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ABSTRACT

An analysis of computer literacy curricula around the middle of the 1980s shows a remarkable overall shift away from teaching computing to teaching applications, information handling, and problem-solving. Computer use is no longer viewed as a goal in itself, but is introduced as a powerful means of fulfilling information needs and of facilitating learning and other instructional tasks. Some recent developments raise the question as to whether separate courses in computer literacy are still needed, or whether computer literacy goals could be better attained in other ways. Two interesting new lines of thinking can be observed. The first implies the integration of computer literacy goals with traditional educational goals by promoting the abandonment of separate computer literacy courses for the instrumental use of computers in existing courses. The second development, now being discussed in the Netherlands, can be characterized as a mixed approach, in which the more general computer literacy goals are realized via traditional subject matter courses, while more specific information handling goals are addressed in short separate courses. Both approaches are discussed, and links are established to The Computer in Education study of the International Association for the Evaluation of Educational Achievement (IEA) in order to provide a context for interpreting some of the study's results. (22 references) (Author/GL)

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INTRODUCTORY COMPUTER EDUCATION: DEVELOPMENTS IN A TIME PERSPECTIVE

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Paper presented at the Open Day of the IEA General Assembly,
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ABSTRACT

An analysis of computer literacy curricula around the middle of the 1980s show a remarkable overall shift away from teaching computing to teaching applications, information handling and problem-solving. This means that computer use is no longer viewed as a goal in itself, but is introduced as a powerful means in fulfilling information needs and the performance of other learning and instructional tasks.

Some recent developments lead to the question whether separate courses in computer literacy were still needed or whether computer literacy goals could be better attained in other ways. Two interesting new lines of thinking can be observed. The first one implies the integration of computer literacy goals with 'traditional' educational goals by promoting the abandoning of separate computer literacy courses for the instrumental use of computers in existing courses (exponents of this approach are Hunter (1984) and Collis (1988)). The second development, now being discussed in the Netherlands, can be characterized as a 'mixed' approach of having part of the computer literacy goals to be realized via 'traditional' subject matter courses, while more specific information handling goals should addressed in a short separate course. Both approaches are being discussed shortly. Finally, some links will be established to IEA's Comped study, so that this paper may provide a context for interpreting (part of the) results from this study, which will become available next year.

INTRODUCTORY COMPUTER EDUCATION: DEVELOPMENTS IN A TIME PERSPECTIVE

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INTRODUCTION

The organizers of this General Assembly asked me to present a paper on computer education in an international perspective, based on results from IEA's study 'Computers in Education' (Comped). As data collection in this study is still in full progress it is unfortunately not yet possible to present a paper based on this study. In consultation with our Korean hosts I will therefore discuss the topic of computer education from the perspective of developments which took place the last few decades, and especially the last decade, during which information technology pervaded all parts and aspects of our societies: the working place (jobs), the homes and also the schools.

These technological and societal developments resulted in a great variety of computer education activities in our educational systems. Russell (1985) distinguishes in this respect several distinct eras in the 30-year history of the 'computer literacy' concept. During the first era, the 1950s, the target group for introductory computer education courses consisted of graduate students and university professors, followed in the second era, roughly spanning the 1960s, by undergraduate students and the business community. Where during the first two eras the introductory computer courses were rather sophisticated, by the time the third era arrived, the level of sophistication was reduced appropriately for the new target audience, high school students (o.c., p. 935). Depending on the educational system in which we participate, we may differ in opinion with Russell whether we are at present in the next stage in this downward sequence (viz. with courses focused on the elementary school student), or still in the third stage of this development. Some people in a few educational systems may even have the opinion that this 'computer literacy' development has phased out, because computers (or more general, new information technologies) have already become such an integral part of the curricula of the schools in those systems, that no separate introductory computer education is needed any longer in these schools. Next year the results of stage 1 of IEA's Comped study will provide us with the empirical evidence as to the state of development in introductory computer education in a great number of educational systems.

However, Russell's analysis clearly illustrates that introductory computer education, often called 'computer literacy education', is not a stable, invariant concept, but one that has developed over time along with technological developments and the changing place of new information technologies in our societies. Especially since about ten years ago microcomputers entered the market place and started their triumphal march in our societies and our schools, many publications are reflecting the intensive discussions and the many --often very creative-- efforts in the domain of the introductory computer education or computer literacy education in our secondary (and sometimes also elementary) education. In this paper we will analyze these developments by discussing how introductory computer education developed over the last ten to fifteen years, and how this kind of curricula relates to the existing, 'traditional' subject matter areas in our schools' curricula. Special attention will be given to the approach in which information handling skills are emphasized as important educational goals, evolving from nowadays technological and societal developments. Finally, some links will be established to IEA's Comped study, so that this paper may provide a context for interpreting (part of the) results from this study, which will become available next year.

The restriction of the topic and the limitation of this paper do not allow for discussing important related topics and problem areas like the changing role of teachers, the implementation of computers in the schools, and the integration of computers in the curricula of existing subject matter domains; see for these e.g. van den Akker, Keursten and Plomp, in press; and Fullan, 1988).

COMPUTER LITERACY UNTIL THE MIDDLE OF THE 1980s

In the literature many labels can be found referring to introductory forms of computer education, like computer awareness, computer appreciation, computer initiation, computer familiarization, informatics for all, and computer literacy. There exists no consensus as to the meaning of these terms, although they are often used to indicate distinct levels of computer proficiency (Plomp and van de Wolde, 1985). In the first part of this paper we will indicate all kinds of introductory computer education with the term computer literacy.

A representative and illustrative definition of computer literacy is the one used in the computer literacy project of the Minnesota Educational Computing Consortium: computer literacy is whatever understanding, skills and attitudes one needs to function effectively within a given social role that directly or indirectly involves computers (Anderson & Klassen, 1981). A similar, but more elaborated definition is proposed by Lockheed et al. (1983) in their publication of survey items for assessment of computer literacy in schools: "computer literacy may be defined as whatever a person needs to know and to do with computers in order to funtion competently in our information-based society. Computer literacy includes three kinds of competence: skills, knowledge, and understanding. It includes (1) the ability to use and instruct computers to aid in learning, solving problems, managing information; (2) knowledge of funtions, applications, capabilities, limitations, and social implications of computers and related technology; and (3) understanding needed to learn and evaluate new applications and social issues as they arise" (o.c., p.8 ff).

Both definitions imply that computer literacy is not an invariant concept. Computer literacy courses could and can vary greatly, depending on the social role of the learners, (e.g. adults or high school students), the state of technology, and, in relation to the latter, what in our respective educational systems is perceived as what persons need to know (e.g. emphasis on programming in the late 1970s, but more on applications in the first half of the 1980s; see Lockheed & Mandinach, 1986). Culbertson (1986) nicely illustrates this by distinguishing the following meanings of computer literacy:

- operational literacy, in the meaning of knowing the basic components of hardware and software and being able to demonstrate the machine-related skills needed to make computers work;
- instrumental literacy, in the meaning of using computers as an instrument in accomplishing certain tasks (for students in schools: learning tasks);
- literacy as algorithmic reasoning, to be acquired through computer programming;
- literacy as education for altered roles, in which comsumer literacy, worker literacy and citizen literacy can be distinguished.

Goals of computer literacy courses

Contextual limits of what computer literacy may comprise can be concluded from the objective areas of computer literacy mentioned by many authors in the early 1980s: hardware, software, programming and algorithmization, computer applications and usage, and social consequences and ethical issues (Kotte, 1988).

Van de Wolde (1984) and Plomp and van de Wolde (1985) summarized the goals of these 'early' computer literacy courses in the following categories:

- development of proficiency in using computers and computer applications: computer literacy courses differ greatly in the kind and level of computing skills;
- development of understanding of a variety of present and future computer applications, and their implications for life at both the social and individual level;
- elimination of computer related phobias and anxieties: this goal was especially of importance at that time when microcomputers started to pervade our working places and many adults appeared to show concems and even resistance towards computer technology (Jay, 1981);
- promotion of a deeper understanding of the capabilities and limitations of computers: partly related to the preceeding goal, this one refers to the development of an adequate 'functional image' of computers.

Besides these computer-related goals, computer literacy is often connected with two general educational goals, which in themselves were emphasized in education long before new infomation technologies were introduced (Plomp & van de Wolde, 1985):

- development of skills in problem-solving and procedure specification: in order to become a productive user of information technology one has to acquire skills in the analysis, synthesis and evaluation of models and algorithms;
- development of information handling skills: to be literate in an information society one needs to be competent in both formal and informal aspects of information handling.

Especially the latter general goal makes computer literacy part of a much broader skill called 'information literacy', which refers to more kinds of hardware than just computers (Hade, 1982). Several authors emphasize that in an information society one has to be competent in information handling and problem solving by understanding, creating and evaluating messages using various kinds of media; they state that introductory computer education must reflect this broader context (AEIT, 1984; Collis, 1988; Hunter, 1984). We will discuss their approach in the next chapter.

Content of computer literacy courses till 1984

Differences between computer literacy curricula do not so much reflect differences in the nature of the above mentioned goals, as well as differences in the weighting of these goals. Van de Wolde (1984) and Plomp and van de Wolde (1985) subdivided computer literacy curricula developed until 1984 according to their content structure into the following categories:

(i) Computer (hardware) oriented. These curricula, emphasizing the bits and bytes of computing and often supported by mainframes, were prevalent in the early 1970s. Since hardware develops at an increasing rate, and related knowledge becomes obsolete at a corresponding speed, only a few curricula still put hardware facts and procedures in a central position. It is often argued that computer education should only stress invariant aspects of information technology, and be built up in such a way that technological developments will not necessarily affect its content. One of the influential proponents of this approach is Luehrman (1981) who advocates that to become a computer literate person it is not sufficient to just learn about computers, but to 'do' computing, that is in the 1970s to do programming. Until the mid 1980s many teachers still paid much attention to 'peeks and pokes', taking for computer literacy education an elementary course in BASIC programming. This may have been partly due to the fact that the background in mathematics or science of many computer literacy teachers at that time did not necessarily make them feel comfortable in teaching 'soft' subjects, such as the impact of new technologies on society.

(ii) Application oriented. In many curricula aimed at computer awareness or literacy the evaluation and (or) use of computer applications frequently plays a central part. Here the emphasis is on dealing with application environments rather than programming environments, as for most purposes schools already had better ready-made software at their disposal than they would ever be able to produce by themselves.

(iii) Algorithmics oriented. These courses are mainly structured around problem-solving strategies and principles of algorithm construction. Though this emphasis is more often found in computer science education at the upper secondary level, algorithmic or procedural thinking was often considered to be the main issue of computer literacy.

(iv) Information oriented. Some curricula tend to deal with information or information needs rather than with computers, as Marland (1981) has shown. In this approach, information technology based on micro-electronics is integrated with older forms of information technology and the computer is considered as just one of the means available (albeit a very powerful one) for producing, storing, retrieving, using, or communicating information.

In summary, seen from a historical perspective, around the middle of the 1980s computer literacy curricula in many countries in Europe and Northern America have shown a remarkable overall shift away from teaching computing to teaching applications, information handling and problem-solving. This means that in education computer use is no longer viewed as a goal in itself, but is introduced as a powerful means in fulfilling information needs and the performance of other learning and instructional tasks (paraphrased from Plomp and van de Wolde, 1985, pp.252/3).

In the following chapter we will discuss how this shift in emphasis may have an influence on the place of computer literacy in curricula of schools.

SOME RECENT LINES OF THINKING

Parallel to the shift in emphasis away from teaching computing, concluded at the end of the preceeding chapter, some other developments took place. The hardware became cheaper and at the same time more powerful, leading in many of our countries to an increasing number of schools equipped with many and more powerful computers, while in many households computers became available also for children providing them with kinds of computer literacy. Although courseware development remains a major problem in the process of introducing computers in education, especially in the Anglo-Saxon countries an increasing number of good educational software in the 'traditional' subject matter domains was developed. Besides, a trend towards open, content free software (making educational use of word processors, data bases, etc) could be observed, allowing teachers in almost all subject matter areas to adjust computer applications better to their style and content of teaching.

These parallel developments lead to the question whether separate courses in computer literacy are still needed or whether computer literacy goals could be attained better in other ways. Although separate computer literacy courses still exist, two interesting new lines of thinking can be observed. The first one implies the integration of computer literacy goals with 'traditional' educational goals by promoting the abandoning of separate computer literacy courses for the instrumental use of computers in existing courses (exponents of this approach are Hunter (1984) and Collis (1988)). The second development, now being discussed in the Netherlands, can be characterized as a 'mixed' approach of having part of the computer literacy goals to be realized via 'traditional' subject matter courses, while more specific information handling goals should be addressed in a short separate course. Both approaches will be discussed shortly.

I. Computer literacy as curriculum - computer integration

Hunter (1984) and Collis (1988) have different starting points and rationales resulting in similar proposals for integrating computer usage in the existing curriculum of the schools.

Hunter (1984) starts from the 'philosophy' that schools have no choice but to adapt to the information age. Learning about computers is only a part of that adaptation. "The more fundamental need is for children to learn to handle information, to solve problems, to communicate with people, and to understand the changes that are taking place in their society. If computers are the powerful intellectual tools they are claimed to be, then they should help in the achievement of these goals" (o.c., p.6). She takes the position that there is no need for a separate computer literacy course or unit, but that computer related objectives and activities must be integrated in the curricula of mathematics, social studies, science, and language arts. "For students in grades K (= Kindergarten) through 8 computer literacy means the ability to use suitably programmed computers in appropriate ways to assist in learning, handling information, and solving problems; and the ability to make informed judgments about social and ethical issues involving computer and communication systems" (o.c., p.9). By designing computer-related activities to support the regular curriculum, computer literacy is viewed as a means, not as an end; there will moreover be less risk of developing a computer literacy curriculum which is obsolete before it is used. From these starting points Hunter designed a computer literacy curriculum integrated with the regular curriculum for mathematics, social sciences, sciences and language arts, organized into six strands: (1) using and developing procedures, (2) using computer programs, (3) fundamental concepts about computers, (4) computer applications, (5) impact of computers on society, and (6) writing computer programs. The strands are interrelated, and include a sequence of objectives to be achieved throughout grades K to 8.

Collis (1988) states that much computer use in schools is a result of social pressure, and a response to a sense that computer literacy was a 'survival skill' that even young children must obtain. The most typical response at the elementary-school level was to obtain one or two computers and provide drill and practice in a separate room; at the grade 7-10 level to offer a separate computer literacy class; and at the grade 11 and 12 level to establish computer science courses. According to Collis this is an underutilization of computer resources, resulting from an inappropriate or unproductive view of educational computer usage itself. This situation is reinforced by the difficulties involved in bringing about any real change in the established teaching and learning procedures present in schools: avoidance of change by teachers if there is no personal need to change their instructional practice. Taking the trend that application programs became a major focus for computer literacy experiences she proposes, in stead of a single course (or units) in computer literacy, an approach to computer use in schools that begins with educational needs related to the existing school curriculum, as well as with applications that attune to the traditional organizational patterns and instructional styles of teachers by focusing on effective uses of computers in the whole-class setting. In her plan for curriculum-classroom computer integration she presents more than 100 lesson ideas for grades 1-12, in which school computers can be used to help teachers in adressing pervasive educational problems. The problem areas are (1) writing and the writing process; (2) comparing and contrasting ideas, objects, and processes; (3) organizational and inquiry skills; (4) locating, accessing, and evaluating information; (5) interpreting and criticizing graphs; and (6) problem solving. The computer applications are in the four major curriculum areas: mathematics, science, social studies, and language arts. Much of the software she deals with is tool-type, content-free software (such as word processing, data-base management, graphing programs, spreadsheet), because (1) content-specific software quickly becomes outdated, and (2) most schools cannot afford to acquire an extensive variety of costly commercial packages.

In summary, both Hunter (1984) and Collis (1988) illustrate that trends in computer literacy are away from teaching computing towards the teaching of applications and information handling. Both believe that the latter type of goals the best can be realized integrated with the 'traditional' curricula of our schools, not just because applications and information handling are empty in itself and need substance for practicing, but because in this way computer literacy can be taught the best, and also because in this way a more effective use of computers in education can be established. The fact that Hunter developed her approach for grades K to 8, while Collis did it for grades K to 12, is not a fundamental difference between their approaches.
The question which remains is whether the characteristics of the new information technologies and its uses are not such that it is justifiable to pay attention to it separately in the curricula of our schools, next to the approach to computer literacy via computer applications which are instrumental in attaining the goals of other subject matter areas. The approach chosen in the Netherlands is an illustration of an affirmati. e answer to this question.

II. The 'mixed' approach in the Netherlands

In the Netherlands since the early 1980s much attention is given to the question of how information technology could be introduced the best in Dutch education. From the very beginning on one of the starting points of the Dutch policy was the need to prepare the young to function adequately in a society permeated with information technology (IT) by giving them also a basic education in IT, next to the starting point of using computers (or more generally new technologies) instrumentally to improve instruction and learning (Plomp & van Muylwijk, 1985). All Dutch policy documents and advisory reports agreed on that this basic education should be part of junior secondary education (grades 7,8, and 9) and would encompass basic skills in the domain of information science as well as computer science. This introductory education was called 'information and computer literacy' (ICL). A first operationalization of these skills and knowledge clearly illustrates both the information handling orientation and the computer orientation (AEIT, 1984; Plomp & van Muylwi k, 1985):

a. the selection, production, collection, storage, processing, retrieval and distribution of data and messages given a certain problem or defined need for information, with or without the help of a computer;
b. the drawing of information from data and messages;
c. the assessing of the reliability and the precision of data and messages and of the validity and relevance of the drawn information for the given problem;
d. the principles of the hardware and software architecture;
e. the design of algorithms and the principles of programming.

Later developments in the Netherlands also followed the international trend away from the teaching of computing towards the teaching of applications; in the Dutch case the teaching of information handling and computer applications.

With respect to the place of introductory computer education in the curriculum of the junior secondary schools, the present approach in the Dutch policy can be characterized as a 'mixed' approach. When preparing the plans for a reform of the junior secondary education (grades 7, 8, and 9), the government decided to have ICL as a very small, separate course (20 lesson periods) in the curriculum (next to 13 other subject matter domains). However besides this small course, elements of ICL and information technology (IT) will be incorporated in other subject matter areas, such as language arts, mathematics, and tecnnique (another new course in the Dutch secondary school curriculum).

For each of the subject matter domains of the reformed secondary education a committee was appointed to develop the goals and objectives for these domains. The development committee for ICL was not only responsible for generating the goals and objectives for the 20-lesson course in ICL, but also for the elements of ICL and IT in other subject matter domains. In their proposal to the government, the development committee for ICL chose explicitly for ICL as the teaching of computer applications and of information handling skills. In its report the Development Committee ICL (DCICL, 1989) makes a distinction between the subject matter domain of information and computer literacy (ICL) and the small course on ICL, planned for the new junior secondary curriculum, which can be considered as only a part of the subject matter domain. Goals and objectives for the subject matter domain of ICL are very broad and have to be realized not only via the separate ICL course, but also via other courses. The operational goals and objectives for the subject matter domain of ICL proposed by the development committee are reflecting their orientation on information handling and computer applications. They are organized in the following four categories:

A. Data, data-processing, information:

students have insight in processes of purposive data-collection, -processing, and -retrieval, and are able to deal with comprehension with data and information;

B. Data-processing systems:

students have a correct functional image of data-processing systems (such as the computer) and, on the basis of this, can use these systems;

C. Applications of information technology:

students know application possibilities of information technology, and can use some applications;

D. Social impact of information technology:

students must have an insight in the societal impact of information technology.

All categories of goals and objectives for the subject matter domain of ICL need to be realized in the curriculum of the new junior secondary school, at the one side by having a small separate course in ICL, and at the other side by having computer applications in as many other subject matter domains as is functional and feasible. The committee claimed for the separate course in ICL 40 lesson periods (in stead of the proposed 20 periods in the proposal of the government), while the time spend to computer applications in the other courses should altogether be the equivalent of 80 lesson periods.

The public discussions about the proposal of the committee reflect a general acceptance of the chosen emphasis, as well as of the 'mixed' approach proposed by the committee; many development committees for other subject areas are developing goals and objectives reflecting applications of information technology. However, the government did not adopt the idea of expanding the separate course to 40 lesson periods.

If the proposal for the revised junior secondary education will be accepted by the Dutch Parliament, then very soon this 'mixed' approach towards introductory computer education with an emphasis on information handling and computer applications will be reality in all Dutch (junior secondary) schools.

In the next section we summarize the rationale the Development Committee ICL used in their report (DCICL, 1989).

Rationale of the Dutch approach

The basic starting point is that the teaching of an basic introduction to new technologies, regardless of teaching it as a separate course or integrated as applications in other courses, should have three components: elements from information science, elements from computer science, and computer applications.

The central focus in the computer science aspects is the hardware and software, and their operation, but only from an operational angle (that is: students must be able to operate the computer as a machine) and an instrumental angle (that is: students must have a correct functional image of the computer to be able to use the computer purposefully). So, one of the goals of this basic education is to prepare students for the operation and the application of computers. In this way, ICL as a basic education serves as a necessary basis for more fundamental knowledge and skills.

ICL has also information science aspects, because it will deal with knowledge and skills needed for data-collection, -organization, -processing, and retrieving --which usually come up only implicitly in applications in other contexts in the more 'traditional' subject matter areas. Here we have to do with a class of skills for which the computer is an important, versatile aid.

The general idea behind emphasizing information handling skills is that data and information are different concepts. Data are codified signs and messages, and therefore controllable and incontestable entities. Information arises from processing and interpreting data, following certain rules depending on the need for certain information. It is essential that students realize that data and information are not necessarily identical, and that the same data may imply different information for different persons. It is also important that students know that data can be collected, organized, processed and retrieved in many ways and for many purposes. Important elements of information science are therefore:

- there are many kinds of data bases (among them electronical ones) which can and will be used by everybody; examples are dictionaries, encyclopedias, registers, time tables of buses and trains, videotex systems, research data, examination files, etc.;
- data bases need a structure or organization to make the collected data accessable and usable; examples are alphabetical, or numerical, or chronological structuring;
- the processing of data (such as ordening, selecting and combining of data) taking place within a certain data structure, with the purpose of relating the original data to the desired information, follows certain rules;
- the interpretation of the results of the data processing needs to follow rules, which are depending on the stated goals, and which has to meet criteria like acceptability, reliability, controllability, and validity.

As data-collection and -processing (with or without the computer) have to be related to 'contents', the third element of ICL consists of the applications of new technologies in other subject matter areas. To these applications is being referred in the Dutch policy plans, when there is a reference to elements of ICL and IT in other subject matter domains. Here we have to distinguish two clearly different aspects. First, certain goals and objectives of information and computer literacy can be realized the best in the context of other subject matter areas. But complementary to this, it is supposed that certain goals and objectives of those other subject matter areas can be realized better by the instrumental use of the computer. This can be illustrated with the example of word processing. In other subject matter areas than ICL (not only language arts), word processing is a 'means' to realize certain goals (often better than in before). From the perspective of ICL, using word processing in other courses, such as mother tongue, will contribute to the perfection of the correct functional image that a student must acquire, to the increase in the skill of using computers (the operational aspect of computer use), and the clarifying of the concept of word-processing as an important application of information technology (the instrumental aspect of computer use). Also societal aspects of the application of new technologies can be discussed when students work with applications (for example, in word-processing the changes in the printing and publishing professions).

The Development Committee proposes that in realizing the goals and objectives in the subject matter domain of information and computer literacy (ICL), which consists of the three above mentioned components, <u>three phases</u> can be distinguished: (1) preparation, (2) applications on other domains, and (3) concluding separate course. This approach of the subject matter domain of information and computer literacy (ICL) is schematized in the following figure:

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<---------------------------junior secondary education------------------>further
                                                                          education
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subject matter domain of
Information and Computer Literacy:

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<--1.preparation----->2.applications---->3.separate course------>further
    (operational &     (in other          as a closure            education
    instrumental       subj.matter        (specific knowledge
    computer use;      domains)           and skills of
    elem. concepts                        inform. handling)
    inform.science)
```

<u>Explanation</u>:

<u>Applications</u> of information technology <u>in other domains</u> are only possible if students possess knowledge and skills to operate the computer as an instrument. Therefore a <u>preparation</u> to applications is needed in which students learn operational and instrumental aspects of computer use, as well as some introductory elements from information science, such as the concepts of data and information, and ways of ordening data. After students have become familiar with a number of applications in other courses they are prepared to study information handling skills. So, to assure that all the goals and objectives of ICL will be attained a short, <u>concluding separate course</u>, in which specific information handling knowledge and skills (on a general level, transcending other subject matter areas) will be taught. Such a concluding course is desirable, because in the computer applications in courses such as mathematics, science, language arts, social studies, etc., goals and objectives of those courses are the central focus; while it is believed that for the attainment of the goals and objectives of the subject matter domain of ICL it is necessary that students explicitly learn some general principles and skills of information handling, as well as societal aspects of the new

technologies, from an information science perspective. By teaching these information handling goals and objectives in the context of a separate course, and not in competition with goals and objectives other courses, the experiences with computer applications in other courses can be lifted to the level of knowledge and skills with respect to data-collection, -organization, and -processing.

The Development Committee for ICL operationalized the subject matter domain of ICL in such a way, that the separate course with an emphasis on information handling (with the help of computers) is the essential closure of a 'route' consisting of a preparation (mainly consisting of an operational and instrumental introduction of computer use) and a substantial middle part of computer applications in other courses. In the proposal to the Dutch government, the committee advices to reserve the available 20 hours for the separate course at the end, to have at least 80 hours of computer applications in other courses (math, science, language arts, social studies, technique, arts), while the schools are suggested to organize the operational and instrumental preparation in accordance with the entry level of the students entering secondary school in grade 7.

In summary, the approaches of Hunter (1984), Collis (1988) and in the Netherlands (DCICL, 1989) illustrate that the trend away from the teaching of programming to the teaching of applications and information handling evoked the issue of the place of introductory computer education (computer literacy) in the curriculum. Research is needed to answer the question whether for the sufficient acquisition of information handling knowledge and skills the approach proposed by Hunter and Collis is adequate, or whether the Dutch 'mixed' approach should be adopted.

It is important to realize that these lines of thinking generate in introductory computer education a new relation between programming and applications. In the 'early' days doing something with computers as part of computer literacy education was only possible by teaching students programming: being able to program meant being able to apply the computer (Luehrman, 1981). Nowadays, with the many open-ended and tool software, it is not longer necessary to teach programming in order to let students apply the computer. In much tool software student activities (such as using a data base or a spread sheet program) are of such a type that we can say that principles of programming are being applied. If teachers explicitly emphasize and instruct these principles to students, an important goal of information and computer literacy teaching can be attained without the direct teaching of a computer language.

We know from research that the real use of computers in the curricula of our schools is often very limited, especially if compared with the possiblities and the claims formulated in the literature (Becker, 1986; Inspectorate, 1986; Plomp, Pelgrum & Steerneman, in press). The developments of introductory computer education over the last decade, and the recent lines of thinking outlined in this paper, give therefore rise to many questions about how the real situation in our schools is; for example

- to what extent are the trends in computer literacy indeed away from the teaching of programming to the teaching of apllications and information handling realized in our educational systems? If not, what kind of variables related to national and school policies can explain differences in objectives and content of computer literacy education, both within and between educational systems?
- is introductory computer education being taught in separate courses, as modules within existing courses (for example, mathematics), or via computer applications in existing courses?
- do we find in countries where much courseware is being developed and available for the schools (for example, USA, France, Canada) indeed less separate computer literacy courses, and more emphasis on the integration of computer applications in the curriculum?
- if there is a discrepancy between possibilites and the actualities of computer use, what kind of problems are experienced on school level as important causes?

To these and many other questions the IEA survey may provide us with empirical answers. In this study, questionnaires at national, school and teacher level address many of the issues that are raised in this paper.

The questionnaire at national level, for example, covers many variables related to national (provincial) policies that are relevant for answering the research questions presented above:

- number of computer education lessons in prescribed lesson plans;
- policy on integration of computer education in existing school subjects;
- prescribed curriculum content for computer education.

At school level relevant variables are, for example:

- computer education as separate subject;
- percentage of students per grade level that particepates in introductory computer education;
- number of lesson periods for computer education by grade;
- school policies regarding the content of computer education;

- availability of software;
- existence of introductory computer and/or programming courses.

The questionnaires for the computer coordinator and the computer education teacher(s) address, for example, variables like:

- kinds of educational software available in schools, and for which subject matter areas;
- kind of computer applications in the school;
- for what instructional activities computers are used, and how often;
- number of teachers using computers;
- instruction about computers as a separate course or as part of another subject;
- availability of inservice training facilities;
- problems experienced in computer use.

The data base based on these instruments will become available next year and will allow us to report to you then some answers to the type of questions stated above. The planned stage 2 of this study (1991-1994) may allow us to study some of these developments over time.

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