THE CHALLENGE OF MICROELECTRONC REVOLUTION TO SWEDISH EDUCATION: THREE ALTERNATIVE SCENARIOS.

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1. The Postindustrial Society, New Information Technologies and the Educational System.

Advanced industrialized societies and, to some extent, semi-industrialized ones have been steadily evolving towards a post-industrial or information state, where, the "overwhelming majority of service workers are actually engaged in the creation, processing, and distribution of information" (Naisbitt, 1984, p.4). The concept of the postindustrial society as it has been developed by its founder, the Harvard sociologist Daniel Bell (1976) deals primarily with changes in the socio-economic structure: the change from a goods-producing to a service economy, the pre-eminence of the professional and technical classes, and the new relations between theory and empiricism. The postindustrial society or rather the information society, is not any more an idea, but already a reality which becomes more obvious when considering the way in which the economy has been transformed. Indeed, tertiary or service activities, such as transportation, insurance, trade, education, finance, health, governmental activities and recreation are becoming more and more dominant. Farmers, who a hundred years ago constituted more than two-thirds of the total labour force in Sweden, now make up less than five per cent of the workforce. Industrial workers, who as recently as fifty years ago constituted more than fifty per cent of the total labour force, now account for less than twenty-five per cent of the total workforce, and are likely to share the fate of the farmers.

Clearly, the convergence of already existing home-information microtechnologies, such as TV, radios and videos with the microcomputer into an integrated information and communication system "will fuel the information society the way energy-electricity, oil, nuclear- kept the industrial society, water, and brute force- sustained the agricultural society" (Naisbitt, 1984, p.16).

In Sweden, there is a widespread notion that new information technologies are viable agents of economic development, national independence and social change. This notion is closely consistent with the efficiency and effectiveness of the educational system in responding and adapting itself to the new demands of the information society.

To this end, the Swedish State provides considerable resources both to broaden computer literacy programmes to include all pupils and adults and to increase the provision of computer equipment in all schools. Recently, Stockholm's head of finance has announced the allocation of 300 million Skr within the next five years through which every pupil in the lower and upper secondary schools in the area of Stockholm will be supplied with a microcomputer in school. This implies an increase of the present equipment up to 40.000 units, in the city of Stockholm alone by the end of 1990. This is indeed a tremendous increase if we take into account the present distribution of computer equipment in schools indicated in the following table.

Table 1. Computer equipment in Swedish schools from 1982/83 to 1984/85

Level	Year		
	82/83	83/84	84/85
Lower Secondary	2.100	3.000	3.400
Upper Secondary	4.200	5.300	5.800
Adults	1.200	1.500	1.700

Source: J.Lennström, Utbildning med hemdatorer. In Datoranvändning i hushallen DsC 1984: 10 Stockholm: Liber.

It is worth pointing out that only two-thirds of schools in 1984 had computers with an average of 7.3 for every school (Myrberg, 1984). This places Sweden at the top among the most computerized countries in the world, such as the USA and England. In the USA, for instance, 68 per cent of schools had computers in 1983 with 11 computers on average for high schools, 7 for juniors and 3.5 for elementary, this is a total average of 7.1 computers (Market Data Retrieval, 1984).

The home computer market has been also rapidly evolving. In 1984, about 3 to 4 per cent of Swedish households owned some kind of home microcomputer, and it is expected that the number may be increased to more than 40 per cent by the end of the coming decade (Makrakis, 1985). The computerisation process in other sectors has also been significantly advanced as indicated by the results of a large survey which revealed that two million Swedes need computer education, one million use computers in their work and 620.000 every day (SCB, 1985). These figures are quite high considering that the total population of Sweden is not more than 9 million, and clearly indicate that Sweden is becoming one of the most computerised countries in the world.

Education thus has a strategic and vital role to play in bringing the beneficial possibilities of new information technologies to the home, the workplace and the school. How, then, can the educational system respond and help the country as a whole to take full advantage of the potential of new technologies? What changes will be required and what will they provide both to students and adults, so that they may understand what is happening around them and what may happen in the future?

2. Future Studies in Education

Although there is a close relationship between education and social change and although the former should be a viable agent for the latter, educational institutions, educational policies and educationists in general are still characterised by conservatism, reactionism, individualism and presentism. These have been revealed by many sociological and future studies such as those by Pulliam and Bowman (1974), Lortie (1975), Kauffman (1976) and Tafel (1982).

Clearly the fact that pupils at the present time will be entering the most productive and influential stage of their lives in about twenty years from now, stresses the need for future studies in the field of education. Burdin (1974) states that "Education must be futurism - an intellectual and imaginative projection of emerging phenomena and conditions" (p.141). Toffler (1974) also adds that the "ultimate purpose of futurism in education is not to create elegantly complex, well-ordered accurate images of the future, but to help learners cope with real-life crises, opportunities, and perils" (cited in Burdin, 1974, p.143). Obviously, computers and other microelectronic innovations are rapidly changing the nature of work, life-style, values and almost all aspects of our daily lives. These dramatic changes increase the

importance of education and demonstrate several needs which will have to be met by schools in the present for preparing the future. They also indicate the need to pursue futures studies in an attempt to shape the future in a desired direction rather than let it be passively shaped for us.

3. The Impact of Computer Technology on Education Modes.

Broadly speaking, educationists have generally agreed upon the threefold taxonomy of education modes, introduced by Coombs and Ahmed (1974), namely, formal, nonformal and informal education. Although there are still difficulties in the way of defining these three modes (LaBelle, 1982, Bhola, 1983), it is widely accepted that there are three major defining characteristics from which definitions can be made: (i) the type of learning and instruction involved, (ii) the organisation of instruction and learning, and (iii) the purpose or intent of the instructional process (Coletta and Holsinger, 1982, cited in Marshall, 1985).

Marshall (1985) points out that traditionally these three modes were defined in such a way that formal education was mostly focused upon knowledge, nonformal upon skill-generation and informal upon attitude. How, then, will the widespread introduction of computers into the school, the home and the workplace affect these three modes of educational transmission?

In recent times, formal education has been heavily criticized (Edwards and Todaro, 1974, Husén, 1979 and 1980, Simmon, 1981 and King, 1982), and there is general agreement that it failed to give a return for a heavy investment put into it. The crisis of formal education both in industrialised and developing countries made policy-makers and educational planners consider nonformal education as an alternative educational strategy in terms of economic returns, human development and national development plans. The continuous inefficiency of formal education in meeting educational needs and goals as well as in keeping pace with labour market needs has been used as a basis for many social, educational and futures researchers to question the very existence of formal schooling (Husén, 1971, Wilson, 1979, Evans, 1979, Dunn, 1983).

In Sweden, the nonformal educational sector is growing fast, especially in the area of new information technologies, mainly due to the inability of the formal sector to respond to the labour market needs in basic, further and specialized training. The most dominant computer firms in Sweden, such as IBM, Luxor, Esselte,

Apple and others, give both basic and specialized training in computers to more than 50.000 people per year (Makrakis, 1985). Also, the total volume of training relating to new information technologies within firms in 1983, has been estimated to be about 100.000 pupil days. This training, to a large extent, aimed at the 35.000 specialists in the field of new information technologies (Myrberg, 1984).

A recent development that has been basically facilitated by new information technologies is distance education. There is a variety of definitions concerning this type of educational transmission that can be found simultaneously in conflict, harmony or both (Peters, 1971, Keegan, 1980 a-b, Baath, 1981, Willén, 1981). In general, there seem to be two main directions representing different schools of thought on distance education, "one stressing individual study and individual, non-contiguous tuturing on the basis of course materials produced for large groups of students, the other aiming at parallelism with resistent study and usually including class or group teaching face to face as a regular element" (Holmberg, 1985, p.3).Broadly speaking, what really makes distance education different from other types of education, is that educational opportunity is available to a large number of people at all levels and ages, in any place and at any time. The following table shows the extent to which educational microtechnologies were used for distance learning in 36 out of 194 organisations that offered distance education in the USA, UK, Australia, Canada, FRG, and Poland.

Table 2. Numbers and percentages of educational microtechnologies used on distance education.

Radio	TV	Printed course units	Audio casset	Video	Films
11	16	35	25	14	8
5.7%	8.3%	18%	12.9%	7.2%	4.1%

Slides	Comput. teaching & instruction	Tel.	Face to face session	Other media
12	9	20	27	2
6.2%	4.6%	10.3%	14.1%	1.6%

The convergence of the microcomputer with other educational microtechnologies, especially video and TV, will clearly open tremendous possibilities for education at a distance which may change the whole educational landscape. It becomes, therefore, apparent that the inefficiency of the formal educational system in keeping pace with the labour market needs in a rapidly changing world, along with the widespread adoption of advanced microtechnologies in individualized and distance learning, will force a reconsideration of the existing organizational structures in the field of education and render superfluous the traditional distinctions of formal, nonformal and informal education modes.

4. Three Alternative Future Scenarios of the Impact of Computer Technology on Education Modes.

4.1. Optimistic.

Over the next two decades all compulsory and upper-secondary schools in Sweden will be adequately supplied with microcomputer equipment. The allocation of microcomputers will be in proportion to the number of students in each school without discrimination between regional and urban districts, deprived and privileged areas. In addition, every citizen will have access to buy his/her own microcomputer and this accessibility will be reinforced by the increasing availability of good quality software adapted to homecomputers. Educational microcomputing at home will be widespread, greatly facilitated by the link of home-computers (HC) and educational computersystems to a central service network, so enhancing the potential use of microcomputers for educational purposes. These changes will open the channels of knowledge to students and other owners of HC, encompassing all Swedisch households. (Where there are economic obstacles to the acquisition of HC, either by students or families, the state will provide assistance through subsidies or tax-relief). As a result formal schools will no longer have the monopoly of knowledge transmission. This, of course, does not mean that their importance will be reduced. On the contrary, due to the wide diffusion of microcomputers partly used for education, it will result in the transfer of certain educational functions from school to the home, the development of individualized and distant learning, so increasing the effectiveness and efficiency of formal education. Consequently, the home will become a "free learning centre" or a "preparatory school" linked to educational computers, in which the student will have access to various kinds of data banks and where he will work individually on his school courses and assignments. The potential benefits of distance and individualized

learning will include access to education for students and adults, especially those who cannot attend schools, either because of their work or because they suffer from some other impediment. The convergence of the already existing home microtechnologies such as TV sets, videos, radios and telephones with the microcomputer will result in the latter being used as a means of communication. This will accelerate the need for the establishment of an open learning system in the form of an open university centred in Stockholm and with connected branches all over the country, particularly in those areas where students or adults might otherwise not have equal opportunities for education. This institution will heavily utilize the potential of microcomputers both as instructional and learning tools and transmitters of knowledge.

Also other types of nonformal education will be affected due to the increasing computerization process in almost all socio-economic sectors, providing a significant part of the educational activities traditionally pursued in formal institutions. Firms and other private organizations will provide training and retraining in their own educational departments and schools, particularly in those areas that are related to new information technologies. This training will be vocational, continuous and specialized, and employers will bear the cost of it. Thus the educational demands of the labour market will be primarily satisfied through the business world itself, and preferably in close co-operation with formal institutions. This development will have a positive impact in terms of the job-security of employees, while the needs of students will continue to be met by public institutions thus avoiding a regress to a free/paying educational system.

It becomes, therefore, apparent that (i) the traditional distinctions of the three modes of knowledge transmission will become less and less divergent, as a result of the introduction of computer technology in the school, the home and the workplace; and (ii) the concepts of distance, adult and special education will become more meaningful and relevant in terms of their aims and applications.

4.2. Pessimistic

From the pessimistic point of view, it is forecast that schools in wealthy or urban communities such as Stockholm, will proceed faster with computer implementation than others. Furthermore, students or families who are economically constrained or otherwise disadvantaged will be excluded from the potential benefits of new technologies. These trends will considerably exacerbate the

inequality of educational opportunity and outcome as well as social inequality, in turn reversing existing policies towards a more egalitarian society. Finally, educational institutions, instead of being users of the computer's central service network, will become simply its satellites, losing their importance with consequent negative implications for students, parents, and the nation as a whole. This detrimental impact will be greatly accelerated by the gravitation of educational decision making from the field itself to network specialists and managers. In general education will be further commercialized and this will have negative implications for the democratic control of education and socio-economic equality.

4.3. The Most Probable

Until recently the central controversy surrounding computers in education in Sweden has concerned the very issue of their introduction in schools. Presently the debate centres on the procedure of introduction, the choice of technology to be introduced, and the programme of utilization once they have been introduced. In the future if computer capacity should approach or surpass that of the human mind, there will inevitably be new concern about the introduction of such advanced technologies to schools.

The computerization process in Swedisch schools will most probably progress rapidly, especially over the coming decade during which all schools from primary upwards will be adequately furnished with computer equipment. However, the benefits of this development will not be realised evenly across the country, as wealthy and urban areas will most probably be advantaged, in spite of political will to the contrary both at the local and national levels.

The most probable forecast regarding home-computerization is that development there will be faster than in schools due to the continuous decrease of hardware prices, increased capacity, and the improvement of the quality of software adapted to home microcomputers.

Formal education will not be able to respond to the emerging information society's increasing demand for knowledge, and the labour market's needs. Therefore, education will take on a nonformal character primarily associated with training and retraining within firms, but also concerned with such issues as distance and individualized education. The latter will be greatly

facilitated by the convergence of the already existing homemicro-technologies with microcomputers. The home and the workplace will thus become learning centres realizing many of the functions presently associated with the formal mode. One likely outcome is that courses in firms, which in the past were restricted to the satisfaction of immediate internal needs, will become increasingly formalised, covering a range from basic training up to university level, meeting the external demands of the labour market as well as their own. In this way education will be increasingly commercialized, especially in the area of new information technologies, and thus public institutions will suffer severe competition. Computer and consulting firms will cover a significant part of the labour market needs in basic vocational, continuous and specialized training in the field of microelectronics. Also, since the formal educational system could not possibly keep pace with the restructured needs of the labour market on its own, its development is likely to involve co-operation with the nonformal educational sector. Furthermore these developments will render meaningless the traditional distinction of the three modes of educational transmission.

5. The Impact of Computer Technology on Learning Processes.

Clearly, what the emerging information society demands is information, and computers are powerful processors of information, rapidly becoming smaller, cheaper, smarter and more functional. This development goes side by side with the development of an integrated information system, encompassing microcomputers and the other information microtechnologies, which in turn will open new possibilities for aiding human learning and so providing a further dimension both to distance and individualized instruction and learning.

There is a widespread notion that individualization of instruction has positive effects on learning and the computer is said to make it easier and more effective (Suppes, 1966). However, as far as the issue of individualization is concerned, there is much disagreement regarding whether the computer contributes to individualized teaching and also whether individualized teaching is socially desirable. Bates and Pugh (1975), Rowntree (1976), and Willén (1981) conclude that instructional technologies including computers cannot meet the individualization needs of teaching. This is largely due to the unique role of the teacher both in creating a tutorial programme and in understanding the pupil's needs. Eide (1981) points out that the role of some educational

technology, such as the computer, in individualized teaching is merely a fantasy. He writes that: "individualized teaching should provide every individual with exactly what he or she needs. But this again presupposes a common agreement on what individual needs are... Furthermore, the more extreme ideas about individualized teaching neglect the fact that, to a very extent, education is a social phenomenon. The social setting cannot in most cases be differentiated according to individual preferences" (p.102).

Baker (1974) also states that "the pupil is responding rather than initiating, reacting rather than inaugurating. The pupil becomes dependent on the programme, being programmemed by the microcomputer, rather than developing multi-experiental routes" (p.114). It is true that the ease, effectiveness, reliabililty, and speed that the microcomputer offers to the pupil, may significantly affect other valuable school and social activities, group work and participatory learning as well as to indulge the natural human inclination to take the very easy way, so turning one's education into a lonely, stereotyped and mechanical process. These warnings provide wellfounded reasons for many educationists and other social scientists to remain sceptical about the introduction of computers as means of instruction. Botkin (1982) identifies at least three ways in which the use of computers inhibits group interaction: (i) "...from an overemphasis on individualization; (ii) from the tendency to concentrate large computers in centralized dataprocessing centres; (iii) from the specialization and complexity of computer software which often obscures the assumptions and freezes the values built into the programmes" (p.23). One fact that should be of special concern to every citizen is that the centralization and control of educational software given through computer assisted instruction provides new possibilities for more effective methods of brainwashing that might be used by a totalitarian and undemocratic regime. A crucial question that could be raised, therefore, is how the computer could overcome these shortcomings and dangers and be used both in more creative ways and as a tool for democratic control. There are three issues concerned with this question. First is the idea of using the computer for "learning with" it rather than "learning from" it. This notion is closely related to Papert's (1980) thinking that instead of the teacher's beneficial use of the computer to programme the pupil, the pupil should rather be instructed to programme the computer, and in so doing stimulate his analytical thinking and creativity. Second, to equip every citizen and every teacher regardless of his/her main area of specialization with adequate knowledge about computers. The latter should be able to create their own software adapted to the

needs of their pupils. Third, the development of a new area of study within teacher education which will mainly deal with educational software development. Undoubtedly, educational microcomputer technologies bring some dangers to the learning process itself. However, they do play a constructive role in education and can be used effectively to facilitate learning and teaching; but "teaching" is really an art in which the human dimension plays so unique a role that it cannot be assumed or changed by any form of technology.

6. Three Alterrnative Scenarios of the Impact of computer Technology on Learning Processes.

6.1. Optimistic

In the past one of the main factors inhibiting the introduction of computers in schools was the failure of educators to evaluate them as pedagogical tools. Today, educators' attitudes are changing due to the increasing development of computers into more sophisticated and useful tools, capable of helping the process of learning considerably. Though not hitherto realized, the potential of computers to function in the learning process will be harnessed over the next two decades, greatly expanding their role and contribution to education.

However, as is known, the most important part of the computer system is its software, that is, the instruction given to it to perform a certain function, and not its physical part itself, the hardware. From the pedagogical point of view, it is optimistically forecasted that educational software will be developed in close co-operation between expert programmers, computer analysts, educators and others. On the technical side, this development will be associated with the further standardization of software, which in turn will enable the user to avail himself of a great quantity of software regardless of the trademark of his hardware. In addition, an advance of considerable importance will be the development of high-level and user-friendly computer languages which will enable pupils to create their own programmes using computers as tools for "learning with" rather than "learning from". In this way too, teachers will be able to produce their own software to meet the needs of their pupils and to utilize the potential benefits of foreign educational software, adapting it to their own social and educational context.

The pupil will actively participate in the use of the computer as a tool for problem-solving educational activities, increasing his

motivation and stimulating his personal initiative and creativity. This will expand learning opportunities and facilitate the use of the computer at all school levels and especially in distance and individualized learning.
The computer will not only be used as a tool for learning and instruction, it will also contribute to the process of learning through other applications in areas such as drill and practice administration and as an organizational and planning tool. On a higher level it will have an evaluative function assisting decision-makers and educators. Optimally, any particular instructional or learning application of the computer will only be accepted along with the theory of learning behind it.

6.2. Pessimistic

With regard to the pessimistic scenario, it is forecast that the wide and uncritical introduction of computer assisted instruction (CAI) in Swedish schools over the coming two decades and educational managers' overemphasis on computers' potential benefits as instructional, learning, organisational and planning tools will bring about some considerable negative changes at many levels.

The wide adoption of CAI or mechanically programmemed instruction will reduce the need for having both schools and teachers, since many courses could be given through suitable terminals linked to the teaching computer. There is no need, therefore, for a student to participate in a course given in a particular classroom. If education is taken over by machines the number of teachers employed will be considerable reduced, and the role of those remaining will become primarily monotorial, supervisory and administrative. In this way also the advantages of participatory learning from the social and pedagogic points of view will be greatly affected and the process of learning will become lonely, stereotyped and mechanical. This last tendency will be reinforced in a situation where the computer will be heavily used as an instructional tool, with students rather "learning from" than "learning with" the computer.

A rapid introduction of computers for instruction and learning as well as for organization and planning without the development of the appropriate infrastructure, along with an experimentation phase, will negatively influence the organization of educational activities, straining existing educational structures and detracting from the more positive aspects of the process of computerization in schools.

One issue that should be of special concern with respect to the pessimistic scenario is that centralized control of the content and method of instruction through computers will generate new possibilities for more effective brainwashing, providing a powerful instrument for a totalitarian and undemocratic regime. Finally, if educators adopt educational software uncritically, be it locally produced or foreign, computers will become a new medium of cultural imperialism, especially in non-western countries.

6.3. The Most Probable

The first point to consider in this scenario is whether the impact of computers on the learning processes is likely to have a dramatic effect in the Swedish context. We can probably expect that the use of computers will extend significantly beyond their mere use for instruction about the technology itself, and even beyond the range of the natural sciences. Though the computer will be used as an instructional and learning tool, this does not have major negative implications for the role of the teachers or their number. In fact, it seems probable that their role will be improved and their number increased.
Computers will become pupils' and adults' friendly partners due to the development of high-level easily learned computer languages and this will considerably facilitate their use in both distance and individualized learning. Though some subjects will be better suited than others to the computers' instructional applications, this process is unlikely to become overly dominant. Some courses will be realized almost exclusively through CAI but in compensation other new courses such as "futures" will be introduced, helping pupils and students to cope with the needs of the new information society and a rapidly changing world. The use of computers, in general, will increase the pupils' understanding and stimulate analytical thinking and creativity.

Foreign educational software will have a great share in the Swedish market, especially in the area of the sciences and languages, but this is not likely to have a major cultural impact due to the relatively narrow gap between Sweden and the principal source-countries. Most of the educational software will be centrally produced by software houses, teachers and pupils then taking on the role of consumers. Because of the high level of the democratization process in Sweden, people's increased critical awareness, general caution regarding experimentation and the social intervention of unions, computers will never be used for undemocratic purposes, nor will they displace teachers. They will simply be used as tools complementary to the traditional methods of knowledge transmission, namely, lectures and seminars.

7. The Impact of Computer Technology on Computer Literacy

There is a widespread warning that educationists in the near future will be challenged by a new kind of illiteracy-computer illiteracy. Computer literacy then is rapidly becoming an essential part of contemporary education. The most recent role for computer assisted aids in education is in the area of "computer awareness" and "computer literacy". These two concepts have been very much debated in recent years and they have often been ill-defined (Johnson, et al., 1980, Luehrmann, 1981, Anderson, et al 1981, Terry, 1984). It may be said that "computer awareness" involves becoming aware the existence of computer technology, its historical evolution, function and possible socio-cultural implications. On the other hand, "computer literacy" includes whatever "computer awareness" involves and in addition, ability and skill in computer programing. Bohland and Anderson (1978) identify two types of computer literacy: first, "general computer literacy"; and second, "functional computer literacy". The former deals with providing a general knowledge about computers and the latter with providing specific computer education in a specific working environment.

Sweden has already entered the new information society and it is likely that almost all jobs within the coming decade will be extensively computerised. This implies that those people who do not know how to use computers will not only be at a disadvantage but they will also bring considerable obstacles to the computerization process with consequent negative implications to the national development. It is found that more than 30 per cent of the computer equipment in Sweden is underutilised or not used at all due to the lack of appropriate knowledge (Makrakis, 1985).

The computerisation process in Swedish schools has also been affected by the inefficiency of the teaching community to meet the new demands, and utilize, to a full extent, the already existing computer equipment, due again to the lack of computer literacy. A recent survey carried out by the National Board of Education revealed that, though computer education has been introduced as a compulsory subject in all schools across the country, one third of them had no activity at all in this field, and that only about 1.400 qualified teachers are involved in computer education, that is .95 teachers on average per school (Myrberg, 1984). Simultaneously, there are more than 35.000 teachers in lower secondary schools who need both basic and further computer education, and this need can be satisfied to only 5.000 out of them yearly. Taking into account this fact along with current policies concerning the introduction of computers in schools and

other optimistic projections that microcomputers will be placed on every pupil's desk and become just another school-tool of the same type as rulers and calculators, how can progress be made then if a great number of teachers have no or little commitment to computers at the conceptual or practical level? This lack of background and training of teachers, as Telem (1984) states "might deter the proper and effective use of the computer as a support tool for administration and instruction and even cause the failure of the computerisation process in the schools" (p.23). He suggests that a way to overcome this situation effectively and rapidly is the establishment of a comprehensive training programme which will prepare educational personnel in the new technology. Terry (1984) emphasizes the need for in-service training of teachers at all levels and in all areas for the use of the computer in school with their own pupils and for their particular subjects. He maintains that there is no need for the majority of teachers to become expert programmemers, but the latter have to work in close consultation with classroom teachers. It is clear that if teachers do not succeed in becoming computer literate, then the status and the prestige of the teaching profession will be seriously threatened. If the promise of the computer is not to be turned into a threat, as Donhardt (1984) states "educators must maintain a healthy perspective of how microcomputer technology will be used to accomplish pedagogical goals" (p.30). He stresses the need to build computer-based curricula which will place technology in a supportive facilitating role. According to him, a computer-based curriculum must accomplish three things as a minimum: "(i) it must have sound educational objectives; (ii) it must reflect an awareness of how students will learn from an interaction with the computer; and (iii) its objectives and their tests must be measurable" (p.30). Clearly, before computers can make an organized impact on the nature of classroom activities, teachers' education must accomplish three major tasks: first, a considerable amount of training has to be invested both in general computer literacy programmemes including all categories of teachers and in specialized computer training in such areas as programming, curriculum development and development of software; second, re-organisation of traditional models of initial and in- service education; and third, an orientation to the needs of tomorrow's learners. The third factor reinforces the need for "futures" studies in the field of education.

8 Three Alternative Future Scenarios of the Impact of Computer Technology on Computer Literacy

8.1. Optimistic.

Optimistically, it is forecast that all Swedish pupils, regardless of their area of study, will have an adequate level of general computer literacy by the end of the coming decade, at latest. Over this period the teaching community will also be well prepared to meet successfully pupils' current and future needs in the area of new information technologies.

The present difficulty in implementing computer literacy programmes in Swedish schools, due to the lack of appropriately qualified teachers, will be overcome through the integration of computer education in teachers' basic and in-service training at all levels and in all areas. This implies that all categories of teachers will acquire a thorough general knowledge about computers, and those teachers who are concerned with computer education itself will achieve and maintain a competent level of computer knowledge through further education and recurrent training. The number of these specialised teachers in each school will be proportionate to the number of pupils and they will be responsible for the implementation of computer literacy programmes, co-ordinating the use of computers in other areas as well. The high level of computer literacy that is optimistically forecast for all teachers will provide them with an invaluable tool for choosing and assessing educational software as well as for adapting it to their teaching. Optimally, a minimum level of computer knowledge will also be introduced for young pupils as early as possible, preferably from the first grades of compulsory schooling. This will prepare the children for later computer literacy programmes, other uses of computers and advanced programmes in computer technology.

Since new information technologies are agents of economic development and social change, the educational system, both formal and nonformal, will be developed towards providing all citizens with a general knowledge about computers, assuring them continued influence and adaptibility.

8.2. Pessimistic.

With regard to the pessimistic scenario, it is forecast that computer literacy programmes will not be implemented considerably in schools across the country due to the unequal competence of

teachers in the area of computer education. A computer knowledge elite will thus be created, both among students and teachers, having a general effect on the equality of opportunity and outcome. As a result this will lead to a situation where the new information technologies will be in the hands of a select group of specialists, so reducing people's possibilities for influencing technological development in a human direction.

8.3. The Most Probable

It is likely, in fact, that the expectations outlined in the optimistic scenario will be realised for the most part over the next two decades. This is because there is a general consensus of opinion that this is the path that should be followed to cope with the demands of the new information society. It is clear, therefore, that all citizens will acquire a certain level of computer literacy above the international level.

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