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Tibor Vasko and Darina Dicheva

Introduction

The process of education is as old as the human race. All through human history this process has become increasingly formalized and socialized (one milestone being, for example, the introduction of compulsory education). These steps made the responsibility of education for the future of the whole society (a Nation) more explicit. In spite of the fact that this responsibility has not been questioned for centuries, there are many very recent documents monitoring the disquieting state of the educational process which may not fulfill this responsibility. These signals are coming even from countries which devote considerable resources to education.

Because of its importance, education is an inherent part of development strategies in most countries, industrially developed or developing. Appropriate institutions (ministries) are designing policies aiming to influence the behavior of individual actors in education processes in the desired direction. The efficiency of individual measures taken in achieving the selected objectives is difficult to predict because the educational process at large is a complex social phenomenon where several disciplines are involved. The resulting semantic and methodological differences make it sometimes difficult to achieve a fruitful communication through interdisciplinary barriers. Because cultural factors are also involved cross-national, cross-cultural and comparative studies might bring a specific insight into the process. This by no means proves that one could easily transfer experience from one country to another.

Sources of Increased Interest in Education

One long-term source of growing interest in modern education is created by even faster scientific and technological development. With an increased amount of information circulating in the national economy and in modern products as proponents of "information society" point out the knowledge to handle the information by computers is considered particularly important.

More generally speaking the importance of an educated labor force has been known for centuries, but more exact explorations made by Denison (1962) concluded for the USA using methods which became known as "growth accounting" that:

> Increased education is not only one of the largest sources of past and prospective economic growth. It also is among the elements most subject to conscious social decision.

Five years later the study was repeated for Europe and reached a similar conclusion (Dennison 1967):

> The increase in education has been a principal source of growth in the United States and it is important to know that European countries have not been achieving more rapid growth by raising the education of the labor force more rapidly.

More recently Drs. Millendorfer and Hussain (1985) tried to correlate the labor force qualification by means of neoclassical production function and as they claim (see Figure 1) received a reasonable correlation between the economic growth (in GDP/capita) and qualification of the labor index (including developing countries), even if we neglect the time lag between the causal factors. Recent economic decline only increased this challenge. We are inclined to call these a "pull" factors.

There are valid even more for modern technologies. After serious studies Soete and Freeman (1984) expressed important views that education and training in a high technology environment are sometimes a more important ("intangible") investment than the physical capital investment and should not be considered as consumption or current cost.

Out of curiosity we cannot avoid a quote from the early work of K. Marx made around 1857 when he wrote referring to the increase of the free time of the society: "The savings of work-time is equal to increase in free-time, i.e. time for full development of an individual, who acts back on the productivity of labor as the greatest productive force. He can be considered from the point of view of immediate production process as production of *capital fixe;* this capital is the man himself." (Translation and italics are mine).

Among "push" factors one can include influences of the fact that resources devoted to education are large and in some national institutions managing public funds are predominant. Higher expenses then for general education are recorded for vocational training. Authorities responsible for education often strive to decrease those resources and yet to meet the increasing requirements. This is another factor pushing innovation into the education process.

Educational policies have to deal with intricate economic, political, managerial, and technical problems where the introduction of computers is only one issue among many others. To illustrate it we would like to mention a most recent interesting study of educational policies of seven countries (Hough 1984) where no one explicitly mentions the introduction of computers.

Some Policy Responses

A fragmented overview of some policy responses of different countries is outlined in the following paragraphs.

USA

In the USA, research activities and pioneering efforts in applying computers to education started as early as 1966. Between 1966 and 1971 over 150 million dollars were spent by the government (US Office of Education, National Science Foundation), more than this sum was spent at both the state and local levels for funding research projects on the introduction of computers into the educational system. The best known large scale projects were developed at several universities – the Plato Project at the University of Illinois; the TICCIT Project at the Brigham Young University at Provo; the PCDP Project at the University of California, etc.

The US educational system is very decentralized. As the state governments are fully responsible for education there is no general plan for the introduction of computers into schools all over the country. This process results from decisions and efforts at regional and local levels. Educational policies vary widely from state to state. The governments of some states encourage the introduction of computers and provide funding, support and expertise, for their schools. In other

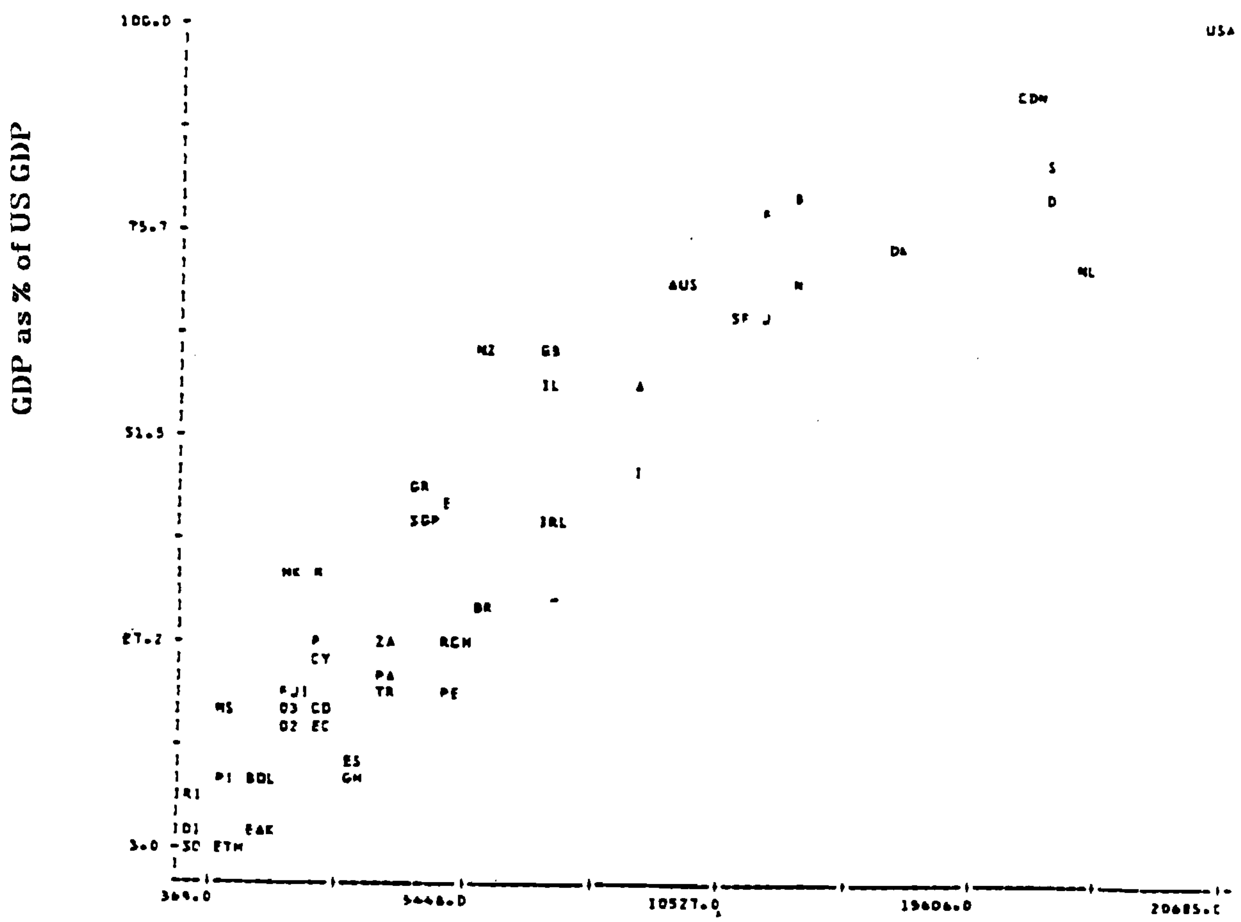

Figure 1. Qualification of Labor Index (Source: Millendorfer and Hussain, 1985)

states, schools themselves have to shop for computers. For example, in California because of a law providing tax incentives for computer donors, producers donated 13,000 microcomputers to schools in 1983. In Tennessee, the first statewide mandated computer literacy program "Computer Skills Next" has placed 14,000 Apple microcomputers in schools across the state over the last two years. Because of competition in the US school market, computer manufacturers propose either large educational discounts or give free computers to schools if the government agrees to tax exemptions for the manufacturers. For example, Apple has two discount programs, the first program gives schools a better price on larger orders, the second allows a school to acquire computers immediately and make repayment over a three year period (D'Ignazio 1986).

During the last several years, the number of computers in US schools has steadily increased from 33,000 in June of 1981, to 130,000 in 1982, to 630,000 in June 1984 and to about 700,000 in 1985. For 1983–1984 the total expenses for equipment was about 200 million dollars. In January 1983, about 60 percent of all US schools had at least one microcomputer, however, in 1985 this number changed to 90 percent. Some experts predict that there will be 20 students per microcomputer towards the end of 1987 (as compared to 34 students per micro in 1985) (Hebenstreit 1986).

The situation is different for university education. Some universities already require that a student owns a microcomputer. For example, according to Clarkson University's student computer plan, by 1986 every undergraduate student and most faculty and graduate students should have a personal computer (Bray 1984).

The results of the second national survey of elementary and secondary schools in the US, conducted in 1983 (Becker 1985), showed that 85 percent of secondary schools and 42 percent of elementary schools have at least one microcomputer. A majority of micro owning schools have fewer than 5, and less than 8 percent have as many as 15 microcomputers, 10 percent of secondary schools with micros have their computers linked into a network. Although schools have been doubling their microcomputers every year for the past several years, in 1985 the majority of schools had fewer than 10 microcomputers.

Statistically, microcomputers in schools are used for about two to three hours per day (in primary schools a microcomputer is used about eleven hours per week; in secondary schools - about thirteen hours per week).

At the elementary school level the trend is to give many students access to computers, unlike the secondary level where the trend is to give longer access time to only some of the students. The median number of minutes of computer time per week per student user in elementary schools is 23 and in secondary schools it is 45. Typically in secondary schools 64 percent of the students who use a micro get more than 30 minutes of computer time each week in comparison to only 24 percent of the student users in elementary schools.

As there is no national policy for the introduction of computers in schools there is no general plan for teacher training and educational software development. Teacher training is left to local initiatives. The production of educational software is almost completely left to private companies (about 750 companies are producing software packages for schools). In a survey of commercially available educational software (Williams & Williams 1985) it is estimated that mathematical applications (28 percent) exceed all others. This is followed by language arts (21 percent), science (11 percent), social studies (6 percent), reading (5 percent) etc. Roughly 69 percent of all programs have versions for the Apple microcomputer.

Several institutions have been created that aim at helping schools in their choice of hardware and software: the Minnesota Educational Computing Consortium, the National Co-ordinating Center for Curriculum Development, the information center MICROSIFT at the Northwestern Regional Laboratory, the Conduit Consortium (Iowa), etc.

Typically in elementary schools, about 40 percent of the time microcomputers are used for drill-and-practice mainly in basic mathematical and language arts skills. In secondary schools about 70 percent of computer time is used for teaching computer literacy, and only 18 percent is used for drill-and-practice. The majority of microcomputer owning schools teach informatics as an optional subject during 30 to 60 hours. Teaching informatics, nearly everywhere, means giving instruction by using the BASIC programming languages (98 percent of these schools use BASIC, 5 percent use FORTRAN, Logo and Pascal; 84 percent teach programming only in BASIC).

The results of the second national survey shows that as schools gain greater experience in using microcomputers, there is a decline in their usage for drill-and-practice. Also, there is a consistent increase in the use of microcomputers for teaching programming both in secondary and elementary schools.

Although during the last several years, the general trend was towards using computers for teaching computer literacy, presently more and more educators turn their attention to using the computer as a teaching and learning tool in various school disciplines and towards integrating computer education into the curriculum. An impressive project called "Project Athena" is now under way at the Massachusetts Institute of Technology. This project is an experiment to explore the potential uses of advanced computer technology in the university curriculum (Balkovich *et al.* 1985).

France

The French centralized strategy for computerization is based on the strongly centralized educational system in this country. The first experiment, known as the "fifty-eight lycees experiment" ran from 1970 to 1976 with a budget of about 5 million US dollars. Within this framework 58 secondary schools were equipped with a minicomputer with eight terminals and a teletype. In 1979 a five-year project started aimed at introducing 10,000 microcomputers in secondary schools. For 1981–1982 the total expenditure was in the range of 10 million US dollars. By the end of 1982 the cumulated number of microcomputers installed was 3,000 and the total number of trained teachers about 19,000. At the beginning of 1983 the "10,000 microcomputers project" was replaced by a new "100,000 microcomputers project" which should be completed by 1988. It was decided to broaden the experiment by including lower secondary and elementary schools. For 1983 the total cost was about 18 million US dollars, the number of microcomputers installed, 12,000, and the number of trained teachers, 11,000. For 1984 the total cost was about 45 million US dollars, the number of microcomputers installed, 25,000, and the number of trained teachers, 20,000.

In January 1985, a more ambitious plan was announced to install another 120,000 microcomputers in all primary and secondary schools and to train 100,000 teachers before the end of 1985, with a total budget of about 200 million US dollars. This means that the total number of computers is about 160,000 (for a total school population of about 12 million) and a total number of trained teachers is about 150,000 (about 25 percent of the total number of teachers).

The centrally defined strategy of computerization allows all French schools to be provided with standardized hardware and software. The 120,000 microcomputers will include 14,000 of IBM-PC compatible type, and 106,000 of home-computer type (all of them French-built computers). Almost 12,300 schools will receive a local network made up of an IBM-PC compatible microcomputer linked to 6 home-computers. Moreover, each school will receive a software box including some 50 software packages, all of them running either under CP/M or MS/DOS. Over 60 percent should be educational software products (in mathematics, physics, foreign languages, history etc.), 10–20 percent should be utilities: text-processing, database applications, spreadsheets, computer-aided drawings etc. BASIC, LSE and Logo and one or two author-languages should be included also.

From the very beginning computer science was considered not a subject to be taught in general secondary education. The main aim of the experiment was to develop courseware based on simulation and modeling in all disciplines. In order to promote the exchange of software a special highly interactive Algol-like language was created – Langage Symbolique d'Enseignement (LSE).

In 1981 the teaching of informatics as an optional subject was started in twelve French secondary schools (in the tenth and eleventh grades) and was later extended to some forty secondary schools. The pedagogical objectives for teaching informatics were to develop children's creativity and their aptitudes for analyzing and solving problems (Arsac 1985). In 1986 an informatics course was made compulsory in secondary schools.

It is considered that the dominant mode in which computers will be used in schools in the future (even before the end of the eighties) is for their use in assisting in education: assisting the student, assisting the teacher, and assisting the teaching process (Hebenstreit 1985).

United Kingdom

The National Development Program in Computer-Assisted Learning began a sustained effort in 1973 in the United Kingdom, with a modest budget of 2 million pounds sterling. Within the framework of this program several projects were developed in the area of both computer aided learning and computer managed instruction, mainly aimed at higher education. In 1980 through the Department of Education and Science the National Microelectronics Education Program (MEP) was started with a total funding of 9 million pounds sterling. MEP is aimed at primary and secondary education and has two main objectives (Aston 1985):

- the investigation of the most appropriate ways of using the computer as an aid to teaching and learning, as a guide to the individual child, as a learning aid for small groups of children, or as a system involving the whole class;
- the introduction of new topics in the curriculum, either as separate disciplines or as new elements of existing subjects.

In 1981, the British government allocated 1.1 million pounds sterling to introduce a trial computer-based learning program to the nation's education system. The intent of the, so called, Coventry Computer Based Learning Project was to study the different ways in which technology can be integrated into learning environments and to evaluate the feasibility of computer-based learning (Bell 1986).

In 1982 through the Department of Trade and Industry an associated project "Micros in Schools" (for a total of one million pounds sterling) was started to persuade every secondary school to buy a microcomputer. Within the framework of this project, secondary schools could buy one out of two British made microcomputers with a 50 percent subsidy from the government. This scheme seems to have been a success: in the first year about 5,000 secondary schools (80 percent of state-run secondary schools) bought a computer. In July 1982 a second project "Micros in Schools" (estimated to cost 9 million pounds sterling) was focused on 27,000 primary schools with the same conditions. Moreover, each primary school buying a microcomputer was given free a self-instructional package for teachers, and about thirty software packages. Most of the schools spent their own funds to purchase more micros.

Typically the secondary schools have 9 or 10 computers; some schools have as many as 15–20, often linked by a network. By 1986 it is estimated that the Department of Education and Science will have spent 21 million pounds sterling on the microelectronics program and the Department of Trade and Industry a further 21 million pounds sterling on hardware and software. About 80 percent of schools in the United Kingdom have been provided with BBC microcomputers (Edmundson 1985).

Important parts of the MEP are an extended program of in-service teacher training and a mechanism and structure for developing and disseminating educational software.

Although there exists a Department of Education and Science at the government level, the educational system in the United Kingdom is characterized by a good deal of autonomy at the local levels; the Local Educational Authorities (LEAs) are responsible for education. The principle of decentralization is reflected in the structure of organization and management of the activities within the framework of the MEP. It was decided that all LEAs would be grouped geographically into 14 regions and two-thirds of the funding would go to regional initiatives against one-third only to national initiatives. The regional centers were established in each region aimed at assisting with in-service training courses for teachers and developing and disseminating software products and different materials. They are equipped with a library containing software packages and other relevant teaching materials as well as computers that teachers can make use of. They publish a newsletter for all the schools in their area.

Each regional center organizes a variety of courses (at several levels): a three day course, a one week course, a three month course and a teacher's teach course. At least two teachers from each school that buys a computer at half price, with the help of government funding, have to attend some of these courses as a condition of the purchase. MEP provides funds in the range of 60,000 pounds sterling per year to each region for organizing courses. The trials are made as far as possible to ensure that courses bear no cost to teachers attending, and some money is given for traveling expenses. Also, distant-study courses are given by the Open University, the BBC and the National Extension College.

Educational software and relevant teaching materials are developed at national, regional, and local levels. For example, at the national level MEP is funding part of the "Computers in the Curriculum Project" at Chelsea College, and other projects from organizations such as the Geographical Association Package Exchange. At the regional level teachers are encouraged to participate by forming teams to develop courseware packages. About 60 publishers were selling courseware in the United Kingdom in 1983. The average program costs about 10 pounds sterling. For six to fourteen year old children there are about 250 packages available commercially. Except for the regional centers, some organizations help to disseminate available packages and others distribute to all their members the packages written by some of the members. Despite efforts made by MEP there is still a shortage of well designed educational software for primary and secondary schools.

There is a great difference between the responses of each of the 114 LEAs in England and Wales. Some already have their own well equipped centers and teacher support teams, they are developing classroom materials as well as organizing and supporting various projects (Murphy 1985), others, however, have no policy at all. In secondary schools the emphasis is on teaching the subject Computer Studies, that deal with the principles and applications of computers.

Japan

Applying computers to education is a part of national strategy in Japan denoted by the term "Information Society" (Masuda 1972). Part of this project was a Computer-Oriented Education in an Experimental School District (cost $266 million). This plan conceived of conducting computer-oriented education in preschool, kindergarten, primary school, junior and senior high schools, university playing a central role. The plan includes rationalization of school office work, an individual education guidance system, computer-oriented education, and an educational science research center. The project planned to help solve problems concerning future computer-oriented education, measuring the educational effect of the intelligence network, planning a standard education system, and developing a new individual educational system. It was conceived as an experiment, permitting objective scientific data collection and analysis of differences between the computer-oriented, private instruction, problem-solving type of educational system and the contemporary group uniform education system.

In the early stages, a computer-aided instruction (CAI) system model classroom has been tested in primary schools under the direction of Tsukuba University; training programs in computer operation and programming were begun in public commercial high schools. But Japanese children are already in contact with computers when they attend kindergartens, which they attend until they reach the age of five (in Japan there are 14,893 kindergartens). From five until 12 years of age they attend elementary schools amounting to 24,945). This is followed by lower secondary schools (10,780) and then by upper secondary schools. Ninety percent of the population continue their education until the age of 18. In Japan the state-run schooling follows a national curriculum and private schools provide education to 7 percent of the population.

It is claimed that no other nation's children devote so much time to computers as Japanese children. However, it is also claimed that, for example, even if all Upper Secondary Schools in Japan have computers, only 2 percent of these schools have more than 20 computers, e.g. in every classroom (Shiba 1985). Some critical comments have pointed out that education in Japan has been too application oriented, not fostering creative, logical and philosophical thinking. To remedy this is one of the tasks of the new, almost legendary, fifth generation computer project in Japan. Also an ad hoc committee has been established, under the supervision of the Prime Minister, with the task to draw a plan for basic changes in the educational system. First findings indicate a trend into individualization, internationalization, elimination of "gakureki shakai", and a common test scheme, etc. (Japan Times, April 25 1985, p. 3).

Canada

As education is the responsibility of provincial governments the policy may differ from province to province. In 1984 an interesting experiment was started in Manitoba Province. Several departments jointly established the Manitoba Educational Technology Program (ETP). This program has three aims (Prokopanko

1985):

- to ensure access to new information technology,
- to support curriculum and professional development,
- to stimulate the development of courseware for the use and needs of the national and international markets.

An Educational Technology Resource Center was established to coordinate:

- centralized hardware purchasing,
- responsibility for promotional courseware licensing,
- network distribution for Manitoba schools.

To fulfill its functions the center is equipped with the most up to date hardware, courseware, and support staff. It also acts as a preview center.

Austria

In Austria, up until now, computers have been used predominately in post-compulsory education till now. At this stage there are three main types of schools which give access to universities, and also post-compulsory vocational schools that do not give access to universities. The curricula, which is edited by the Ministry of Education and Arts, states that "the aim of the subject is to promote knowledge and the ability to solve different problems with the aid of computers".

A voluntary courses in Electronic Data Processing was organized in some schools for 15-16 year old students. Starting this autumn an informatics course will be made compulsory in all gymnasiums. Teachers are given great freedom to choose the content of the course. As a result of this much has been done in the past year. Microcomputers have been given to gymnasiums (each gymnasium in Vienna is provided with at least 6 IBM-PC compatible microcomputers), equipped with the programming languages Logo, BASIC, and Pascal, and with an integrated software package, including possibilities for using data bases and spreadsheets, text-processing and communication. Moreover, each gymnasium in Vienna has one terminal for the Austrian interactive videotext system MUPID. The next step will be to provide the physics laboratory of each gymnasium with a specialized micro-computer with additional input/output devices.

Computer education for teachers was also instituted within the curriculum for mathematics teacher students, a one-term informatics course is available 5 hours a week. For in-service informatics training of teachers, 8 hour and 16 hour courses are organized.

Recently, at the Academy of Pedagogic Sciences, a Computer Center has been established to coordinate and organize the activities connected with the usage of computers in all schools. This center has units in other regions of Austria whose roles are similar at the regional level. One of the activities of the center is informatics instruction for students studying at the Academy of Pedagogic Sciences. A two week optional course (80 hours) on informatics is carried out. In autumn all students will have to attend a 16 hour compulsory informatics course. In-service courses at several levels are available as well. In most courses Logo is taught. The development and dissemination of educational software are among the tasks of the center.

There are also projects, (computer camps) organized by a professional society (the Austrian Computer Society) that strive to teach a more creative use of computers, beyond numerics, during vacation periods. Several commercial companies also organize informatics courses for children.

Federal Republic of Germany

As education is not a federal issue its policy is handled by individual states, which allows for regional differences. In almost all states the activity connected with the introduction of computers in education comes to the development of curricula for optional informatics courses at the upper secondary level. It is estimated that only 10 -15 percent of all general secondary schools have permission to offer informatics as a specialized subject, or as a base-course and examination subject because of the lack of technical equipment and of qualified teachers. Common opinion is that the minimum number of workstations (microcomputers or terminals of a multi-user system) necessary for satisfactory teaching informatics in one class is 8 - 10. The preferred programming languages are BASIC, Pascal and Elan.

Bavaria has gone furthest toward computer literacy and compulsory informatics in the lower secondary schools. All gymnasiums with mathematical orientation are offering 28 hours of informatics (mainly programming in BASIC) in grade 10 mathematics classes. There are 3–4 microcomputers in one classroom.

Each of the 11 states has established a system of in-service teacher training, but the number of teachers qualifying for teaching permission in informatics is very small (e.g. in Niedersachsen 60 teachers in three years, 1977 - 1980).

The first project for investigating the application of computers as an instructional aid (Computer Assisted Education) was the project "Data Processing in Education", included in the 2nd Federal Data Processing Program. This project ran from 1971 to 1975 with a budget of about 53 million DM. As the results were not considered satisfactory, the Government reduced the funds for the project within the framework of the 3th Federal Data Processing Program (1976 - 1979), to 15.5 million DM. In 1979 the Government published its intention to discontinue all investments in the research and development of educational data processing systems. Since then this area has been left completely to the states.

Computerization is relatively slowly finding a foothold in educational policy for several reasons. One reason is that the complicated procedures, generated by the complicated structure, only slowly muddles through the necessary steps (teacher training, curriculum development, etc.) (Gorny 1983).

Finland

In 1979 the Government of Finland established a National Data Delegation as an advisory and liaison body for issues regarding information technology. In the scope of this activity the Delegation recommended (Raasio 1985):

- the introduction of courses for the 9 - 12 age groups to familiarize them with the use of computers;
- measures to increase the support for information technology in general.

In the beginning of 1985 the Ministry of Education started a national research project "Computers and Teaching" aimed at developing a strategy for introducing computers into schools (Ahonen 1986). According to the final report of the project, published in Spring 1986, about 43 million Finnish marks (about 8 million US dollars) will be necessary for 1987.

Currently there are about 3,000 microcomputers in secondary schools, each school is provided with 6–7 microcomputers. Informatics is an optional subject in all secondary schools and it is estimated that half of the students choose to study it. About 3,500 microcomputers are installed in vocational schools where teaching informatics has been a practice for a long time. More than one hundred computer clubs have been organized in primary schools. (As a comparison, the total number of all students in Finland is about 800,000.)

Through the Ministry of Education, several research projects will be aimed at creating new curricula. From 1987 there will be an optional informatics course in lower secondary schools and two kinds of optional informatics courses in all upper secondary schools: a 36 hour course and a 72 hour course. In vocational education, starting in 1986, an informatics course will be compulsory for 80 percent of the students.

The goal is that every secondary school student will have a personal computer, and every student and teacher in vocational schools should have their own workstation within the next ten years.

There is a well defined plan for teacher training. In-service courses at three levels will be available: a three day course, a five week course and a fifteen week course. It is estimated that about 1,300 teachers (from both regular and vocational schools) have to attend a fifteen week course, about 12,000 have to attend a five week course and about 32,450 have to attend a three day course (the total number of teachers in Finland is about 75,000).

Helsinki University of Economics and the major Finnish computer company have jointly started a two-year project aimed at creating methods, tactics and tools for developing courseware.

Netherlands

In May 1981 an Advisory Committee for Education and Information Technology (AEIT) was established to advise the government concerning the introduction of information technology (IT) into the national education system. The AEIT has divided the role of IT in education into four categories (Plomp 1986):

- learning and teaching about IT;
- learning and teaching with IT, especially with a computer;
- learning and teaching through IT, especially through a computer;
- using the computer as a tool for organizational purposes.

This classification has been utilized as a base for investigating the role IT should have in compulsory education and in vocational training. It is considered that universal basic education in IT should be an integral part of the school curriculum in which every student will participate. AEIT has described the skills and knowledge that should be used as the basis for developing an IT curriculum for inclusion in compulsory education. A three-year research project aimed at integrating IT within the general school curriculum is now under way. One hundred schools are involved in this project.

With regard to vocational training, a pilot project in technical informatics started in 1982. Four secondary technical schools began a supplementary course "Technical Informatics" as an experiment as well as a pilot activity (Linden 1985).

The Dutch government realizes not only that new curricula must be developed at all levels of education, but also that relevant software must be created and training must be provided for teachers.

Switzerland

A coherent policy started in 1975 when the Training Center for Swiss Teachers in secondary education set up an informatics coordination group. Its aim was to develop a pioneering activity in the field of introducing informatics into secondary schools, as well as organizing training courses in informatics.

The Swiss educational system is decentralized and the decision taken for education lies in the hands of 26 sovereign states. Consequently, the situation in the different states is not the same.

There is an opinion nowadays that informatics can be considered as only an object of teaching and not as a means for teaching because there is a lack of useful educational software.

In all states informatics is taught on a voluntary basis by single teachers–enthusiasts. The content of the courses depends on the teachers knowledge and preferences. In almost all cases, the courses consist of programming in BASIC. Only in the state of Genf have some systematic activity been developed for a long time. Since 1974 they have tried there to create a pedagogical concept for both teaching informatics to students and the training of teachers.

Recently the Educational Council of Zurich decided to develop a three-year project "Informatics for the Secondary Level of Public Schools" and also to organize teacher training courses. The project will decide if and in which way informatics can to be introduced into schools (Bauknecht 1985).

Denmark

In September 1983 a Committee was set up to work with Informatics in Folkeskole (primary and lower secondary education). Its task was to (Jensen 1985):

- propose aims for teaching informatics;
- write guidelines for curriculum and teaching informatics;
- propose the integration of informatics elements into other subjects.

As a result a new subject "Dataleare" (Informatics) was introduced in August 1984. Applying computers to schools is backed by interesting research initiatives. It should be mentioned that the Danish programming language COMAL, was created especially for use in education.

As the Danish educational system is decentralized (the local authorities are responsible for education), there is a difference between the number and the kind of computers available in the schools in the different regions. It is estimated that about 25 percent of the schools had computers for teaching in 1985.

The Royal Danish School of Educational Studies has developed the teacher training program that was implemented in 1985. It organizes short and long refresher and further educational courses. In addition, short courses are available at the regional level, a part of the instructor's salary is paid by the government.

Sweden

In Sweden in 1974 the Swedish Board of Education started a project called DIS (Computers in Schools) where three distinct functions were followed:

- general knowledge (what every citizen should know) about computers;
- the computer as a tool for different subjects in secondary schools;
- what hardware and software should be used.

Norway

The Norwegian Government launched an action program which comprises:

- teacher education;
- introduction of experimental technology in selected schools;
- development and testing of software;
- introduction of computer technology in vocational education.

These activities cover the most important issues regarding the introduction of computers into schools (Wibe 1985).

Israel

The introduction of computers in Israel began in schools having many disadvantaged students. This was supported by the "Educational Welfare Program" of the Ministry of Education, and by the educational branch of "Project Renewal", who are concerned with revitalizing extremely poor neighborhoods and towns.

Presently the control of government funding for educational software development, teacher training, and the purchasing of equipment, is centralized in a high-level Committee of the Ministry of Education. In recent years about 50 percent of the funding went for organizing computer literacy courses by several teacher colleges and universities. About 30 percent went for general curriculum development, and 20 percent to equip schools and teacher colleges. All 600 secondary schools, and about one-third of the 1,600 elementary schools, are now using computers. Another third of the elementary schools are arranging to obtain computers. Atari, Commodore and Apple microcomputers, as well as DEC minicomputers, are widespread. In elementary schools computer-aided instruction systems are used. Courseware exists mainly for mathematics, English, reading comprehension and language usage. Most of the developed systems are supported by the Ministry of Education.

With regard to teacher education, all teacher-college students must attend at least one computer literacy course (Davis 1986).

Soviet Union

Computers were introduced to schools in the USSR very early on, starting at the university level in the early 1950s (first generation computers). Later secondary schools also received computers, generally a microcomputer. At the same time the curriculum was changed, accommodating several courses of programming and computer science on different levels. New specializations have also been introduced.

In the mid-1970s more elaborate schemes were worked out. To illustrate the point, we can describe the scheme approved by the Ministry of Higher Education of the USSR dated January 12, 1978 – the so-called "Automated Teaching Systems". The scheme is based on two stages. The first (up to 1982) aims:

- to develop computer systems custom-made for schools;
- to start research and development into the psychological and didactic issues raised by the application of such systems;
- to work out a methodology for developing algorithmic and semantic structures of teaching courses and appropriate monitoring systems. Among the first are some aspects of physics, chemistry, mathematics, and programming languages;

- to develop languages for teaching, user control languages, and interactive (dialogue) programming languages.

The second stage counted with interconnecting the individual functional systems into an integrated network.

In 1984 (Pravda, January 4) a major policy paper was presented in the USSR on "Basic reform directions of general and professional schools" initiated by the Central Committee of the Communist Party of the Soviet Union (CPSU). The paper stated that the grandiose tasks of the end of the century and at the beginning of the next one will be solved by those who are sitting behind school desks today. Among many recommendations intended to improve the efficiency of education one can mention the task to:

> ... equip the students with the knowledge and habits to use modern computer technology, to secure wide applications of computers in the educational process, to build for this purpose special school and interschool cabinets.

On March 28 1985, the Politbureau of the CPSU and the government approved a decree which proposed to introduce, into all secondary schools, a new subject "Basis of informatics and computer technology," also to use computers extensively for teaching other subjects, and to start courses for training teachers (from September 1985).

Computers should also be used in out-of-school environments, in technical creative activity, youth clubs, centers of culture, etc. It was stressed that the intensive mastering of computers by the younger generation should be an important factor in speeding up scientific and technical progress.

To help this program to materialize, the results from many projects which are now underway in the whole Soviet Union will be used.

Bulgaria

In Bulgaria pioneering activities for introducing computers into schools started as early as 1979. These activities are coordinated by government bodies like the State Committee for Science and Technology, the Academy of Sciences, and the Ministry of Education. The centralized strategy of computerization allows all Bulgarian schools to be provided with standardized hardware and software. The first step was made in 1981 when the Ministry of Education commissioned, and financed, the elaboration of the first series of 200 Bulgarian microcomputers (Pravets-82, compatible with Apple-II). In 1985 the Prime Minister of Education announced that 6,000 "home-made" microcomputers would be installed in secondary schools before the end of the year, and that by 1990 about 40,000 microcomputers of the Pravets type would be in secondary schools.

Besides some research projects concerning the introduction of computers in schools have been developed. The Research Group of Education at the Bulgarian Academy of Sciences, and the Ministry of Education, for instance, had been experimenting, since 1979, with a new kind of education in which informatics is treated as an integral part of general education. Informatics is taught from the first grade, as a part of the encyclopedic education, and from the fifth grade, as a separate subject. Special textbooks are being created and attention is being paid to teacher training. This experiment is now taking place in 29 schools (about 1 percent of all schools in the country).

A national long-term program (until 1990) was worked out by the Ministry of Education for introducing computer technology in secondary schools. The main aims of the program are (Pisarev 1985):

- to provide computer education as an element of general education;
- to guarantee the effective use of computers as teaching aids, and to create the necessary software for general education;
- to provide the necessary technical facilities and personnel for the introduction of computer technology in secondary schools – training of teachers;
- to provide the necessary hardware and software for the control of the educational process and of the educational institutions.

In accordance with this program, starting this autumn, a three-term informatics course will be made compulsory in all secondary schools. For this purpose every secondary school will be equipped with 10 microcomputers by the beginning of the school-year.

An important part of the program concerns the in-service training of teachers. The courses, at various levels, are already functioning: a one week (36 hour) course, a one month (140 hour) course, a three month (440 hour) course, and a one year (940 hour) course.

Some other organizations are also working on the promotion of computer literacy for young people. The Dimitrov Youth Organization, for instance, establishes "Computer Clubs" throughout the country, which organize out-of-class activities with the students, on various aspects of computer technology.

Hungary

In 1981 a long-term program of computer science education was started by the Ministry of Education. Presently there is a computer in every secondary school; one computer is used by 600 students on the average. Moreover, the Council of Ministers allocated 140 million forints to the Ministry of Education for the introduction of computers in primary schools and for school application of computer science and video technology. In 1984 about 1,700 Hungarian computers purchased by the schools using centralized funds were used in education, as were computers from individual purchases.

In the 1983 program, the Ministry of Education determined the tasks related to the introduction of computer science in secondary education (Benedek and Balogh 1985):

- establishment of the base of devices;
- forming the educational program package set;
- distribution of the education program packages;
- extension training of pedagogues;
- training of teachers;
- formulation of curricula;
- further training of cultural experts.

In Hungary, the use of computers is not included in the regular curricula, it is voluntary. Furthermore, computer education was introduced in the military (18 months military service is compulsory in Hungary). Some other activities to promote computer literacy are carried out outside school education. For example, the Neumann Janos Society of Computer Science, the Computer Applications Engineering Company, and the Television jointly launched a TV-BASIC course, accompanied by publishing a book including the full content of the course as well as complementary practice. "Micro-clubs" are established throughout the country aimed at providing possibilities for computer use and consultation.

With regard to the development of educational software, it should be mentioned that the continuous competition for the creation of educational programs was announced by the Institute for Science Organization and Informatics in 1983. Presently, about 400 teaching programs are available. However, they cannot satisfy the teaching demands (Benedek and Balogh 1985).

Other Socialist Countries

In the other socialist countries the introduction of computers also started in the early 1950s at the university level. Later, secondary schools were equipped with microcomputers. Now with the wide availability of the 8-bit micro-processor, microcomputers are being widely applied to secondary schools. A strong interest is also devoted to vocational training which is being coordinated with secondary school education. Also important are the activities of professional organizations which, for example, in Czechoslovakia, created 39 regional centers to spread knowledge on the use of computers to the widest audience. This is in addition to the long-term program of introducing computers into all school levels as prepared by the Czech and Slovak Ministry of Education. It is intended from the 4th grade in elementary schools and counts on standardized system set-ups for different school levels. It should be in harmony with out-of-school activity. In Poland a similar government scheme has been adopted to apply computers in education in the years 1986-90 (Petshak 1985).

Tentative Preliminary Conclusions

It is an almost impossible task to give an exhaustive report on the state of the introduction of computers into education in individual countries. We rather presented a sample of the situation. Nevertheless, some preliminary conclusions can be attempted.

1) As with the general application of computers to the other softer applications, for example, management we could detect several stages of computer diffusions (Nolan 1973, 1975).

Stage I	initiation	(acquisition)
Stage II	contagion	(intensive system development)
Stage III	control	(proliferation of control measures)
Stage IV	integration	(user/service orientation)

(Similar stages can be detected in innovation diffusion in general (Brown 1981).

Different countries can be in different situations, but also within a country some institutions might be in different stages. For example, in several countries computerization at the university level is in a higher stage than that in the secondary or elementary level. Yet it is important to analyze and identify the present situation system-wise before making any policies for the future. So much for the dynamics of the process.

2) One can detect several directions as far as approaches are concerned. Perhaps the most distinct ones are:

- the computer as a tool and/or aid in teaching and learning;
- informatics as a scientific branch, and the computer as one of its implementations; development of corresponding curricula;

There are also, of course, mixed strategies. The trend seems to turn to the second option. In 1986, for example, in Austria, Bulgaria, and France, informatics has become a compulsory subject in all gymnasiums (secondary schools). In 1985 it was compulsory in the USSR. From 1987 similar courses will be optional in all secondary schools in Finland, et.

3) On the organizational level strategies for computerization are dependent on the structure of the national educational system and its management. However, the causal relations seem to be fuzzy. They run from fragmented policies (Netherlands, Rushby 1981), to more coherent ones (FRG, UK), to centralized ones (France, USSR, Poland, regions of the FRG, Canada, etc.).

4) Components of the policy are among others:

- Overall educational policy strategy, centrally defined, (Japan, France, USSR, etc.):
  - including – standardized hardware, software, courseware;
  - teachers education;
  - curriculum;
  - guidelines;
- Financial support:
  - special funds, grants, etc. (UK, France, USSR, etc.);
  - tax allowances (USA);
  - subsidies (Austria, UK, USA, Norway, etc.);
- Organizational response:
  - the creation of specialized institutions (Canada, Europe-ATEE);
  - funding of R&D in existing organizations (Finland);
- Societal measures:
  - involvement of parents (Austria, Bulgaria);
  - use of leisure-time (out of class) activity (Austria, USSR, Hungary, UK);

Useful activities can emerge from new international organizations such as ATEE (Association for Teacher Education in Europe). It prepared a syllabus and courses for teachers, in different areas, on Information Technology and Society, Problem Solving by Algorithmic Means, etc. The syllabus is being implemented, experimentally, in the FRG, Denmark, and the Netherlands (Gorny 1985).

Many new policy measures have been introduced recently. Certainly a most interesting topic for further research could be the efficiency and effectiveness of these measures, as well as the most efficient forms of their implementation. All of these measures have the ability to guide and enhance the known positive impacts of computer use in education.

Education systems seem to be particularly resilient to innovations. Although the computer is very specific, its impact, in spite of wide studies, is not well known. Recently, it has been pointed out that the impact of television is only now becoming apparent after 30 years of use. I would subscribe to the claim of the Armenian Socialist Republic's Minister of Education who said:

> Miracles are not taking place. Especially in education. It takes hard work to teach pupils useful knowledge, but it is clear that the computer can help. (Achumyan 1984).

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