of finding measurable effects on higher level cognitive functioning. At the close of observations in Fall 1990, 23 classrooms were involved in the study: one each from Bulgaria, Canada, China, Hungary, Israel, Japan, the Netherlands, New Zealand, Sweden, the United States, Russia, and Zimbabwe; two each from Costa Rica, France, and Romania; and four from Mexico. Thus, 16 countries were represented by approximately 680 students.

Analysis and Findings

In October 1990 most of the ITEC researchers were able to meet in Canada to examine the data and reach a consensus on ITEC findings. After viewing the videotapes of IT classroom activities and reviewing translated teachers' comments, the researchers categorized behaviors seen during computer-using student activities into the following 10 classes of evidence of metacognitive development:

1. Relating a problem to previous problems
2. Formulating appropriate questions
3. Trying alternative approaches
4. Evaluating one's actions
5. Analyzing problems
6. Recognizing relationships
7. Generating new ideas
8. Synthesizing information
9. Observing central issues and problems
10. Comparing similarities and differences (Collis, 1993).

These condensed categories were then used by the researchers to judge how many of the indicators they had observed in the classes that they had visited and videotaped. It was then possible to include researcher as well as teacher judgments when drawing conclusions from the data.

Some of the major findings of ITEC Phase 1 related to student metacognition were:

- 91% of the participating teachers reported observing one or more indicators of higher level cognitive skills among their IT-using students.
- The majority of the researcher-observers also reported one or more students displaying higher level thinking behaviors during the IT-using class.
- The student metacognitive skills most frequently observed by researchers were: (a) analyzing problems, (b) evaluating one's actions, and (c) formulating appropriate questions.
- Teachers and researchers reported that the students in IT classrooms developed new strategies for working with peers, were very motivated, and enjoyed and became more self-confident in their work (Collis, 1993, p. 252).

These behaviors associated with higher order cognitive activity occurred, regardless of type of computer use, of type or number of computers, type of instructional activity, or cultural context. The common factors were enthusiastic and good teachers, supported by principals convinced that computer-use was valuable for young children.

The findings from ITEC Phase 1 are discussed in detail in chapter 4.

YCCI

The Young Children's Computer Inventory Project (YCCI) was begun in 1990 as a longitudinal study of childhood computing in school. The project was designed to provide findings from students in Grades 1 to 3 to complement two other multinational studies (ITEC and IEA CompEd) addressing the effects of IT on students at higher grade levels (Collis & Jablensky, 1989; Pelgrum & Plomp, 1991). The project was conceptualized primarily as a quantitative policy study rather than a test of a psychological theory.

Project Rationale

The YCCI Project began as a Japan–U.S. collaborative effort to search for three kinds of evidence related to the use of computers in primary schools:

1. Evidence that early computer exposure in school can have a positive, lasting impact on children's attitudes toward computers.
2. Evidence that computers can have a positive, lasting effect on learning-related dispositions such as creative tendencies, motivation, and study habits.
3. Evidence that computer use by primary school students does not have significant negative side effects such as loss of touch with reality or diminished concern for the welfare of fellow human beings.

With respect to the first goal, previous studies had indicated that computer access can improve attitudes toward computers for students of high school and college ages (D'Souza, 1988; Justen, Adams, & Waldrop, 1988). A Soviet–U.S. study of 8- to 12-year-old children also supported this claim (Martin, Heller, & Mahmoud, 1992). However, no previous studies were known to have documented this effect for children as young as Grade 1 in school. The second goal was strongly emphasized in the United States. There teachers supported the early introduction of computers (Bruder, 1990) and previous research provided encouraging results (Clements 1987; Clements & Nastasi, 1988; Lehrer & Randle 1987; Lever, Sherrod, & Bransford, 1989), but pressure continued to mount to document the educational effectiveness of computers in school. The third goal was emphasized more strongly in Japan. There computers were purposely not introduced into public elementary schools during most of the 1980s (Knezek, Miyashita, & Sakamoto, 1990), while both the "light and dark sides" of increased computer exposure were being contemplated (National Council on Educational Reform, 1986, 1987).

The initial research plan was to compare quantitative data on attitudes among students at schools newly equipped with computers in Japan, with attitudes at comparable Japanese schools not possessing computers, using time-synchronized data from the United States as a cross-cultural control. Mexico was added as a new research initiative for 1992 in order to provide a third cultural perspective. An overview of the YCCI project is provided in Table 2.3.

TABLE 2.3
Overview of Project Characteristics: YCCI

	Years of Data Collection
	1990–1993
Participating countries	Japan Mexico (1991–1992) United States
School type	Primary education Grades 1–4 (ages 6–10)
Participants	7 schools in Japan 2 Japanese Advancement Schools in U.S. 2 schools in Mexico 5 bilingual Hispanic schools in U.S. 10 English-language schools in U.S.
Research type	Quantitative, pseudoexperimental, pretest–posttest Longitudinal trend analysis Qualitative enhancements
Instruments and procedures	Likert-type student self-report questionnaires Observations of labs and classrooms Interviews with teachers and administrators
Sampling	Urban, suburban, rural schools with and without computers paired in Japan; schools with computers selected for same categories plus public vs. private in U.S.; Spanish-speaking schools selected for geographic dispersion in Mexico and U.S.
Supported by	Fulbright Foundation Japan Society for the Promotion of Science Meadows Foundation Texas Center for Education Technology

Instrumentation

The YCCI instrument was developed to carry out project research (Miyashita & Knezek, 1992). It is a 48-item Likert-type self-rating questionnaire measuring six psychological dispositions (prevailing attitudes): Computer Importance, Computer Enjoyment, Motivation/Persistence, Study Habits, Empathy, and Creative Tendencies (Knezek & Miyashita, 1993). With respect to overall project goals, Computer Importance and Computer Enjoyment served as measurement indicators for Goal 1, whereas Motivation/Persistence, Study Habits, and Creative Tendencies served

as measurement indicators for Goal 2. Empathy was the measurement indicator for Goal 3.

Subjects

Student responses from 46 school administrations were included in the study (Knezek, Miyashita, & Sakamoto, 1994). Schools from Japan and the United States were included in questionnaire administrations for each of the years 1990, 1991, 1992, and 1993. Data from Mexico schools were also included in 1992. The pilot test year was 1990, with data collected from Grades 1 and 2 at three schools. In 1991, data were also collected from students in Grades 1 and 2, but at 14 sites. In 1992, data were collected from Grades 1 through 3 at 21 school sites, and, in 1993, from Grades 1 through 4 at 8 school sites. Some subjects at selected schools provided data three consecutive years, as they advanced through three grade levels.

Selected Findings

Some of the major conclusions drawn from the study were as follows:

- Computer use in primary school has a strong positive impact on attitudes toward computers.
- Educationally relevant computer activities can have a positive impact on motivation and study habits, over the course of several years.
- Gender differences with respect to attitudes toward computers do not generally exist at the first-grade level; they probably do not emerge until after Grade 3.
- Evidence indicates that creative children may choose to use computers, rather than computer use fostering creative tendencies.
- Student perceptions of computers and school are surprisingly similar for children residing in their native cultures in Japan, Mexico, and the United States.
- Japanese students whose families are temporarily (for a few years) residing in the United States maintain dispositions very similar to their peers in Japan.
- Bilingual Hispanic immigrants to the United States appear to commonly possess and maintain learning-related dispositions more positive than either their Spanish-speaking counterparts in Mexico or their English-speaking peers in the United States.

Nineteen major findings are presented in chapter 5.

WAYS OF KNOWING

The studies described in this chapter used several different techniques to determine the effect of computer use on children in school. The IEA study initially focused on the frequency and ways in which computers were used, and the

achievement-related outcomes of the introduction of IT. IEA sought to describe the impact of computer use on the "system" of education. The ITEC study, on the other hand, chose to observe students using computers in their normal classroom learning environments, and rely on the expert judgments of researchers, principals, and teachers to determine the impact. The focus was on the effect of computer use on student's higher cognitive functions. The YCCI Project asked the students to supply their own perceptions of how computer use was affecting their psychological dispositions. In some cases, the same students were asked to rate themselves for 3 or 4 consecutive years. These complementary methods become especially significant when findings from one method reconfirm the results derived through another. Cross-verification greatly increases confidence in the accuracy of the results.

One characteristic common to all three studies was their reliance on cross-cultural data, or, more accurately, their use of transnational data from many cultures. IEA gathered data from 21 educational systems in 19 nations, whereas ITEC looked at 23 classroom ecosystems in 16 countries. YCCI studied students in their indigenous cultures for 3 nations, plus a "between cultures" Japanese-living-in-America group of students, and a "first-generation-immigrant-culture" of bilingual Hispanic students residing in the United States. All studies had the potential of meeting the criterion that findings can be considered "robust" if they are supported in at least three cultures (Foschi, 1980). That is, if findings are replicated in at least three cultures, then there is a sound basis for expecting that similar effects will also be found in other cultures.

The next three chapters examine each study's cross-cultural findings. These form the foundation for the synthesis of findings and the generalized implications presented in chapter 6.

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