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The Challenges of ICT

IN FINNISH EDUCATION

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1 INTRODUCTION

The rapid development of information and communication technologies (ICT) during the past two decades has had many points of contact with education and training. The development of technology is placing new demands on expertise, and it is also leading to the increased use of information technology (IT) in instruction and learning. As early as in the 1970s discussions of the future of school systems started to pay attention to the opportunities provided by ICT. Now with the approach of the new millennium, IT is playing an increasingly central role in almost all future planning of schools and instruction. Finland has actively participated in this development. With the help of state and local funding, information technology has been purchased for schools ever since the 1980s. The state has also found many ways to support teacher training in the use of IT, and it has also allocated funds for the production of IT programs. Instruction in the use of IT has also played an important role in teacher training organized by local school authorities.

When Finland devised a special information society strategy in the middle of the 1990s, the use of IT in instruction figured prominently as a key way to accelerate the progress of the information society. Based on the information strategy on training and research prepared for the educational sector under the Ministry of Education, significant additional funding was allocated to schools, universities and vocational institutions in order to purchase information technology and to network schools. Funding was also made available for teacher training. The significance of the special funding allocated to ICT in education is further emphasized by the fact that public expenditures in Finland were sharply cut at the same time. These cuts have had a deep impact on Finnish education. In several schools they have meant that at the same time as schools have had to cut down their activities quite sharply in order to save, they have had more money than before at their disposal to purchase ICT equipment.

It is against this background that the need arose to find out how far we have progressed in the application of ICT in education and what impacts these significant economic investments have had. It is also time to start a value-oriented discussion of how strongly the future of the Finnish society—and with it, of education and training—will be linked to the vision of an information society brimming over with technology.

A school system is a complex social institution which has several significant social tasks and whose practices have developed little by little over a long period. This is why it is difficult to carry out rapid changes. It is to be assumed that the model of instruction and learning based on the extensive use of ICT presupposes such profound changes in traditional practices that the mere offering of technology to schools and the wish expressed by school administrations for its introduction do not yet ensure that purposeful practices are being developed. In order to provide guidance for future measures, additional information is needed on how ICT has been introduced in training, what IT skills are being used by people who work in the education sector and what impact the introduction of technology is having on the practices and outcomes of education. In recent years the Committee of the Future, established by the Finnish Parliament, has had the task of planning and carrying out an evaluation of these aspects in order to improve Parliament's access to information and to obtain information regarding significant technology-based development projects and their impacts. The Committee started its evaluation with two pilot projects, one of which examined the impact of ICT on instruction and education. This book gives an account of the starting points of this evaluation, the central results and the recommendations for the future use of technology in instruction. The Committee stated two goals for the evaluation project.

Firstly, Parliament wanted to gain the experience necessary for developing its own activities, especially with respect to the methods available to it for obtaining information and insights on the impacts of technology for the purpose of supporting its own decision making. Secondly, the project was to produce information in a demonstrable form that could be used by various sectors to develop policy-making alternatives concerning changes made possible by technology—changes which affect the educational system, working commu-

nities and the activities of ordinary citizens during the transition from instruction-centered learning to the application of the principles of lifelong learning.

Thirdly, in evaluating the impacts of technology, those changes are emphasized that have social and ethical impacts on individual human beings or on the interaction between people—impacts that can be either desirable or undesirable. Technology and its economic ramifications create a framework which, although it is described in the project, should not dictate the results of the evaluation.

Carrying out this evaluation project became the task of the National Fund for Research and Development (Sitra). The project's goal was to devise an up-to-date and well-grounded evaluation of the impacts of ICT on instruction and learning as an extensive cooperative project, in such a way that

– technology is mainly understood to be the new ICTs and their use
– instruction and learning mean instruction and studies in schools and lifelong learning for working life and for leisure; the analysis is also focused on the learning process itself
– the impacts are analyzed as a function of a complex systemic interaction relationship between a school system, schools and individual citizens
– the analysis evaluates ICT both in terms of the contents of instruction and studying and the ability to use ICT as a tool for instruction and studying
– the challenge being issued to the information society is understood as an even larger entity when one regards ICT as a cognitive and social tool
– the analysis is based on a changing concept of knowledge and a new conceptualization of reality with the help of technology.

Furthermore, the following are taken into account in the analysis:

- society is networking and becoming more complex
- expertise changes
- the role of information and knowledge is changing society
- technology also changes our concept of information.

One of the goals of the project was to support the development of legislation on instruction and the steering of education. The project was also to give direction to the sensible use of ICT in supporting

instruction and learning and, in addition, to find out if it is possible to reach some kind of consensus on the impacts of educational technology.

ICT in this connection means the use of computers in instruction and communication for purposes of instruction that takes place mainly through information networks with the help of communication technology. However it also refers to traditional analog interactive electronic communication (video technology as well as telephone and videoconferencing technology) because in education, as in other domains of society, traditional electronic communication and digital telecommunication technologies are rapidly converging. In carrying out this project we have not thought it necessary to be excessively precise with our definitions.

Instruction and learning are understood to include as extensively as possible the whole spectrum of school-based education from primary education to the university. The focus of the investigation is the use of ICT as an aid to instruction and study, not as an object of instruction and study. Thus, information technology, data processing and the teaching of multimedia, for example, remain outside of the project as separate contents. On the other hand, the investigation is not limited to schools, for studying is breaking down school walls more forcefully than before, extending itself to be a lifelong and open activity of many forms without being limited to place or time. We follow it to homes, old people's homes, libraries and businesses.

In order to carry out this project, Parliament created a steering committee. Among its members were Members of Parliament Markku Markkula (chair), Tarja Filatov, Aino Suhola and Kari Uotila. They were assisted by the secretary of the technology section of the Committee for the Future, Ulrica Gabrielsson. Sitra summoned Matti Sinko (University of Helsinki) to be the project manager, and it established an advisory expert committee for the project. Professor Erno Lehtinen (University of Turku) was invited to chair this committee, which included the following members:

Dr. Seppo Collan (University of Oulu)
Professor Jorma Enkenberg (University of Joensuu)
Dr. Kai Hakkarainen (University of Helsinki)
Dr. Antti Hautamäki (Sitra)
Antti Kauppi (Research Director, Helsinki Polytechnic of Business and Administration)

Dr. Kaisa Kautto-Koivula (Nokia Telecommunications Oy)
Jari Koivisto (Counsellor of Education, National Board of Education)
Dr. Jussi T. Koski (Ministry of Education)
Professor Reijo Miettinen (University of Helsinki)
Professor Hannele Niemi (University of Helsinki)
Jukka Orajärvi (Chief Technologist, Oulu Technical College)
Aulis Pitkälä (Director of Education and Culture, City of Vantaa)
Professor Seppo Tella (University of Helsinki)
Professor Reijo Töyrinoja (University of Helsinki)
Professor Matti Vartiainen (Helsinki University of Technology)
Dr. Jarmo Viteli (University of Tampere)

Both the steering committee and the expert committee participated actively in defining the project's goals, carrying out the work plan and evaluating the results. Most expert members themselves participated in the actual evaluation, writing sub-reports and attending meetings. The project utilized the new ICT to link a surprisingly extensive and well-functioning network of experts.

The project was divided into five sub-projects, and each of these was further subdivided. As the result of the work, a total of eight reports were produced. This book, which is aimed at an international readership, is based on the material of the whole project.

The sub-reports treated the following objects of evaluation:

- universities (two sub-reports) edited by Jarmo Viteli and written by Jarmo Viteli, Seppo Collan, Antti Kauppi, Hannele Niemi and Leena Vainio, with the assistance of many other reporters
- kindergartens and institutions of general and vocational education edited by Liisa Huovinen with the assistance of many reporters
- lifelong learning, edited by Irene Hein
- digital learning materials, written by Pekka Lehtiö

In addition, the authors prepared two reports for Parliament as well as the final Finnish-language report. As we started to prepare this English-language version of the report, a new national information society strategy was completed called "Finland towards an Information Society." This strategy attaches even greater importance to learning and instruction technology, if this is possible. Along with the translation of this report, the Finnish Ministry of

Education has been preparing a new National Training Strategy for Education and Research in the Information Society for the Years 2000-2004. Its directions are based to a great extent on the results of this evaluation project and the recommendations made in it. The purpose of the book at hand is to give an international readership a succinct description of how far the Finnish education system has progressed on its way towards an information society.

Acknowledgements

This report would never have come about without the initiative of Parliament's Committee for the Future and especially Markku Markkula, as well the willingness of Sitra to assume responsibility for funding its completion and publication. The vision of Antti Hautamäki, research director of Sitra, was needed to enable the project to mature from an idea to the product at hand. A growing group of people working in various capacities have committed themselves to the instructional use of ICT. We had the pleasure and the great privilege to find a core-group representing this bigger group to support us in many different ways. We are greatly indebted to the expert committee and to all other project reporters, article writers and other colleagues who participated in so many ways and of whom only a small number can be mentioned here by name. Translating into English this—in some ways—very unique evaluation of Finnish reality was a demanding challenge that was met with resourcefulness and sensitivity by a working group consisting of Kimmo Absetz, Henry Fullenwider, Nely Keinänen and Anu Virkkunen-Fullenwider.

2 THE ASSESSMENT PROJECT'S POINTS OF DEPARTURE:

NEW CHALLENGES TO COMPETENCE IN THE INFORMATION SOCIETY

Education, learning and teaching emerge in one way or another in all recent national and international documents where attempts have been made to outline the road to the information society. Since 1995, Finland has had an officially approved information society strategy which contains two main objectives: to develop and utilize the opportunities afforded by the information society; and to identify and avoid possible threats related to this development. This strategy is founded on a vision of Finland as a network society actively developing information and communication technology applications and thus remaining a top international player in ICT and related industries. This strategy emphasizes that information technology and information networks are turning into major tools, that the information industry is important to the country's future economic development, that high-level expertise in information and communication technologies is essential, that all citizens should have basic skills in information technology and lastly that a competitive and effective information infrastructure must be created ("Finland towards an Information Society," 1996). As a result of this emphasis on basic information technology skills and professional expertise, the educational system and various forms of lifelong learning have emerged as one of the central areas where the information society strategy is being implemented. In order to answer these challenges, the Finnish Ministry of Education commissioned a national information strategy for education and research which presented plans for developing the skills needed in the information society and for renewing the form and content of education through the use of ICT ("Education, Training and Research in the Information Society: A National Strategy," 1995). In 1998, a proposal for developing Finland's

information society strategies placed even greater emphasis on education and learning, noting that: "Finland is progressing towards a knowledge-based society. In the information society, knowledge forms the foundation for education and culture and constitutes the single most important production factor. . . .To this end, it is important to develop an individual's, organization's and society's knowledge" ("Quality of Life," 1998). In a report on know-how in the information society, Raivola and Vuorensyrjä (1998) suggested that the Finnish economy is changing into:

- an economy based on information and knowledge,
- an economy based on information technology, intelligent logistics and project organization and,
- an economy which serves and is served by quality-conscious and digitally oriented people.

They argue that these economic trends place totally new kinds of challenges on lifelong learning and ethical competence, and consequently on all the policies and infrastructure responsible for continuously maintaining and developing people's skills.

Two different approaches to the skills needed in the information society are now being discussed. The narrow interpretation focuses on the need to train citizens to use the technical tools, such as computers, information networks and multimedia, which constitute the most concretely visible part of the information society. The information strategies of the Finnish Ministry of Education highlight the importance of computers, networks and the skills to use information technology and to produce media contents. These views of future development, directly related to the use of technology, have been used as central arguments for the relatively sizable information technology investments which have been made in the educational sector in recent years. In 1997, the Ministry of Education assessed its own information strategies in this light, devoting most of its attention to investments in hardware and networks as well as to the measures taken to advance the information technology skills of educational personnel. The assessment describes significant achievements in constructing infrastructure, but also notes that some objectives were not reached due to insufficient resources. Moreover, the assessment warns against becoming overly technocentric and reminds us of the need to direct more attention to quality as we develop education,

learning and teaching in an information society ("The Status of the Ministry of Education's Information Strategies," 1997).

Alongside this narrow interpretation of the information society, which concentrates on technical equipment and its use, we must also adopt a wider view, especially when considering the challenges and possibilities of education and training. We must consider the profound qualitative changes in people's lives brought by the information society. Profound changes in the cultures of work and know-how are connected with the rapid construction of an information society, the emergence of a digital and global economy and the development of additional media (Giddens, 1990; Naisbit, 1994; Negroponte, 1995; Senge, 1994; Tapscott, 1996; Toffler & Toffler, 1994). It is impossible to predict these changes accurately, but based on the most advanced working life practices and visions provided by futurology we can outline some trends in the ways work is changing and assess the competence requirements related to these changes.

As a result of technological development, significant changes in the structures of work are taking place. This can especially be seen in the growing importance of information-based services, or, to use different terminology, symbolic-analytical services. Although the significance of information-based work will grow, the importance and need for other kinds of activities—routine work and personal services—will remain. On the other hand, some visions of the information society assume "the end of work" (Rifkin, 1995), meaning that a relatively substantial proportion of the population will not do salaried work in the traditional sense. Discussions of the educational and training needs of the information society have usually been tied to the demands of information-based work. However, the perspective should be expanded to include opportunities for basic education and lifelong learning for those who will be excluded from this type of work. Some form of selection or tracking is an inevitable part of education, but it is essential that such selection to shorter educational tracks will not effectively suffocate a person's learning skills and motivation, as these are important for continuous learning.

The information society is not reflected in our lives only through work, for our entire everyday environment is also undergoing similar changes. Ensuring our development and well-being outside of work requires us to develop our information society skills. When examin-

ing the information society, we need to widen our perspective: rather than looking narrowly at information society skills and taking a work-centered approach, we need to broaden our view to take into account the whole spectrum of life. On the other hand, the tools which are brought by the development of the information society offer many opportunities for new kinds of participation and learning taking place outside of educational institutions. People's relationship to ICT can be assessed from the perspective of their entire lifespan by looking at the various roles an individual has in different stages of life: in working life, leisure time, as a member of a family, etc.

The development of Finnish society will largely be determined by how well individual people, organizations and the entire society are able to meet these demands on their competence and ability to function. The question is thus about safeguarding Finland's international economic competitiveness without sacrificing her cultural wealth and principles of social justice. By surveying present and future trends, we may identify at least the following new challenges:

a) Managing complex, ill-defined problems and rapid change is emerging as an increasingly central strategy for "survival." Increasing information does not unambiguously make our lives more manageable, but in many cases leads rather to growing uncertainty. With the tools provided by technology, people attempt to steer and control their environments with increasing efficiency, but at the same time the social, cultural and economic environment shaped by that technology is becoming more difficult to control and to predict. Formal and precisely defined knowledge alone is not enough for managing this complexity, as we need to be able to combine the knowledge traditionally transmitted through education to the informal knowledge which develops in connection with various activities and which usually cannot be accurately described or defined (Lehtinen & Rui, 1996). Rapid changes in social and political practices and in people's social and technological operating environments require that both individuals and organizations flexibly restructure their old practices and thought models and learn continuously. This in turn calls for a more developed understanding of knowledge and how it is constructed in individuals and in social practices. Learners must adopt a learning orientation which aims at surpassing their own expertise limits

and acquiring high-quality learning skills that are manifested as the ability to adapt their expertise and learning to the requirements of their present activities (Bereiter & Scardamalia, 1993).

b) A new operational model is emerging in production, scientific activities, administration and everyday practices. In it competence and expertise can no longer be described as the skills of one individual only, but are instead the collaborative expertise of teams and networks, a socially shared cognition. Shared and distributed expertise is different from the traditional model of the division of labor. For one, there is no "higher" management which, in principle, has a mastery of the entire problem being solved and assigns various steps to be carried out by different experts; rather, the networking of expertise takes place without any such hierarchical organization. In addition, networks of expertise often center around projects. They emerge quickly for the purpose of solving some particular problem, and once the project is over they disband. For individuals, the essential skill is the ability quickly and spontaneously to create reciprocal cooperation and communication relationships between experts who represent different types of expertise. For organizations, the essential skill is to be able to create and use the various cognitive tools needed in group problem solving. One such tool, for example, is network-based flexible applications which support communication and the collaborative memory of an organization or a network.

c) Successful work in an environment based on information networks and increasingly globalized information sources requires new kinds of information technology and communication skills, along with the intellectual capacity to control them. For example, it is only data which moves in information networks. Not until data becomes organized does it turn into information. Information only becomes knowledge and wisdom through the interpreting processes of a person with expertise (Hautamäki, 1996). Network technology creates enormous possibilities but demands high levels of skill from its users. The issue is not just technical mastery of network use, but above all the cognitive skills of presenting and developing meaningful questions, and interpreting information by integrating it with previously accumulated knowledge and giving it an appropriate context. One must also be able to assess crit-

ically the reliability and relevance of information. Because of these severe demands, the development of information networks may actually lead to the undemocratic restrictionof acces to (meaningful) information unless education and training can assure not only sufficient technical skills but also especially the cognitive skills necessary for using information sources. By these skills we mean both the skills needed for processing and evaluating information as well as a well-organized foundation of prior knowledge.

d) Since networks enable rapid interaction between people representing various cultures and professions or people and organizations previously unknown to each other, the challenges of reciprocity and understanding others become even more complex. Network-based operating practices are not just about possessing the skills to use information technology hardware and media, but of possessing more general skills of cooperation, information processing and communication. The essential element in these skills is ensuring that the information acquired through the networks be understood and transferred (by all parties) into usable knowledge by connecting it to meaningful contexts.

e) The development of an information society confronts people with new kinds of ethical problems. Ethical issues emerge in a concrete way when we evaluate the contents of information networks and the possibilities of using them as sources of learning and as environments for children and young people.

f) Many recent surveys show that ever new demands on people's skills and competencies are being made by technology and the economy. However, we should also pause to take a look at whether the starting point offered by the economy and technology might be too one-sided when it comes to the goals of learning (see "Setting a computer science research agenda for educational technology"). We must ask how these goals fit in relation to the prerequisites for learning, whether people are motivated for the kind of continuous learning envisioned by the information society and whether it is ethically justified to force people into the extended compulsory education that serves the information society.

Are we up to the challenge?

In discussions of the challenges to competence outlined above, the solution most often presented is the principle of lifelong learning. As a political stance, the recommendation or demand for lifelong learning does not yet contain an articulated view of the extent to which it is possible to flexibly adapt continuous learning to these new demands. On the other hand, rapid change and the growing demands of working life have raised the idea that organizations should also be viewed as learning and information-producing communities (Nonaka & Takeuchi, 1995).

Looked at from the perspective of an individual, the potential for developing competence is, in principle, very substantial. Research in human cognition shows that practicing a certain task over a long period of time results in powerful cognitive adaptation; individuals develop knowledge structures which help them master the information load of that task. Two factors are essential in developing expertise: intentional practice and progressive problem solving. Continuously setting new, challenging problems and operating close to the upper limits of capacity create a foundation for the development of new cognitive skills. Indeed, it is important to develop the ability to move beyond previously learned skills and apply old knowledge to new problems, and thus derive new solutions and practices (Ericsson & Lehman, 1996).

On the other hand, research on both cognitive processes and motivation has shown that a typical human characteristic is also to resist fundamental changes in our ways of thinking. On the basis of recent research in conceptual change it seems apparent that when people meet new learning challenges, they attempt to interpret and master them by using their own earlier theories and beliefs. Learning goes smoothly when it is based on enriching previously acquired knowledge with additional details and more specific distinctions. Learning which demands genuinely new ways of thinking and changing one's earlier beliefs has turned out to be difficult and often very time-consuming. Thus, trying to teach or learn these new ways of thinking too quickly can lead to systematic misconceptions and superficial learning. People learn to give the correct answers to questions having exactly the same content as those dealt with in the teach-

ing. At the level of their own thinking and beliefs, however, people stick to their previous conceptions even if these are in clear conflict with the new ideas and concepts being learned (Vosniadou, 1994). At present, this phenomenon is clearly seen, for example, in the adoption of ideas concerning teaching and learning. Teachers have rather widely adopted the vocabulary of learning models based on constructivist epistemology, but this is not yet manifest in their interpretations of everyday situations or in the ways they organize learning situations. Learning resulting in profound changes in one's thinking is not nearly as easy to achieve as the proponents of lifelong learning seem to believe.

Longitudinal research in the development of learning skills and so-called metacognition (skills in controlling one's own learning and thinking) show that individual differences in these skills grow very markedly during basic education. While some students develop very sophisticated, efficient and self-directed learning skills, others seem to develop much more slowly, or not at all. From the viewpoint of lifelong learning, these pronounced and growing differences in strategic learning skills are a serious problem. It seems that a large proportion of students coming out of school have completely inadequate learning skills when viewed in light of the challenges of continuous learning. A similar trend can be seen in the area of motivation. For example, the ways that the educational system tracks students can cause problems for those steered into what are known in Finland as the shorter educational routes, paths leading to lower-level vocational rather than university-level education. These students may suffer from a lack of motivation and self-confidence and thus choose not to take up intellectual challenges. This has obvious ramifications for their later educational development, as their information society skills are likely to remain poor.

The goal of education has traditionally been to teach the basic skills in various culturally established and precisely defined fields of science and the competencies needed for basic communication and problem solving. These tasks will remain in the future as well, but in addition there are pressures on education to teach more concretely the skills demanded by the rapidly changing working life and social practices. This presents a serious challenge to traditional forms of education. Transferring learned knowledge into new and wholly dif-

ferent situations seems to require learning processes which explicitly require students to apply the knowledge to practical situations outside school.

It is not realistic to think that institutional education alone could assume responsibility for responding to the expanding and continuously changing challenges presented by current societal developments. And indeed, the majority of learning already takes place outside of schools or specifically-organized teaching and learning situations. From a social and political perspective, this probably means that differences in learning opportunities between individuals will continue to grow. Those with good basic learning skills and much previously acquired knowledge will be better able than others to find information and various learning opportunities. Therefore, in order to ensure social equality, it will be necessary to assess the effects of technology on teaching and learning and to outline future strategies for the educational use of ICT.

In Finland, there is a rather widely-held idea that education plays an important role in ensuring equality and that education should thus try to equalize differences resulting from children's differing backgrounds and strive to prevent large differences in student achievement. In terms of the information society, this aim turns out to be even more important, but also increasingly problematic. Can the idea of compulsory education be extended to cover what have been called "information society skills" in the same way it has covered literacy, for example? Are computer skills, to take one example, genuinely comparable to literacy as lasting skills which are basic to an individual's social acceptability and survival and which the society can require as compulsory skills from all children and youth? We could of course justify such a policy based on the strategic significance of information technology in Finnish society. What makes this problematic, however, is that compared to literacy these skills change much more rapidly, and it is extremely difficult to predict what kinds of technology skills will be essential in working life and for social and political participation in, say, ten years.

What can we learn from previous national and international assessment projects?

To begin, we have learned that any assessment must be based on sufficient information about the prior research on the effects of information technology. In the following discussion we have utilized knowledge provided by extensive international assessments and comparative surveys of the use of ICT in different countries.

The prevalence, forms and effects of ICT use have been the target of numerous national and international assessment projects during the past two decades. To provide a background for this assessment, we have familiarized ourselves with many extensive national and international assessment projects on the educational use of ICT and related experiences, including the following:

- *IEA Study on Computers in Education (CompEd) (phase 1: 1987-1990, 21 countries, and phase 2: 1992, 12 countries)*
- *ITECS, Information Technology in Education and Children (with UNESCO, 1988-1992, 25 countries)*
- *YCCI, The Young Children's Computer Inventory Project (begun in 1991, a comparison between Japan and the United States)*
- *The application of multimedia technologies in schools (report for the STOA programme of the European Parliament, material from 1997 from EU countries)*
- *Scientific approaches to new learning models for new learning environments (report for the STOA program of the European Parliament, material from 1997 from all EU countries)*
- *Changing work patterns and the role of education and training. Secretarial Report (OECD-CERI, 1986)*
- *Adult learning and technology in OECD countries (OECD Proceedings, 1996, 14 countries)*
- *Computers and classrooms: the status of technology in U.S. Schools (Policy Information Center, USA, 1997)*
- *Setting a computer science research agenda for educational technology (Computing Research Association, USA, 1995)*
- *Survey of information technology in schools (Government Statistical Service, England, 1996)*

- *Teaching and learning for the future (The Royal Dutch Ministry of Education, 1996)*
- *New information technology in education: United Kingdom (Commission of the European Communities, 1993)*

Earlier surveys provide a good foundation of information on which we can base our survey of trends in the use of technology and refine the criteria for assessing the present situation. At the same time these surveys also give us an idea of how quickly the situation changes when it comes to the technology itself, as well as to the ways technology is used generally or for pedagogical purposes. Such constant change makes it difficult to assess the effects of ICT. For example, the improvement of information network connections and the development of the Internet and especially the World Wide Web in the early 1990s very rapidly changed the possibilities of utilizing information technology. Surveys of the uses of information technology done before the expansion of the Internet into schools give a very different picture of the pedagogical role of ICT than what we see now that these network connections have opened up.

Experimentation in the use of the computer as a teaching aid has been conducted since computers were first developed, but it was not until the development of the microcomputer in the 1970s that it became possible to utilize this technology outside of universities. After that, computers quickly started to become a natural part of a school's teaching equipment, especially in the United States, many Western European countries and some of the Asian countries with a high standard of living (Collis et al., 1996).

Comprehensive international surveys have shown that computers were in wide use in secondary education already in the mid-1980s, although it took longer for computer technology to spread to the primary level. However, there have also been large differences between industrialized countries with a high standard of living. Especially the assessments done in the 1980s showed that the use of ICT was most widespread in the U.S. school system, where computers were in use in nearly every school by the end of the decade. Many Western European countries have approached the U.S. situation, but differences between countries remain substantial (Collis et al., 1996; Pelgrum, Janssen Reinen & Plomp, 1993). The fact that schools have had computers has not, however, meant that their effect on school practices has been particularly great. After analyzing the results of three ex-

tensive international comparative surveys on the use of information technology in schools, Pelgrum (1996) concluded that for a majority of students the use of information technology in teaching and learning was still of very little significance.

Many national and international strategy policies and surveys have attempted to set norms for suitable or adequate numbers of computers in relation to the number of students. After assessing the results of international comparative surveys, Collis et al., (1996) raised the important point that a sufficient number of computers is not so much a certain ratio between the numbers of computers and students, but actually a much more complex pedagogical issue. If computers are used mainly in addition to traditional teaching, so that students work with individual drill and practice programs or educational games, it will be inevitable that the number of computers will be insufficient. From this perspective, there would only be enough computers if each student would always have a computer at his or her disposal while at school. Similar results emerged for instance in the IEACompEd study (Pelgrum & Plomp, 1993), the data for which were collected in two stages (1987-1990 and 1992) from three different grades (ages 10 and 13 and the secondary level) from a total of 27 countries. Teachers brought up the problem that they could not use the machines regularly since all the students in the class could not use them at the same time.

A wholly different picture emerged in a long-term (4-year) ITEC study which involved 25 countries. For this study, teachers and classes (students aged 9-10 years) known to use information technology innovatively were selected (Collis 1993). These classes seldom used computers for playing educational games or for working with drill and practice programs; instead, teachers utilized various ways to integrate computers into their teaching. Computers could be used as presentation tools, sources of information, common information storage tools, etc. According to Collis (1996), an insufficient number of computers was generally not cited as a problem in the schools selected for the ITEC study, although they generally had no more computers than many of the schools in the CompEd study.

According to international surveys, the number of computers compared to the number of students has grown rapidly in the 1990s. For example, in England in the academic year 1991-1992 there was one computer for every 25 students, but four years later one computer for every 15 students (Survey of Information Technology in Schools

1996). In the Netherlands there was one computer for every 80 students in 1989-1990, but by 1996-1997 the ratio was already one machine for a little over 30 students. At the same time the number of teachers using computers increased substantially. According to the survey by Brummelhuis and Janssen Reinen (1997), in 1994 about 40% and in 1996 already 80% of Dutch teachers used a computer weekly. Also, in England about 80% of teachers already used computers in 1995-1996.

These surveys also brought out an interesting difference between England and the Netherlands. In the 1990s, Dutch principals grew more confident about the positive effects of ICT at about the same pace as the schools acquired more new technology. In England, however, the opposite seems to have happened. There the confidence of principals that information technology is significant for teaching and learning decreased all through the 1990s, although the availability and use of technology simultaneously continued to increase (see "Survey of information technology in schools 1996" and Brummelhuis & Janssen Reinen 1997).

The proportion of schools with computers does not tell the whole story, however. Since students can get experience in the use of information technology both at home and at school, it would be important to examine the various contexts in which students coming from different countries and social classes have the opportunity to use information technology. Data collected in 1995 show us that there are large differences between countries in how many students have a computer at home (see Figure 1).

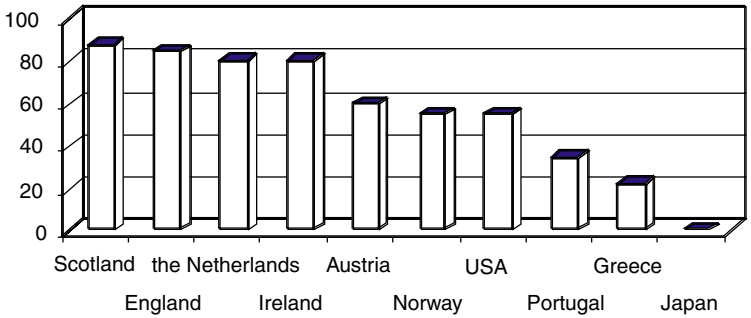

Figure 1. Percentages of fourth-graders in different countries who have a computer at their disposal at home (adapted from Mullis et al., 1997).

In some countries 80% of the fourth-graders had access to a computer at home, while in others the figure was only 20%. Equality between social groups and sexes has often been raised as a central issue in the context of developing pedagogical uses of information technology. Gender differences in computer use have been studied relatively extensively, and the results strongly suggest that information technology has specifically been a technology of boys and men.

Equality in the use of information technology can also be viewed from the perspective of social and ethnic groups. In the extensive review articles by Becker (1983) and Becker and Sterling (1987) clear differences in access to information technology were shown between different social and ethnic groups. In schools for white middle-class children the child/computer ratio was 155:1, in lower-status white neighborhood schools the ratio was 192:1 and in black neighborhood schools it was 215:1. Later, when computers had become more commonplace, the child/computer ratio improved in all groups, but these relative differences remained about the same. The most recent American surveys (Computers and Classrooms, 1997) reveal that differences between schools in the accessibility of computer technology remain substantial and are often based on the status of the school. The Finnish school system may be somewhat different, in that differences in the social status of neighborhoods may not be reflected in the resources available to schools. However, recent changes in government funding for schools, combined with national support for information technology investments based on competition, might have had the paradoxical effect of increasing differences in access to ICT between municipalities and schools despite efforts to the contrary. Although no detailed surveys of the matter have been made, something can be deduced, for example, from a 1997 Finnish Book Publishers' Association survey. The survey mapped the use of electronic learning material in comprehensive and upper secondary schools and found substantial differences in hardware and software resources between schools.

In Finland, a family's educational and financial status affects its information technology purchases. In a 1996-1997 survey by Statistics Finland on the use of ICT in households, a clear correlation was found between the income level of a family and its purchase of home computers (Nurmela 1998, see Table 1).

Income Fim/month	Family size			
	3 persons	4 persons	5 persons	Total
5,001–9,000	29	40	54	64
9,001–15,000	40	48	63	84
15,001–21,000	29	62	60	85
Over 21,000	17	35	49	68

Table 1. The percentage of families with a home computer in 1997, grouped by family size and income level. (1 Fim = 0.167 Euro)

Although Table 1 reveals a direct and rather strong correlation between income level and computer purchases in the whole population, this correlation is not as clear in families with children. Indeed, Finnish families with children seem to consider the purchase of a computer as extremely important, and consequently even lower-income families have bought them, rather as they used to buy large encyclopedia sets to help their children in school. Families gave similar motives for buying a computer, saying that the children wanted them or that they were buying them for the good of the children.

In contrast to this Finnish data, recent American data have shown a strong correlation between access to information technology and family income, as can be seen in Figures 2 and 3.

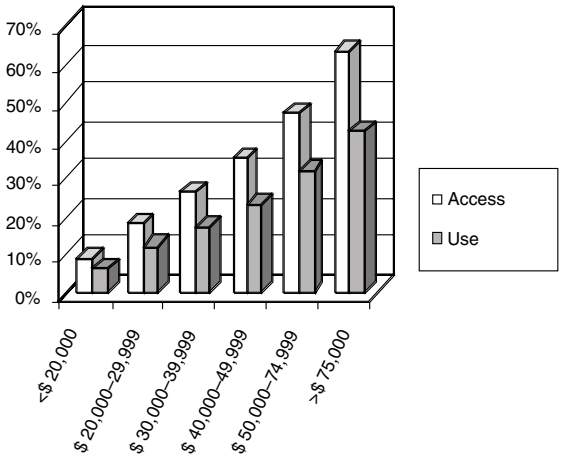

Figure 2. Computer use at home by school children in the United States, grouped by family income level in 1993 (adapted from Pelgrum 1997)

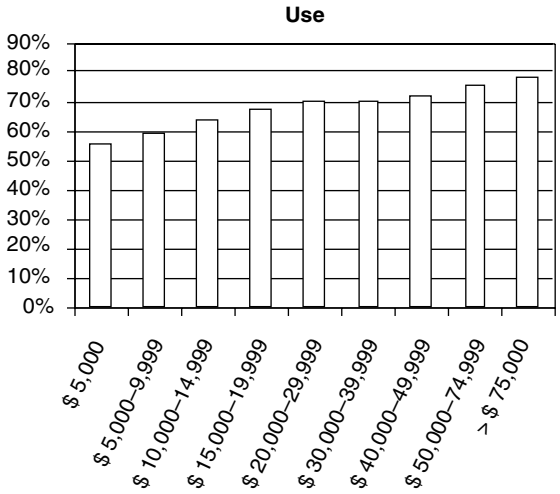

Figure 3. Computer use of primary school children grouped by family income level in 1993 (adapted from Pelgrum 1997)

These results are fully what could be expected when considering the possibilities for computer use at home. In 1993, families in the highest income class were six times more likely to have a computer than families in the lowest income class. It is even more surprising, however, that these differences are duplicated at school and that children from different income levels have differing access to information technology in pre-school and primary school. Figures from 1989 and 1993 indicate that although schools were acquiring substantially more machines, differences in the access of children from different income classes to this technology at school remained about the same. These differences tell us much about the peculiarities of the American school system and perhaps cannot as such be generalized to other places. However, there are grounds to assume that children of higher income families will continue to have better access to information technology than children of lower income families if the supply of technology is strongly dependent on local decisions and the wealth of a given municipality.

Sutton's (1991) review article looked at the use of information technology in schools specifically from the perspective of gender differences. The article combines data from 15 different studies which

examine how girls and boys use computers both at home and at school. Only two of the studies did not find a gender difference in schools; in the others, boys had better access to computers both in school and at home. Sutton also reviews studies which compare the attitudes of girls and boys towards computers. These attitudes reveal that computers are still powerfully thought of as a masculine tool. In data compiled by Statistics Finland in 1997, we can see that in Finland as well there is a very pronounced gender difference in computer use in the whole population. However, for young people the clearest difference between boys and girls is in playing computer games and not so much in using computers for practical purposes (Nurmela 1998). International surveys indicate that these gender differences in home use are duplicated at school, and it would be important to study this issue with data on Finnish schoolchildren and students.

In many countries, various information society strategies for education have been drafted on a national level, with the main focus usually being to improve the schools' information technology equipment. In many of these national strategies, the year 2000 marks a milestone by which they attempt to reach a certain student/computer ratio established as a pedagogical goal (for instance 5-10 students per computer in Denmark, 16 students per computer in Japan, a computer in each elementary and secondary level classroom in Portugal, etc.). Many countries also have ambitious plans to connect their schools to information networks by the year 2000 (Pelgrum 1997).

Data collected in the mid-1990s revealed that even then it was relatively uncommon for schools in different countries to have Internet connections providing access to the World Wide Web. Schools in the United States had the most connections (Pelgrum 1997; see also Lehtinen 1997). However, national educational strategies indicate that the situation is rapidly changing in many countries. This was also made clear in the OECD symposium "ICT and the Quality of Learning" held in Paris in June 1998. Experts from different OECD countries presented their visions of the information society, with information networks and the possibilities they open up taking center stage. Educational development strategies based on information networks are not just a feature of educational policy in the developed industrialized countries; the World Bank, for example, is launching extensive

school information technology projects for the developing countries, where the central aim is to network the schools.

The market for multimedia products is experiencing explosive growth, and this means that large economic interests are connected to the production and distribution of multimedia. In her report to the OECD Paris meeting, Anne Leer (1998) described the new market trends of educational software and multimedia:

- Convergence and new chains of value. Formerly separate techniques and actors are becoming integrated, and this is leading towards the increasingly global production and distribution of information.
- Globalization. The world is getting smaller as information networks gradually cover the whole world. This globalization also crucially affects the distribution and availability of educational applications. It is to be expected that large numbers of people will hook up in information networks through which one can quickly distribute all kinds of teaching material anywhere.
- Consolidation. The development would seem to lead towards increasing centralization, and a decreasing number of companies will dominate the global markets of teaching software and multimedia. The Americans are very strong in this respect.
- The emphasis of investments will shift from technology towards content. Thus far the main investments both in the public and the private sector have been to develop the technical infrastructure, which has led to the powerful development of information networks. However, these investments will be meaningless without sizable new investments in the production of content material.
- The use of multiple platforms of distribution. Traditionally, learning material has been based on a single format (book, television program etc.) Now the most advanced producers of educational material are quickly adopting an operating model where the same content material is transmitted in parallel formats.

This development is leading to some transformations that educational policy decisions must take into account. The central issue is how the political steering of educational content and curricula should be defined in this new situation, shaped as they are by multiple media and efficient global networks. What should be regulated and who can regu-

late the increasingly globalized production of educational material? How do we safeguard national interests such as a nation's own identity, language and culture when the production of educational materials is becoming increasingly Anglo-American and globalized? How do we fit together public sector services and commercial interests (that is, how can we create new cooperation between the public and private sectors which would be appropriate and fair to both)?

According to the expert report presented to the OECD (Leer 1998), the development of the global production of educational material has thus far been problematic in many ways. The production of teaching materials has been technology-driven to a large extent, and pedagogical expertise and goals have had very little effect on content. Most educational software and multimedia products have been made by large software companies that do not have sufficient links to the educational system and to pedagogical expertise. Most commercial software is produced in the United States, and adapting it to other cultures is problematic. Learning material on the Internet and available on CD-ROM is mainly of poor quality, a fact which prevents the new media from gaining higher esteem. In her OECD report, Leer (1998) states that improving the quality of high-tech educational materials requires extensive cooperation and large investments in developing new kinds of expertise, so that both the training for people developing educational material and the funding for high-quality material production can be improved.

Impacts of ICT use on education according to international research

The potential and limitations of a survey of international research

Above we outlined the educational use of ICT as seen in international assessment projects. These reports present a general picture of how the use of information technology is spreading and of the official strategies for developing educational technology in different countries. However, these surveys do not provide more specific knowledge about the qualitative effects ICT has had on the development of teaching, learning and the schools. In order to examine these effects, we must look at experimental studies on the educational use of information technology. Here, we will attempt to present a comprehensive picture of the effects of ICT and its various applications on teaching and learning, as presented in the research literature.

When compiling international research data to provide background for the Finnish assessment project, we had to take into account certain limitations in this research on the effects of educational technology. First of all, the studies reviewed were based on earlier generations of computers. The pace of development in computer, network and software technologies is so fast, however, that present and future technologies will open up many possibilities which we do not yet know enough about in order to design the most appropriate wide-ranging studies. Secondly, extensive impact studies have usually concentrated on the immediate short-term effects of ICT on learning, learning skills, motivation and student attitudes. Essential parts of the learning and teaching effects of ICT are indirect, however, and are revealed as gradual changes in systems, ideas and teaching practices, and social processes in the classroom (Salomon 1990; Venezky 1998). Capturing these kinds of effects through extensive review studies is more difficult, but this is the very information which may be most important from the viewpoint of goal-oriented strategic planning.

We have attempted to collect information from all the important review articles and so-called meta-analyses of the educational effects of information technology. It is important to remember, however, that these meta-analyses are simplified summaries based on a large number of studies, and they provide only a very general picture of the direction and magnitude of learning effects. These kinds of studies do not provide answers to any of the more profound qualitative questions about the level of learning or the nature of pedagogical processes. On the other hand, information based on comprehensive summaries is important since it allows us to assess the so-called consensus issues: do these results prove anything about the pedagogical effects of information technology and can such findings be replicated?

When interpreting review articles and meta-analyses we must keep in mind that they might contain errors which give an overly positive picture of the effect of using information technology in education, as Kulik and Kulik (1987) point out. For one, although review articles are based on a large number of published studies, it is important to remember that before a research article is published, it goes through a critical evaluation process which usually screens out articles which present "zero findings." Articles which obtain results in accordance with their hypotheses have a much higher likelihood of getting published, and hence it might be possible that studies which hypothesized positive results but found none would simply not get published. A second problem with analyzing the effects of ICT on learning arises from the experimental setup. A new method (here, teaching with the help of ICT) is usually tried out by the most enthusiastic and committed teachers, which is not necessarily the case with the control groups. A third often-cited potential source of error is based on the possibility that a great deal more effort might be put into planning the teaching which utilizes information technology than into the teaching of the control group. It is possible that this planning effort alone, without the use of information technology, would bring about the effects shown (see for example Kulik & Kulik 1987). It is therefore problematic that review studies usually look only at outcomes and pay little if any attention to investments. From the perspective of a political decision maker, it would be important to know how large an investment of resources is needed in order to achieve the possible positive results.

The articles forming the basis of this summary are based on about a thousand original studies.

Early reviews of the effects of computer-assisted instruction

The first attempts to assess the educational use of information technology by compiling the results of several empirical studies were made in the early 1970s (for instance Edwards et al. 1975; Vinsonhaler & Bass 1972). The first summary articles describing the experiences of the late 1960s and early 1970s concluded that computers seemed to help in training basic skills. The early summaries already attempted to look analytically at the effects of different ways of using computers. For example, Edwards et al. (1975) started by making an interesting and still relevant distinction between two different kinds of experimental uses of information technology in teaching: one where educational programs were seen as substitutes for teachers and another where educational software was used as an aid or supplement to the teacher's work. Their results especially supported the latter approach, and many later studies have very consistently come up with this same finding.

Stennets (1985) published a review article summarizing numerous previous review articles. Based on all of this research data, there seemed to be a powerful consensus that the use of carefully planned computer-assisted drill and practice programs, when combined with teaching by a teacher, was more effective than traditional teaching alone.

On the whole, these early review articles showed a phenomenon which has later repeated itself in numerous surveys: studies often produce conflicting results. Some studies show marked improvements in learning outcomes, while others have not displayed statistically significant effects, and in some cases traditional teaching has yielded better results than computer-assisted instruction (see Becker 1987; 1990; Dalton & Hannafin 1988; Khaili & Shashaani 1994; Kulik & Kulik 1987). However, we might summarize these early surveys by saying that computer-assisted learning situations on average resulted in better learning outcomes and reduced the time needed to learn a given set of knowledge or skills when compared to traditional instruction. In the

1980s, surveys based on over 300 individual studies (Bracey 1987; Burns & Bozemans 1981; Kulik, Bangert & Williams 1983; Kulik 1985; Kulik & Kulik 1987; Niemiec 1984; Stennet 1985) also indicated differences between different ways of using computer technology, different durations of use and the types of software being used. Effects also seemed to be different at different levels of education. For example, a relatively common observation was that the most positive effects of computer-assisted instruction were obtained at the primary school level. However, many of the characteristics of the educational use of information technology which were studied in these surveys have already become obsolete due to technological development.

In a series of articles in the 1980s, Kulik and Kulik systematically described ways of utilizing technology (Bangert-Drowns, Kulik & Kulik 1985; Kulik & Kulik 1986; Kulik, Kulik & Shwalb 1986; Kulik, Kulik & Bangert-Drowns 1985); their work covered nearly two hundred studies ranging from primary school to university and adult education. The authors themselves classified ways of using computers into three different categories: (1) computer-aided instruction (CAI); (2) computer-managed instruction (CMA), where a computer was used to manage and organize instruction; and (3) computer-enriched instruction (CEI), where computers were used as tools for computing, programming or simulations.

Cotton (1997) has compiled the essential findings in nearly 60 publications from the 1980s and early 1990s. Many of these publications in themselves contain several studies, so the summary as a whole covers over one hundred original studies. Cotton's results can be summarized as follows:

a) Computer-aided instruction produced better achievement effects than traditional instruction alone.
b) The use of computers and word-processing software led to superior writing performance than traditional pencil-and-paper work, as manifested by longer written samples, greater variety of word usage, more variety of sentence structures, more substantial revision, greater responsiveness to teacher and peer feedback, better understanding of the writing process and better attitudes towards writing.
c) The use of computers in teaching also led to positive changes in attitudes towards school and learning in general, as well as in motivation.

d) The studies showed that using computers in instruction yielded different results for different student populations: low achievers and handicapped students benefitted more than higher-achieving students; positive effects were greater with young students than with older ones; students with a weak socio-economic background benefitted more than students whose parents were wealthy and highly educated; boys benefitted more from computer-aided instruction than girls.
e) The positive effects of computer-aided drill and practice programs were especially visible with respect to simple cognitive tasks such as retaining learned material and doing various routine tasks.

Using meta-analyses to more accurately assess impacts

The methodology and practice of writing review articles by compiling results from separate studies has been profoundly influenced by the so-called meta-analysis developed in the late 1970s (Glass 1976; Glass, McGaw & Smith, 1981). In a meta-analysis, statistical analyses of the original studies chosen for the analysis are done for a second time, as it were. This makes it possible to get a quantitative summary of the results of earlier studies. In a meta-analysis, researchers first identify an issue, and then calculate an effect size for that item based on the outcomes in previous studies. "This effect size describes in standard deviation units the difference in performance of the experimental and control groups" (Kulik & Kulik, 1987).

It may help to include some figures to provide a general understanding of effect sizes. For example, an effect size of 0.30 means that student scores went up by .30 standard deviations, which means that a little over 60% of the students in the experimental group scored better than the average of the control group. An effect size of 1.0 means that 84% of the experimental group exceeded the average of the control group.

Another way to try to concretize the effect size is to compare it with results from extensive statistical surveys showing how much improvement takes place in a student's knowledge during an average

school year. Here we could interpret an effect size of 0.3 to mean that a particular group has learned one third more than is normal during a single school year (Glass, McGaw & Smith 1981). A problem with looking at effect sizes in this way is that it trivializes learning into a mere quantitative change.

Kulik and Kulik (1987) performed a meta-analysis on the 199 studies they had discussed in their earlier surveys. The results of this meta-analysis can be summarized as follows:

"1. Students generally learned more in classes when they received help from computers. The average effect of computers in all 199 studies used in our meta-analyses was to raise examination scores by 0.31 standard deviations, or from the 50th to the 61st percentile.
2. Students also learned their lessons with less instructional time. The average reduction in instructional time in 28 investigations of this point was 32%.
3. Students also liked their classes more when they received computer help. The average effect of computer-based instruction in 17 studies was to raise attitude-toward-instruction scores by 0.28 standard deviations.
4. Students developed more positive attitudes towards computers when they received help from them in school. The average effect size in 17 studies on attitude toward computers was 0.33".

The results of the Kulik and Kulik's (1987) very extensive meta-analysis promise quite positive results from the use of computer-aided instruction. We must note, however, that the effects summarized above were average results. As a fifth point, they note that 29 of the studies analyzed came to the conclusion that computer-aided instruction had no effects which would have differed from those achieved through traditional instruction.

A few years later Kulik and Kulik (1991) updated their extensive meta-analysis by adding to it all of the effectiveness studies done in the late 1980s. This study also showed that cognitive achievement was improved by computer-aided instruction (effect size 0.30). Later, Kulik (1994) published a summary of 12 previous meta-analyses, which turned out to have parallel results. The effect sizes found in these summaries reached all the way up to 0.50. Such large effect sizes already signify essential improvements in learning outcomes.

Liao & Bright (1991) compared the effects shown in 65 studies by examining their relationship to different kinds of experiments. Their results showed that experimenters usually obtained higher effect sizes in short experiments and with computer environments which emphasize self-directed learning (for example, environments based on Logoprogramming). The researchers also found differences related to different educational levels. In this meta-analysis, the highest effect sizes were found in the primary grades and also at the tertiary level, whereas the results of experimentation at the secondary level were not as good.

In a meta-analysis of 120 separate studies published in the early 1990s, Fletcher-Flinn and Gravatt (1995) analyzed the effectiveness of computer-assisted instruction, their special focus being the size of the effect for various subjects and different grade levels, but they did not find significant differences for the different grade levels. For the various subjects, the greatest effectiveness was obtained in the teaching of mathematics.

In the meta-analyses undertaken during the present decade, the focus has often shifted from looking just at the effect sizes towards more specifically looking at how and in which environments the experiments have yielded the highest effect sizes. One of the most interesting was the study by Ryan (1991), where meta-analysis was used to analyze 40 experiments in the use of computer-assisted instruction in elementary schools. From these 40 studies, a total of 58 different and more or less commensurable characteristics were identified for which effect sizes could be calculated. These effect sizes ranged from 0.482 to 1.226. This means that these studies produced highly inconsistent results. At one extreme, computer-assisted instruction clearly weakened learning when compared with the control group, whereas at the other extreme the results were significantly better.

In Ryan's study, the average effect size was 0.31, which means that significantly over 60% of the students who had utilized computer technology had exceeded the average achievements of the control group. Of the 40 studies included in the meta-analysis, six reported the use of computers to have negative effects on learning and 34 concluded that the effects were positive. In some of the studies, however, the positive effect sizes were so small that they could not be considered meaningful. On the basis of Ryan's meta-analysis, it is possible

to take a somewhat more detailed look at the effects of different ways of using computers and the computer technology know-how of the teachers on the learning achievements. In this analysis, the ways computers were used were classified into the categories of drill and practice programs, tutorial, simulation, programming language, discovery programs and utilities. There was no clear correlation between different categories of use and educational effectiveness. From the effect sizes we can deduce, however, that a combination of different forms of use was generally more effective than using computers in only one way.

Ryan also meta-analyzed the effects of teacher training in computer use. In those studies where specific training in the use of computers in instruction had been provided to the teachers prior to the experiment, a clear correlation between time used for training and effectiveness of the experiment was discovered. In experimental classes led by teachers who had received less than five hours of training the effect size averaged 0.141, while in those led by teachers who had received more than ten hours of training it averaged 0.530, indicating that the effect of thoroughly training the teachers is very significant. Further proof of the significance of the teachers' computer expertise and commitment is provided by a comparison of the origins of the computer programs used with the effect sizes. In experiments where the teachers themselves had developed the programs they used, the average effect size was 0.815. In experiments where commercial software were used, the effect size was much lower at 0.29.

A similar approach was used in the meta-analysis undertaken by Khaili & Shashaani (1994). They compiled studies from the late 1980s and early 1990s where the effectiveness of computer applications in teaching had been empirically studied. Of the 375 studies they surveyed, only 36 had been carried out and reported in such a way that justified inclusion in a detailed meta-analysis. These studies, however, were very extensive and looked at many aspects of learning. Based on them, a total of 151 different effect sizes could be examined. Among these, 138 (91%) turned out to be positive and 13 (9 %) negative. The largest negative effect size was 0.88 and the largest positive was 1.54. The mean effect size for all 151 sizes studied was 0.38, indicating that the achievements of students participating in computer-assisted instruction were better than for the control groups.

More interesting than the general effectiveness results are the specific results which the authors present based on the studies they compiled. In Table 2 we have included some of the specific results of this meta-analysis. Many interesting results emerge from these samples. One of the important features which clearly emerged in the meta-analysis of Khaili & Shashaani (1994) was the duration of the experiment: effects of very short-term computer-assisted instruction remained rather minimal. A crucial increase in the effect size resulted from increasing the duration of the experiment from a few days to four to seven weeks. On the other hand, for experiments that lasted even longer, the effectiveness began to decrease again. This might indicate the existence of the so-called Hawthorn effect. This simply means that there is some kind of novelty effect. A new method or technique brings new interest to the learning situation, which in and of itself increases motivation and improves achievement once, after a short period of practice, people learn to work with the new system. When the new method or technique has been in use in the classroom for somewhat longer, the novelty fades and what remains is the effectiveness created by the new activities and learning processes provided by the new system. Results on the duration of the experiment show us that with more long-term teaching/learning periods the effect stabilizes and no longer decreases if the duration of the experiment is extended even further. Based on these results, we might argue that in the early 1990s studies of teaching effectiveness, the effect size purged of the novelty effect would have been somewhere between 0.30 and 0.40.

There are interesting differences between the results of these studies done mainly in the 1990s and those done earlier. There is a clear difference in the level of education for which effects were obtained. In the studies from the 1970s and 1980s, it seemed that the largest effect sizes were found at the elementary level and that the effectiveness decreased towards the higher levels. More recent results draw a very different picture. Relatively good results are still obtained at the elementary level and they get worse at the lower secondary level. However, at the upper secondary and tertiary level they are even better than at the elementary level.

Variables	No. of studies	Effect sizes
Grade Level		
Elementary	9	0.34
Middle school	6	0.11
High school	7	0.62
College	12	0.45
Duration of Treatment		
1-3 weeks	6	0.14
4-7 weeks	3	0.94
8-11 weeks	5	0.37
12-15 weeks	10	0.36
More than 15 weeks	8	0.32
Type of Application		
Drill and Practise	4	0.11
Logo	6	0.45
Other programming languages	5	0.33
Tutorial	8	0.26
Simulation	4	0.79
Problem-solving	11	0.41
Subject Area		
Mathematics	18	0.52
Computer science	3	0.28
Science	7	0.12
Reading/ Language	6	0.17
Others	2	0.80

Table 2. Selected effect sizes from the meta-analysis by Khaili and Shashaani (1994)

Another clear difference between the earlier and the more recent studies is related to the effects of the type of applications used. The earlier studies suggested that the greatest effects came from the use of drill and practice programs based on the ideas of programmed instruction. The recent studies show that the effects of using these programs are very small when compared with applications which demand more autonomous active problem-solving from the learner.

We can find at least two explanations for this large change. Firstly, computer-assisted learning environments based on a more modern (constructivist) learning theory were developed into workable applications only towards the end of 1980s and during the 1990s. The second explanation is based on a change in the assessment of learning outcomes. The earliest studies made clear that computer-assisted instruction had the greatest effects on simple memorization and straightforward tasks, but that the programs were not effective in teaching higher-level cognitive processes. With the shifts of emphasis in learning theory, from the early 1990s onwards these studies have also focused more on measuring problem-solving skills. This has powerfully changed our attitudes about the kinds of learning environments which produce the best learning achievements.

In addition to the results shown in Table 2, Khaili and Shashaani (1994) made one important finding. Experiments done with very small student groups have produced extraordinarily high effect sizes, while the effects shrink significantly once the group sizes in the experiments increase. This result is related to an important theme which is presently being debated among scholars studying learning environments. How can we expand methods developed in small-scale experiments to cover the entire educational system? Many of the innovative methods require that the teacher is very experienced and enthusiastic and has plenty of expertise. A method might be hard to transfer into classrooms where the teacher has not internalized the entire theoretical framework on which the method is based.

In their extensive survey, Teh and Fraser (1995) studied gender differences in computer-assisted instruction at the senior high school level. Their results showed that a computer-assisted development and problem-solving environment provides significantly better learning achievements than traditional instruction, but that although the general results were positive for both sexes, boys on average benefited more than girls.

The most recent meta-analysis (Liao 1998) compiled results of 35 studies that compared hypermedia with traditional instruction published in 19861997. The results of this analysis in many ways support the earlier published findings. In most cases hypermedia environments produced better learning outcomes than traditional instruction. In Liao's study, the mean effect size was 0.48. This study also

brought up the phenomenon already noted earlier that hypermedia experimentation with small groups provided considerably better outcomes than large-scale field studies. Liao's recent analysis also brought up the effect of the duration of the experiment. In this study as well, the central finding was that when the use of hypermedia environment lasts longer (here meaning over four months), its effectiveness decreases somewhat.

Towards a more differentiated impact analysis

The studies behind the summaries described above were mostly conducted in the 1980s. Likewise, many survey articles and meta-analyses done in the late 1980s and early 1990s attempted to answer a question which was interesting politicians, teachers and parents: whether information technology helps students achieve better learning outcomes. During the present decade, the number of such studies and surveys has decreased, and there is a clear reason for this. We have begun to see the role of ICT in teaching and learning to be such a varied and complex phenomenon that it no longer even seems relevant to ask whether the use of information technology promotes learning. There is no single way in which technology influences learning; rather, there are hundreds of different ways. It is impossible to look at the effects of technology alone, separated from ideas about instruction, learning and learning environments, as the technology is now intertwined with all of them.

On the other hand, as our ideas of learning have developed, we have begun to see learning itself as such a complex phenomenon that it has become exceedingly difficult to value a certain learning achievement more highly than another. There is no sense in using any result of an achievement test as an unequivocal measure of learning, since there are so many kinds of changes related to high-level learning. If we understand learning to be a process of organizing and constructing information in the mind of the learner, then it could be manifested as immediate changes of performance on some cognitive test or as slow changes which become visible in the long term as changes in individual performance levels. The most essential qualitative learning outcome may well be an individual's increased awareness of his or her own thought processes and skills, as well as changes in his or

her learning skills. These forms of learning are all still related to a learning theory which views learning as a process where an individual acquires information. However, theories of learning which have emerged powerfully in recent years have provided a totally different way of thinking about learning. According to this philosophy, learning cannot (exclusively) be described as a process whereby an individual acquires knowledge, but above all as changes in the ways in which the individual participates in various activities or is connected to his/her social environment (Sfard 1988).

Through the most recent international comparisons and surveys and on the basis of recent research literature, our ideas of the significance of ICT in teaching and learning are rapidly changing (see Vosniadou et al. 1996). In the use of information technology in teaching we can clearly see a shift of perspective from a focus on the use of technology to a wider look at the environments where learning, collaboration, information acquisition and interaction take place. The role of ICT is often important in these environments. Technology is used to support individual construction of knowledge, collaborative activities of the learners, and the networking of the students with cultures of knowledge and expertise outside of their school. In their review of the tools, working models and effects of computer-supported collaborative learning, Lehtinen et al. (1998) compiled information from about 200 studies in the area. It seems that radical changes have been taking place in the way information technology is being applied in learning environment research. Where computers were formerly viewed as a tool for individualizing instruction, they are now viewed more and more as a tool for social interaction and collaborative activities. Many studies report positive learning effects with computer-supported collaborative learning. The message of many of these studies was, however, that collaborative learning situations implemented with ICT produce wholly new kinds of processes for activities and learning which have not even been sought in traditional teaching and whose effects also cannot be directly compared with the outcomes of traditional instruction. Also, the most recent studies on computer-supported collaborative learning reveal the same problem related to wider applications which emerged in all earlier assessments of the learning effects of technology use. Even if small-scale experiments and single classrooms have shown fantastic results, it has proven

very difficult to get similar results as soon as the scale is expanded even a little.

Recent developments have very closely linked the educational use of information technology with developments in learning theories and pedagogical theory (Lamon et al. 1996; McGilly 1994). Many researchers of the educational use of information technology have come to the conclusion that adopting ICT changes the classroom culture in many ways. However, these changes are complex, partially unforeseeable and difficult to steer, as is the case with the effects of information technology in other areas of society (Salomon 1996; Schofield 1995). Related to these very changes are interesting pedagogical possibilities for developing new types of learning environments which lead to higher-level learning. However, both from the perspective of the educational institutions and of the teachers, it has turned out to be difficult to adapt to these changes and to identify and support their positive characteristics.

ICT IN SOLVING EDUCATIONAL PROBLEMS – THE THEMES OF THE ASSESSMENT

The picture emerging from the surveys and research reviews discussed above provides us with some guidelines for evaluating the future role of ICT in education. Technology is changing rapidly, however, and the entire cultural environment of education is producing changes and challenges which are sometimes surprising. The monopoly of schools as the primary learning environment of students is breaking, and on the other hand we must today strive to develop skills for managing complex, real-world problems. Thus we need to involve parties outside of schools in developing effective learning environments. In recent research on learning, there has been an emphasis on so-called authentic assignments and environments and on participation in genuine social activities as a part of the learning taking place in schools. The aim has been to develop the autonomy and self-direction of the students and then have them personally familiarize themselves with expert cultures outside of school. With information technology and network-based

practices, it is possible to break traditional boundaries of schools in such a way that students will participate in interesting activities assisting their learning outside of school, while expertise from the outside is transmitted into the learning projects taking place within the school. The opportunities brought by ICT have opened up new learning environments which are independent of schools and which in principle can be utilized by people of varying ages much more flexibly than our traditional educational services have been.

In present discussions of the information society and the information highway there is often the implicit thought that technological development and the extensive utilization of information technology which accompany it in themselves would lead to humanly desirable social development. However, technology-driven development is a much more problematic issue than is usually seen to be the case in most public visions of the information society. Technological possibilities and innovations have led to the emergence of unprecedented public and commercial pressures for reforming learning environments, studying methods and educational contents. To a very large extent, these technology-driven ideas and solutions have been developed without practical experience or theoretical knowledge of the school system and the teaching/learning process. Connected with the development of information technology there is anarchy and commercial ambition. While these in part may open new and fresh opportunities for new forms of learning that are not bound by old traditions, the new forms might also be unfounded and poorly-suited to the tasks of the schools. Developers of these new systems should also critically assess the single-minded, technologically-driven development of educational applications and ensure that technology serves the development of learning environments which are humanly, morally and culturally well-grounded.

Recent developments in learning research have brought up new ideas about the nature of appropriate learning environments. However, many of these are such that their implementation by the means available to traditional schools would be difficult. ICT applications seem to offer the possibility of putting models of learning environments supporting high-level learning into productive use.

The objective of this assessment was to chart how the possibilities offered by modern learning theory and technological applications

have been made to serve high-level learning in the Finnish educational system. Social and technological developments have placed new requirements on competence and expertise, and recent research has changed the ways we think of learning. Therefore, as we develop learning and learning environments, we need to emphasize the following areas:

- learning and problem solving skills along with self-directed learning
- social interaction and collaborative learning based on the theories of socially shared and distributed expertise
- constructing and arguing well-organized and complex knowledge structures
- learning environments supporting self-directed and genuine learning aspirations
- a new kind of teacher-student relationship, emphasizing collegiality and the expertise of students
- finding, processing and critically evaluating information in the modern media environments
- establishing closer links between education and expert practices in the economy and other sectors of the society.

The development of the information society has thus brought new kinds of challenges to learning and education. At the same time, technology offers many opportunities for organizing education and learning environments in new and innovative ways. Above we have looked at the problems related to assessing the effects of ICT. What can we use as a basis for our assessments in a situation where the technology itself is rapidly changing (for example, the development of networks), the availability of technology is growing rapidly, the pedagogical principles and learning theories related to the appropriate use of technology are changing and where there is even discussion about how we should understand learning in general (as the acquisition and integration of knowledge or as increasingly full participation in culture)?

In this assessment we look at the effects of ICT in education and learning as a part of the development of the information society. This means that one of the starting points is identifying the challenges presented by the information society and how the development of forms of education and learning will meet those challenges. This dis-

cussion is based on the numerous surveys done by the Finnish National Fund for Research and Development, the various ministries and research institutes concerning the factors connected with the development of the information society.

The assessment was directed more specifically to the justifications used for the adoption of ICT, to investments in technology, to systemic changes in organizations, to economic effects, to learning outcomes and to general ethical and social questions.

We are attempting to assess these issues concretely, by using extensive questionnaires and by describing specific experiments and practices on the basis of common evaluation criteria. We included individual case studies in order to see what added value new technology has brought to learning and what else has been achieved or learned along the way besides the actual objectives of each project. Our attempt was to go beyond the surface level, to examine how and why a project was meaningful for the individual, the organization and the society, or, failing that, how and why it failed to meet its goals.

3 ICT IN PRE-PRIMARY EDUCATION*

Study of the ICT use of pre-school Finnish children did not begin in Finland until recently. With the help of research and experimentation an effort is now being made to find out, among other things, what purposes are served by the use of ICT in education, what kinds of activities it could be integrated with and how IT can be used to support the acquisition of other skills. In Finland, children generally start school at age 7. For younger children, the local authorities provide daycare which families have to pay for. Daycare is not part of the Finnish school system, but it is under social administration. No formal curriculum is carried out in daycare; instead, its educational goals have more generally to do with supporting the children's physical and mental development. Pre-school for six-year-old children, in which most of this age group participates, is organized more like a school.

In the national plans concerning pre-primary education very little mention is made of the role of IT in pre-primary and primary education. The rationale of the pre-school curriculum put together by the National Board of Education (1996) comments laconically: "It would also be good if children could find out how to use the computer as early as in pre-school."

The current state and future uses of ICT in pre-primary education were studied with the help of questionnaires, interviews and observations made in the spring of 1998. The questionnaire was designed for educators and researchers working with children in administrative and other leading positions within pre-primary education. The purpose was to survey the use of ICT as a tool in the personnel's own work and in children's activities. In addition, an effort was made to discover problems in the use of ICT, as well as the chal-

*This section on the evaluation of pre-primary education is based on a report prepared by Marjatta Kangassalo and published in Sitra Report No. 191 (1998).

lenges facing its utilization and development within pre-primary education and daycare. In addition to the questionnaires, which were distributed throughout the whole country, two development projects were described and evaluated that were designed to explore the potential of communication and IT and the challenges facing its implementation in practice. The children's own experiences and views were surveyed by interviewing them.

Questionnaires were sent to 339 people who were involved in various experiments and training programs in pre-primary education and daycare in different parts of Finland. Of these, 135 were returned. Daycare centers employ kindergarten teachers, who nowadays obtain the lower university degree (BA in Education), and nurses, who graduate from vocational colleges. The goal was to get an overall picture of the experiences and views of these experts on the use of ICT in pre-primary education. The questions focused on the adults' own computer use, the use of communication technology in children's activities, and future challenges. The questions were open-ended, and the responses were classified and described on the basis of the different alternatives given in them.

ICT AS A TOOL FOR USE BY ADULTS

About 85% of the employees who participated in the survey reported that they use ICT in their own work. Those who work with children use word-processing programs somewhat more than the administrative personnel. However, electronic mail and Internet applications were used less by the people working with children than by the administrative personnel. Various teaching programs, games and paint programs were used by somewhat less than 50% of the people who were working with children (Fig. 4).

About half of the personnel evaluated their own computer and IT skills as satisfactory. About one quarter of the administrative staff and about one third of the field workers rated their skills as poor. According to the answers of both of these groups, communication turned out to be the central use for ICT. In addition, those who were working with children thought that IT could be used more than pre-

viously, for example, for writing various reports, for documenting children's activities, for planning and for sending information to parents (Fig. 5).

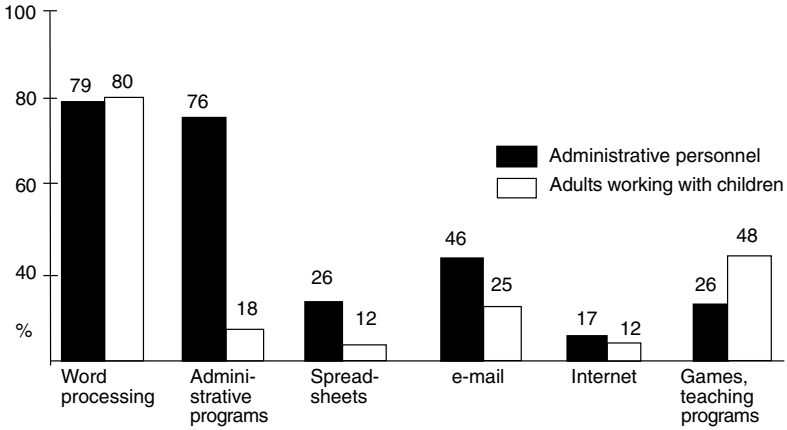

Figure 4. Information technology applications used by pre-primary school educators

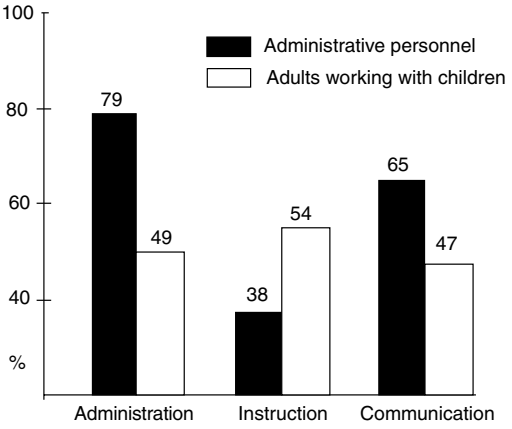

Figure 5. Pre-primary educators' ideas about the possibilities for increasing the use of ICT

ICT in children's activities

About 66% of the children used computers at the places where the surveyed employees worked. Usually, one to three computers had been set aside for children's use, in some individual cases even more. More than half of the children used computers daily, for the most part using various learning programs, games and paint programs. The programs were used to support the children's mathematical and linguistic development, their visual expression and in connection with topics having to do with nature.

The spectrum of opinions concerning the value of these programs is quite broad. Thirty-nine percent of the respondents had a positive opinion of the programs used by the children. Thirty-one percent had a partly positive, partly negative response. Nineteen percent of the respondents saw the programs as only negative.

Current projects dealing with research, experiments and development of ICT were also surveyed. Thirty-seven percent reported that experiments on the use of computers in the children's activities were being conducted at their place of employment. In most cases, the experiments had been initiated by the daycare center personnel in connection with their own professional activities. Some daycare centers and projects were cooperating with businesses, parents, a university or another school.

The respondents listed a number of situations and subject matters in which the children were able to use ICT. This list reflects the same actual uses of technology as in school: mother tongue, mathematics, music, environment, history, visual expression, animation, simulations, multimedia, preparing materials for recreation, various tasks for design and illustration (among others, for fairy tales), communication between children and the daycare center, research, searching for information, communication with disabled children, becoming acquainted with the basic functions of the computer.

According to 75% of the respondents, the greatest obstacle to the introduction of IT in children's activities was the lack of adequate funding. The second biggest barrier was the lack of information and training. Attitudinal problems and the lack of high-quality programs were also mentioned as barriers.

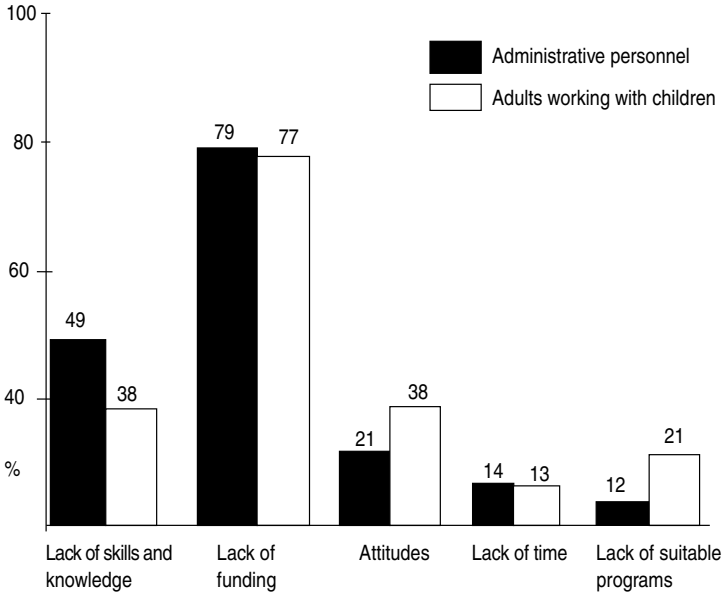

Figure 6: Obstacles to the introduction of ICT in children's activities

In the survey, 36 children were interviewed who had used IT. Their ages ranged from three to seven years. Most commonly, computers were first used at home, but some children had started using them at the daycare center. Most of the children said that they played games, drew, and colored pictures with the computer, and that they liked the games best. Working with a computer interested almost all of them.

Twenty-two children reported that they worked with a computer both alone and together with other children; three children used it only with others; and five children indicated that they only worked alone. The most understandable reason for working alone may have been the wish to work on "secret stuff." Not all children were interested in computers.

Twenty-four of the children said that they use a computer at home, while a few of them said they use one at a friend's home or at a library. When asked what they had learned, the children mentioned the computer and its use. They also mentioned that they had learned games and how to do writing and spelling exercises.

The results of the experiments

The goal of the experimental projects was to develop the use of IT as a pedagogical tool for the instruction of pre-school children. In this undertaking the Vantaa Pähkinärinne Daycare Center can be regarded as the pioneer in all Finland. Its example shows how the initiative, industry and involvement of one daycare center can lead to innovations. The Tampere TIVA Project is an example of a project that is being carried out in several daycare centers in one municipality.

The projects are attempting to discover, among other things, the impact of computers on pre-primary education, what purposes they serve and which applications of computer technology are beneficial. Among the educational goals that came up were the children's natural reactions to IT, seeing it as an everyday tool for various tasks, an effort to get over the threshold to use computer technology notwithstanding age or gender, and offering children the opportunity to feel what it's like to use a computer.

According to all the interviews that were conducted with those who were actively involved with the experiments, the children were unreservedly enthusiastic about IT. According to the interviewees, there was no danger of overusing it or playing too many games. This risk, however, has to be recognized so that the problem can be avoided. The fear that IT might lead to social isolation was also not confirmed, for the children worked at the computer most often with one or more other persons.

It seems that with the help of IT, groups of children and social relationships are created which would not be formed without computers. Computer technology can also offer some children an area of know-how which they otherwise wouldn't have become acquainted with at such an early age and which can have a positive influence on the development of their self-confidence and self-image.

The projects have as their goal that ICT would have some additional pedagogical value for what is being done by those who use it. In Pähkinärinne, adults and children are producing their own learning materials together. The children seemed to be using computers also for community activities. The introduction of IT has also made it possible for the daycare centers to network. This is especially clear in the Pähkinärinne Daycare Center, which has partners in the busi-

ness world and elsewhere, whereas the TIVA Project has made it possible for the daycare centers to network with each other and with the University of Art and Design Helsinki.

4 ICT IN COMPREHENSIVE AND UPPER SECONDARY SCHOOL*

General education in Finland consists of nine years of comprehensive school for every child. Instruction in primary school, which is the first six years of comprehensive school, is given mostly by classroom teachers. The last three grades in comprehensive school make up the lower secondary school, in which instruction is given by subject teachers. In Finnish comprehensive schools there is no tracking for students of different intelligence levels. However, handicapped and learning-disabled schoolchildren have special instruction at their disposal in connection with regular schools and in special schools. After comprehensive school the students can continue their studies either in the upper secondary schools leading to the university or in vocational schools. A little more than 50% of those who finish comprehensive school will nowadays enter an upper secondary school, where the main emphasis is on theoretical studies. The majority of the rest will continue in some vocational school, and only a very small percentage of the students terminate their schooling after they have finished comprehensive school.

The purpose of the school questionnaire was to survey the schools' equipment situation and to find out how extensively the teachers were using information technology, what the role of ICT was in the curricula at that time and what the future developmental prospects were judged to be. The purpose of the teacher's questionnaire was to determine the level of computer know-how, what equipment was being used, and how frequently. In addition, the teachers' views of learning and information, as well as the impact of these views on their practical work, were taken into account.

**This section presents the status of ICT in comprehensive schools and upper secondary schools. The observations are based on a sub-report for Project No. 3 that was edited by Liisa Huovinen (Sitra, No. 191, 1998).*

The students' questionnaire was used to survey their mastery of computer technology as well as their views on learning and the influence of computer technology as a tool for learning. The school questionnaire was administered to a regionally representative, random sample consisting of 200 primary schools, 100 lower secondary schools, and 100 upper secondary schools. Numerically there were more primary schools because they are smaller than schools at other levels, and the 200 primary schools included some small village schools with just one or two teachers. Many Finnish primary schools are small schools with only two teachers and from 20-30 students where one teacher teaches grades 1-3 and the other teacher teaches grades 4-6. The sampling process was designed by the Institute for Educational Research at the University of Jyväskylä. The questionnaires themselves were designed at the ICT Learning Center at the University of Helsinki.

It was decided to send the school questionnaires to the persons who were in charge of IT at each school because they were thought to know their own schools' technical equipment best. In addition, these persons were asked to distribute the teachers' questionnaires to all those teachers in their schools who used information and computer technology. The persons in charge, in collaboration with the schools' principals, were asked to fill in that portion of the questionnaire that dealt with the curriculum and future prospects. A total of 170 schools (43% of the original sample) returned the questionnaires.

The decision was made to send the teachers' questionnaires only to those teachers who were using IT in their work. This was done because the intention was to get specific information about the extent and level of knowledge about IT, the tools used by teachers in their work, and the relationships between, on the one hand, how well they had mastered computer technology and, on the other hand, their views on learning and their teaching practices. Thirty-eight percent of the schools returned the teacher questionnaires, altogether 609 forms, making for a response percentage of 62%. Of the respondents, 37% were men and 63% were women. Of the schools that responded, 40% were primary schools, 26% were lower secondary schools and 17% were upper secondary schools. In the following figures the category "others" refers to schools which have both primary and lower secondary schools, lower and upper

secondary schools, or all three schools together. These schools accounted for 17 % of the teachers. Nineteen different school subjects were represented.

Student questionnaires were sent to 30 schools (10 primary, 10 lower secondary and 10 upper secondary schools). The schools were chosen from among those where the persons in charge and their teachers had responded to the questionnaires and where several teachers were using IT in their work. This was done in the hope that the students who filled in the questionnaires would be experienced in using computer technology. The schools were also specifically requested to give the questionnaires to a group of students that had used information and computer technology in many ways. Thus, the answers in the students' questionnaires may represent the "top" of the schools and the students in the sample, rather than the answers of average students. The results of the students' questionnaires can therefore not be generalized to apply to the entire country and to all schools.

Technical equipment

Currently, the comprehensive and upper secondary schools are estimated to have, on average, one computer per 13 students. In the primary schools the national ratio at the moment is approximately 10-12 students per computer. In the lower secondary schools and upper secondary schools the ratio is about 14 and 15 students per computer, respectively. Some of the computers are outdated and very worn through hard use. Less than one half of the computers in the primary schools were attached to the local network. In the lower secondary schools almost 90% and in the upper secondary schools almost all of the computers were part of the network.

The computers are unevenly distributed. In small primary schools it is on average two or three times easier for a student to have access to a computer than in big lower secondary or upper secondary schools. In primary schools with less than 100 students, one computer would appear to meet the needs of six students, whereas in big upper secondary schools with more than 250 students there is in theory a line of almost 18 students waiting to use every computer. In various con-

texts a ratio in the vicinity of six students per computer has been thought to be a pedagogically justified target level. Under those circumstances, the students could be estimated to be able to spend an average of about one hour each school day on the computer. So far, this target has been reached for the most part only in the vocational schools.

Grade level	Number of students	Students per computer	Students per Internet connection
Primary	< 100	6	12
	≥100	> 16	>24
Lower secondary	< 250	8.6	16
	≥ 250	15.4	24.4
Upper secondary	< 250	9.6	13.5
	≥ 250	18.4	22.3

Table 3: The numbers of computers and Internet connections in schools of various sizes (Finnish Book Publishers' Association, 1997)

An Internet connection is available for every second computer in the primary schools, on average. In those primary schools without a local network, the Internet connection has often been made via a modem (45%) or with the help of an ISDN connection (30%). In lower and upper secondary schools the connections between the local network and the outside world have been established with a fixed line in three out of four cases. There are comparatively more Internet connections for computers in lower and upper secondary schools because practically all the computers in those schools are linked to a local network. Nevertheless, the situation in the large lower secondary schools with more than 250 students is the weakest: about 24 students per computer with an Internet connection.

The school equipment frequently includes CD-ROM stations and scanners. Other equipment that is used in conjunction with computer technology is clearly much rarer. For example, surprisingly few schools have digital cameras (Table 4).

Equipment	Used by % of the Schools
CD-ROM Drive	78
Scanners	69
Midi interface / Synthetiziser	27
CD-ROM distribution tower	18
Digital cameras	16
Videoconferencing equipment	12
Writing CD-drive	8
Audiographics	5

Table 4: Schools' equipment

The maintenance of IT equipment is a problem in comprehensive and upper secondary schools. In the schools that responded to the questionnaire responsibility for servicing the equipment is usually in the hands of the teacher in charge of IT, or it rests with municipal support personnel. Both are overworked.

Teachers as ICT users

With respect to the instructional use of computer technology and the way the teachers' ICT skills can be improved, each teacher should have a computer at home so that he or she can become acquainted with it in peace and use it to plan and prepare instruction.

Eighty-three percent of the teachers who filled in the questionnaires reported that they have a computer at home at their disposal. Thus, a computer was more than twice as common in the homes of teachers who use computers in their work than in Finnish homes on average. Equally many reported that they have a computer at their disposal in the teacher's room. The higher the level of the school the teacher worked in, the more likely he or she was to have a computer at home. Teachers who did not have a computer for their use at home represented all age groups and both genders equally. The fact that most teachers have a computer at home provided a good basis for developing their expertise in IT.

The second premise for the instructional use of computer technology is the expectation that the teachers have a computer in those classrooms that they use for teaching. According to the results of the questionnaire, 71% of the teachers have the possibility to use computers somewhere in the school. Forty-six percent of the respondents have a computer for their use in their own classrooms. However, one has to take into account the fact that only some teachers—and they represented primarily the primary schools—had a classroom for their own continuous use. The use of IT would be better supported if the teachers had either a computer in their own classrooms or a separate space for preparing their instruction where several computers were at their disposal. However, almost all teachers had the possibility to use computers in the IT classroom.

The new information and computer technology is presenting great challenges to the development of the teachers' pedagogical expertise. The respondents to the teacher's questionnaire approved of the central principles of recent learning research—principles which emphasize the significance of the learners' active information construction. However, very often there is a conflict between approving of these principles and actual learning practices: even though most teachers approved of the principles mentioned in the study, far fewer implemented them in their own instruction. (These results will be presented in a more detailed form below in the section entitled "Pedagogical concepts dealing with the use of information technology," pp. 68)

There seems to be a close relationship between the teachers' use, mastery and pedagogical notions of IT. Those teachers who can do so use it actively, and they seem to represent a more varied vision of how to use ICT in instruction.

According to IT teachers, more than half of all teachers have received training in how to use general purpose software. According to their own evaluations, teachers were well acquainted with the use of word processing, moderately well acquainted with the basic use of a computer, including operating system commands, and to some degree, with the use of information networks and graphics programs. The majority of the users were, on the other hand, not able to use other applications, such as desktop publishing software, picture scanners, spreadsheets, filing programs and databases, let alone authoring tools, groupware, and videoconferencing techniques. The appli-

cations the teachers had at their active disposal naturally influenced which aspects of computer use they knew well.

Male teachers judged their mastery of IT to be significantly better than did female teachers. All teachers had a rather positive attitude toward its use as a tool. More than half agreed totally or almost totally with the notion that "IT is a natural tool for me." Only 3% totally disagreed with this proposition. The men had a more natural attitude toward IT than the women. They also used it much more than did women.

It was, however, comforting that only a small number (about 16 %) of the respondents thought it difficult to learn new software applications. Almost half of the respondents regarded it as easy. However, male teachers experienced the learning of a piece of software to be statistically significantly easier than women did. The differences observed in computer technology skills in homes show a different pattern; however Juha Nurmela, who studied home use, has reminded us that the standards that men and women use to evaluate their own skills may be quite different, for women may underestimate their skills more often than men (Nurmela, 1998, p. 96). Furthermore, teachers' assessments of their own skills vary according to age, as has also been observed for the general population: the rating young users give to their skills is higher than that given by their older colleagues to their skills.

It was felt that the pedagogical support for the use of IT in instruction was less adequate than the technical support. Seventy-three percent of the respondents felt that pedagogical support was needed to a very great or to a great extent, and 67% felt the same way about IT training. Only 0.7% or 1%, respectively, felt that this training was unnecessary.

The need for training in IT was related to IT use: the teachers who used it only to a small degree emphasized their need for training in it more than the other teachers did. All in all, it is noteworthy that the perceived inadequacy of IT support in instructional use and the need for training came up so forcefully, even though the respondents represent, according to the people in charge of ICT, precisely those teachers who already use it in their instruction. The support for sensible instructional use of ICT clearly presupposes an extensive further training program for teachers, as well as improvements in regional and school support.

Students as ICT users*

The research data came from the responses of 515 students representing different parts of the county. Eighty-three percent of the students also had computers at home at their own disposal. The proportion of girls was somewhat smaller than that of boys, as approximately 90% of the boys surveyed in lower and upper secondary schools had a computer at home. More than one half of the respondents had an Internet connection at their disposal both at home and at school.

About one third of the students were allowed to use the schools' computers after school hours. Especially in the primary and the lower secondary schools, many willing users (more than one third) were not allowed to remain at school in order to use computers, even though they had expressed the wish to do so.

Boys used IT more actively in their hobbies than in their studies. No statistically significant difference was observed between boys and girls in the use of computers in their studies.

Other factors besides the use of computers as a hobby seemed to limit the use of communication technology for study purposes. The most important of these was the amount of IT equipment available at school and the emphasis on it in the curriculum. This is reflected in the statistically significant influence of age: primary school students used IT somewhat more intensively as a study tool than did upper secondary school students.

In spite of the differences in the use of IT in hobbies, more than 20% of the girls used it daily, and more than 70% of the girls in primary schools and more than 50% of the girls in upper secondary schools used computers at least once a week. Many students used computers several hours a day. Only 2% of the students reported that they used computers for more than six hours a day.

The boys' attitudes toward IT are more positive that those of the girls. Despite the remarkable gender difference, only very few students had reservations when it came to IT. The age of the respondents influenced the attitudes, in that lower secondary school students had a somewhat more positive attitude toward it than students in either primary school or upper secondary school.

*This section is based mainly on research by Kari Hakkarainen, Liisa Ilomäki, Erno Lehtinen, Lasse Lipponen, Hanni Muukkonen, Marjaana Rahikainen and Taneli Tuominen.

One indication of the students' attitude toward IT is how they react to computer technology as a tool, for example whether a student prefers writing or drawing by hand to using a computer for these purposes. Sometimes people feel alienated toward IT because it discourages the use of one's hands and prevents one from being in personal touch with another human being. On the other hand, one knows that with the help of IT, both writing and visual expression skills may gain totally new dimensions.

The students were asked, for example, to evaluate whether they preferred writing by hand to writing with a computer (Fig. 7). Only about 10% of the respondents totally agreed with the statement "I prefer writing by hand to writing with a computer," and as many as 40% totally and 20% partly disagreed with it. Even though the data showed that boys in every age group valued IT as a tool much more than did girls, only a few girls had a negative attitude toward IT as a tool.

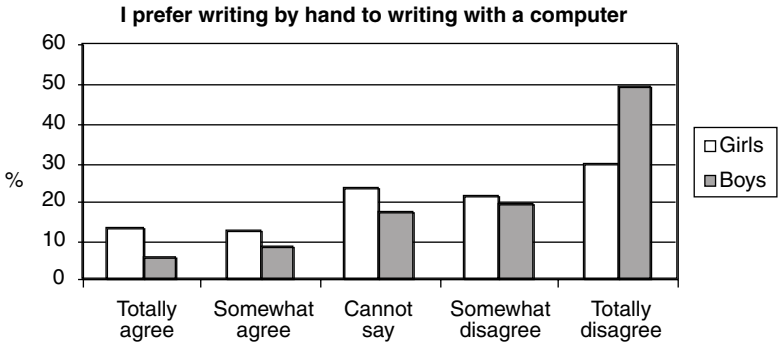

Figure 7. The respondents' attitudes towards text processing

Boys clearly placed more value on IT as a learning tool than did girls. For example, when students were asked to evaluate the statement "I am much more enthusiastic about my schoolwork when I get to use IT," it was noted that 60% of the boys and 30% of the girls totally or almost totally agreed with it. Primary school students had an essentially more favorable view about the usefulness of IT for studying than did upper secondary school students. Most students preferred to use it more as a support for their schoolwork. Boys emphasized their need to use IT more than girls did (Fig. 8).

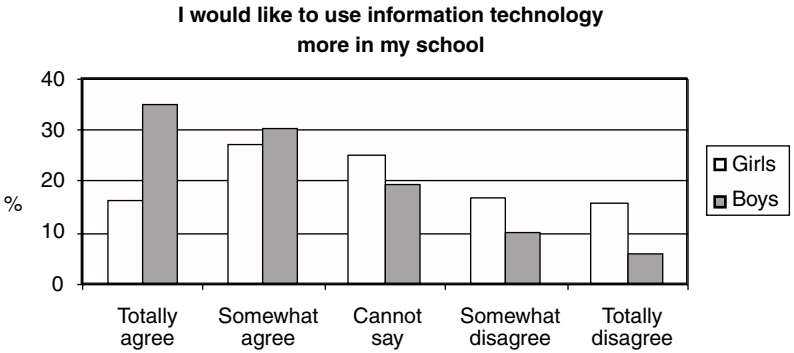

Figure 8. The students' willingness to use information technology in their school work

As expected, boys rated their mastery of IT as essentially superior to that of girls. In their opinion they had mastered word processing, paint programs, information networks and the operating system best.

Ten percent of the boys and four percent of the girls were actively involved every week in maintaining the computer technology of their schools. About 17% of the students (less than 10% of the girls) reported that they had been working with computer technology outside of school every week. More than 10% of the students (only three girls) had received money from relatives or other adults whom they had helped to solve problems concerning IT. In addition, about 32% of the boys and 7% of the girls were planning to pursue a career in IT.

A significant number of students felt that IT is well suited as a tool for group learning. Sixty percent of the students said that it is much nicer to use in company with others than alone. In addition, 40% of them thought that one learns better when one uses IT together with others. The students emphasized the community character of its use. The more they mastered IT, the more they emphasized the communal nature of using the computer. The students' ideas clearly did not support the notion that IT isolates people.

The students were asked to estimate how many people they contacted on average through the computer network each week. More than 20% reported that they are in contact with at least five people weekly. Eight percent of the students were in contact with IT professionals at least once a week.

From the point of view of equality, it is remarkable that the gender difference did not affect one's enthusiasm for IT as much as did the degree of mastery of IT. Especially the youngest girls had a very positive attitude toward it and its use for schoolwork. The ability to access the resources that support learning ICT may presuppose that it has been integrated into other subjects and linked to pedagogical goals. So far, it is being used extensively as a subject on its own and not as a tool for studying various other subjects.

The study showed that a great many students, most of them boys, had mastered IT quite profoundly and were responsible for performing a number of expert tasks, such as, for example, the maintenance of the school's information technology and equipment and the advising of other students. Part of the adoption of an expert role is very definitely networking—working together with other enthusiasts and professionals in the field. When the learning goals of the school are taken into account, the development of this kind of expertise is very positive, and it may also have a significant influence on the development of skills, including academic skills, in other fields.

Many students who have not mastered IT well are prepared to take on challenging problems, which means that with the help of IT in teaching it would be possible for more students to set ambitious learning goals for themselves.

Exploitation of technology in teaching and studying*

What, then, can be said of the present situation and the future of the use of ICT in schools? In terms of the present, we will examine this question in light of current curricula and pedagogical views; in terms of the future, we will look at future-oriented experiments and school web pages.

The use of ICT in schools is still every individual teacher's own thing. Schools do not make teachers use information technology as a

*This section is based mainly on research by Kari Hakkarainen, Liisa Ilomäki, Erno Lehtinen, Lasse Lipponen, Hanni Muukkonen, Marjaana Rahikainen and Taneli Tuominen.

tool. Less than one third of the schools reported that their teaching plans contained definitions of how it was to be used as a learning tool. However, half of the schools had set minimum proficiency standards for the use of ICT. More than one half of them had organized separate information technology courses in an effort to teach these skills. The information in Table 5 may even conflict with the nationally based rationale for the curricula and the school's own instructions for designing them.

Statements	Yes (% of the schools)
The teachers decide themselves whether they use information technology in their teaching.	96
The curriculum contains separate courses in IT.	64
The curriculum defines the minimum skills students have to learn in the use of IT.	46
The curriculum defines how IT is to be used as a tool for learning various subjects.	26

Table 5.The curriculum defines how IT is to be used as a tool for learning various subjects

As a rule, schools do not have a common plan for developing the instructional use of ICT. This seems strange when seen against the background, for example, of the national funding program "Finland towards an Information Society": the schools that applied for funding under this program were supposed to put together such a plan. At that time, the schools answered the question concerning the planning activities for instructional use by saying that they were adding to the amount of equipment and were going to start networking projects. Projects that aim at the development of instruction were mentioned in just a few answers. Such projects were, among others, a school journal, various WWW and open and distance education projects.

Pedagogical conceptions related to the use of ICT

Evaluations of the influence of ICT on teaching practices showed that only one fourth of the teachers agreed either totally or almost totally with the opinion that "communication technology has essentially changed the teaching culture in my school."

Teachers also had to react to statements that were linked to the principles of cognitive research and their implementation in their own instruction. One of the statements had to do with the breaking down of barriers between the schools and the outer world and the success with which the principles behind the statements had been incorporated into the school work (Fig. 9): "Using ICT, the students can deal with the phenomena and problems in the world outside of school independently." Even though the majority of the teachers (68%) agreed totally or somewhat with this statement, only 22% indicated that this principle had been implemented systematically in their instruction.

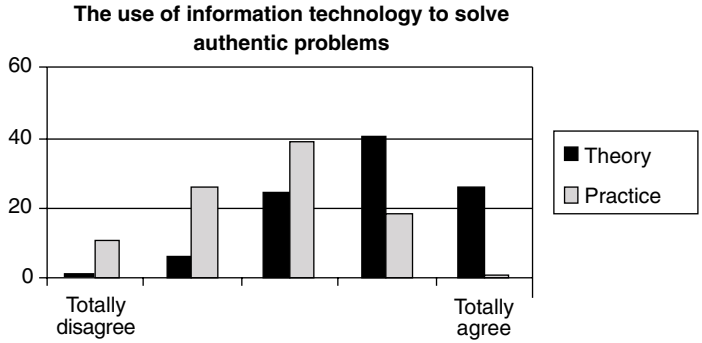

Figure 9. The use of information technology in solving complex and real problems

Similarly, 86% of the respondents agreed totally or somewhat with the statement that "information networks bring more experts and more expert information to school use." However, only 30% of the teachers thought that this principle was consistently reflected in their own instruction.

When the use of ICT was examined as a tool for cooperative and collaborative learning, a corresponding conflict was noted between principles and practices. Sixty-three percent of the teachers either totally or somewhat agreed with the statement that "ICT is suitable as a tool in cooperative work." However, this principle had been implemented in practice only to the same extent as in connection with authentic problem solving: 22%.

Most likely, some of the conflict between principles and practices in the instructional use of ICT can be explained by the fact that not nearly all the teachers have the ICT resources at their disposal that would be necessary to bring about an essential change in instructional practices.

The study also showed that male teachers emphasized the use of ICT more than their female colleagues as a tool for inquiry. They also believed that they used it more than female teachers in implementing learning through investigating real problems. Teachers' pedagogical concepts were also examined in order to determine the intensity of the use of ICT. Of the teachers who used it a lot, only 30% were women, although they accounted for 63% of the whole group.

As expected, teachers who used ICT a lot also used it as a tool for inquiry much more often than those teachers who used it only a little. The equipment at the disposal of the teachers had a very clear influence on this. It seems that the teachers who use ICT most actively also emphasize the principles of inquiry, carry them out in their own instruction and emphasize its use as a support for inquiry more than do other groups of teachers. It is also interesting that the teachers who use ICT intensively place greater emphasis than other teachers on the possibility of developing the students' skills. These teachers placed more emphasis on the constructivist concepts of knowledge.

When their use of ICT as a tool for collaborative learning was examined in its relationship to the intensity of its use, it turned out that those teachers who used it to a great extent emphasized the collaborative aspects of learning statistically significantly more than those who used it to a lesser degree. The age or gender of the respondents had no influence on their evaluation of the significance of ICT as a tool for collaborative learning. All in all, it was worth noting that teachers as well as students regarded IT as a very suitable tool for collaborative learning and that it did not isolate students from one another, as has sometimes been claimed.

It is encouraging that the pedagogical thinking of teachers who actively use IT in their own instruction represented rather well-developed ideas in learning theory. However, in evaluating the results, one has to take into account the possibility that the teachers who use IT actively may have been selected in many ways: working in schools that participate in school improvement projects, being willing to change and actively develop themselves, etc. However, this finding cannot be regarded as evident; it is not at all clear that active use of IT leads to changes in the teachers' pedagogical thinking as well as to changes in their teaching or learning practices. It may be true that teachers who represent well-developed pedagogical thinking have found the computer to be a congenial tool.

Teaching practices

Most teachers have IT at their disposal either in their own classrooms or elsewhere in the school. IT is, however, not used very intensively. Although quite a few teachers have a computer at their disposal both at home and at school, they do not use it systematically in the preparation of their own instruction. All in all, about 31% of the respondents used computers daily to prepare their instruction. Almost half (46%) used IT every week when they planned for and prepared their own instruction. Only 15% of the primary school teachers used it daily to prepare their instruction.

When the distribution of the instructional use of ICT was examined based on the level of the school, somewhat different results emerged (Fig. 10).

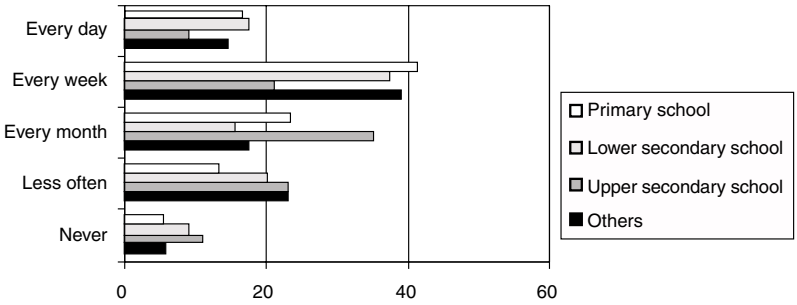

Figure 10. The use of information and communication technology in instruction

The use of IT in instruction seems to be a little more common in the lower and upper secondary schools than in the primary schools. However, only about 15% of the teachers used it in their instruction daily, and 36% every week. The frequency with which computer technology was used was naturally explained in part by whether the teachers had the necessary equipment and software at their disposal.

According to the questionnaire, the teachers use the school's computer lab rather infrequently. In all the material, 9% of the teachers use the computer lab daily and 29% weekly. There may be several different explanations for this. In many schools only the IT teacher has the possibility to use the computer lab daily. One also has to take into account the fact that even the maximal use of the computer lab does not make it possible for every teacher to use it daily.

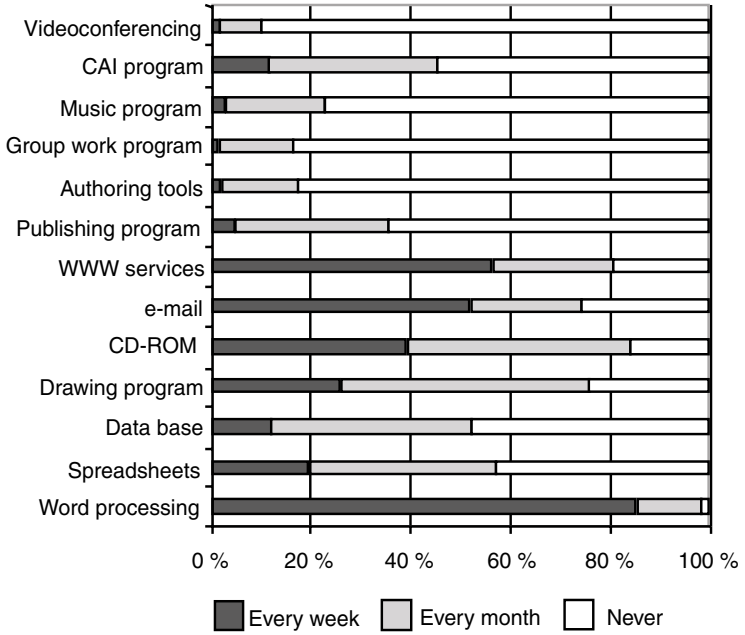

Figure 11. The objects of the informational use of information technology

Instructional use focuses mainly on word processing, WWW services, e-mail, and CD-ROM-based programs. The majority of teachers used e-mail to communicate with colleagues, whereas communication, for

example with students' parents via e-mail, is still rather rare. The WWW pages are used in the teachers' own instruction and in the preparation of teaching materials, as well as for accessing information. Almost half of the schools in the sample had their own WWW pages, but only about 20% of the schools published their students' productions on the net. Open and distance education with the help of information networks is at its very beginning: only about 10% of the schools reported that they used information networks in order to assign and return homework and to advise students. Based on an examination of school WWW pages, the situation is not at all this favorable for the country as a whole. However, information networks have already achieved some significance in school administration, for 50% of the schools in question used information networks for this purpose.

One can conclude from Figure 12 that IT is not yet being used much as an integrated daily tool in the instruction of various subjects. This is true even though the questionnaires were filled out by precisely those students who were supposed to use IT in as many ways in their studies as possible, even outside of IT lessons. As far as the frequency of use is concerned, the teaching of information technology seems to correspond to half of its total use in schools. In these data it is surprising that 25% of the students reported that IT was not being used at all in the instruction of IT! More than 60% of the students use it every now and then when they study foreign languages, their mother tongue, sciences or humanities.

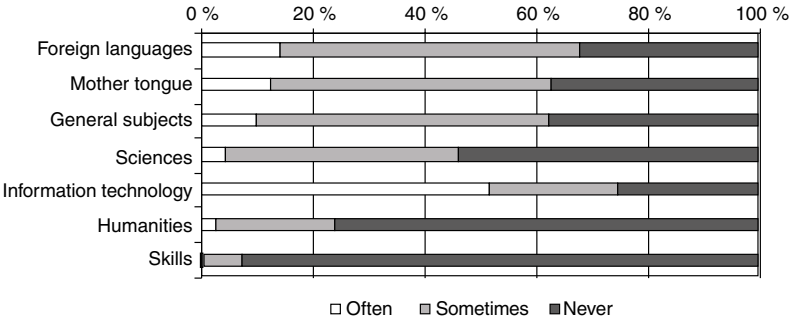

Figure 12. The use of IT

Word processing, drawing and tutorials are the most frequently used applications, together with games. On the other hand, the use of new authoring tools or programming is rather rare in the schools that responded to the questionnaires. A little less than 20% of the students use e-mail daily and about 35% weekly. Surfing and looking for information on the Internet are relatively common ways of using the networks: about 40% of the students surf the Internet at least once a week. Nevertheless, apparently about half of the students do not yet use information networks at school.

Pedagogical exploitation of the Internet in the light of school WWW pages*

At the end of April 1998 the school network pages maintained by the National Board of Education had links to 333 primary schools, 192 lower secondary schools, 165 upper secondary schools, and 138 vocational schools and their WWW pages—a total of 828 schools. In the spring of 1998 school pages on the edu.fi server (http://www.edu.fi) were growing in number at the rate of about 50 per month. At this pace all schools will have their own WWW pages by the beginning of the year 2005.

	Schools by the end of 1997	WWW pages in edu.fi on 28. april1998	Percentage
Primary schools	3429	333	9.7
Lower secondary schools	628	192	30.5
Upper secondary schools	432	165	38.2
Vocational schools	400	138	34.5
Total	4889	828	16.9

Table 6. The WWW pages created by the schools that have subscribed to the edu.fi service

Every fifth school's web page (153 in all) was randomly visited in order to determine how WWW pages were being used in instruction. The publicly accessible pages of these schools contained very few ref-

*This review was done by Markku Juusola.

erences to applications of new ideas of learning. References were noted for only three primary schools, five lower secondary and two upper secondary schools. This does not necessarily mean that new learning concepts are not being used in schoolwork. One cannot even discover for certain how much schools use the WWW just by looking at their publicly accessible pages, and it must be noted that some of the teaching materials developed have not been made public.

The pages of the primary schools clearly include the most recent innovations that have sprung up from the schools', the teachers' and the students' own ideas and enthusiasm. Most often, student work is involved. Vocational school pages mostly concentrate on presenting extensive cooperation projects between various vocational schools—projects which are aimed at an exchange of courses—but there are no signs of a new conception of pedagogy in the sample of 40 vocational schools.

Although half of the primary schools in the sample had exhibited student and group work on their pages, only a third of the lower secondary schools, only some of the upper secondary schools and not one of the vocational schools had done so. Although not one school in the sample had put together a WWW portfolio to cover its students' studies, something similar seemed to have been contemplated, especially in the primary schools.

School home pages show few signs of networking with the surrounding society. There are links to the home pages of other schools in more than half of the sampled home pages: to schools in the same municipality, to neighboring schools, to partner schools in Finland and abroad. Upper secondary level training experiments and links to the cooperating schools are displayed on the pages of vocational schools and upper secondary schools, among other things in the form of descriptions of experiments and courses. Nevertheless, the open access pages indicate that WWW pages are not being used in instruction itself or to support instruction. In our sample, only a few vocational schools had network connections to businesses in the field. People have either not been able to create these connections or have not had time to use WWW pages to connect vocational schools to those expert cultures for which their students are being trained. The sample included only a few cases in which the Internet had been utilized for networking. The sample indicates that thanks to Internet

connections some schools, however, are becoming increasingly important as centers for learning, for example, in distant villages.

The Internet also offers new opportunities for cooperation between the school and the parents, but so far there are extremely few signs that they are being taken advantage of. In all schools, e-mail can most often be sent only to the principal or to the whole school in general. Only some of the sampled schools had apparently made it possible for all of the teachers and students to have their own e-mail addresses.

The schools' curricula were presented on the web pages of two thirds of the primary schools and on the web pages of practically all lower secondary, upper secondary and vocational schools. The courses being offered were usually shown in the margins. In some areas, especially in the listings of courses being offered by both the lower and upper secondary schools, subject-specific pages have been created on which the teachers' views on teaching the subject in question have also been presented: how the subject relates to the immediate environment, tasks that have to do with the subject or a theme, Internet links and other sources.

Self-made, classified collections of link connections have been put together in one fifth of the schools sampled. So far, teachers have not prepared a lot of WWW teaching materials for their own courses, or at least not much of it had been presented. Some had gathered useful materials pertaining to their own fields on their own pages or on their subjects' home pages, for example, materials that had been put together by the universities or the subject teachers' associations. Only one upper secondary school had put together a link collection entitled "Further studying possibilities," even though such links should be of interest to all the students who are finishing school. Some of the university departments have taken advantage of these WWW opportunities to recruit intelligent students.

On the WWW pages of the vocational schools, the main emphasis was on the introduction of degrees, courses, and application procedures. Services combined with work training, for example in a barber shop or a restaurant, were naturally marketed with the help of the WWW, but the Internet is not yet really being exploited to develop functional connections between the experts representing the various fields studied in vocational schools; some of these experts are

themselves also just beginners in using the Internet. However, some special vocational schools have made a promising start.

Examining selected municipalities*

Strategies of introducing ICT in entire municipal school systems were studied in Helsinki, in Jyväskylä and Oulu (two middle-sized towns in the middle of the country), and Valkeala and Paltamo (two rural communities).

In developing their strategy, all of the municipalities studied made an effort to free themselves from a preoccupation with technology *per se*. However, this effort has not yet been very successful, with perhaps the possible exception of some attempts in Helsinki and Paltamo. The strategy of the IT project in the Helsinki schools included the balanced consideration and development of all five of the following aspects: equipment purchases, interschool networks, extensive basic training for teachers, maintenance of the schools' equipment, and curriculum development. In addition, an extensive study of the development of ICT for instructional use is also underway. Such a comprehensive strategy is certainly still rare elsewhere. In Helsinki, the organizations for further training of teachers are exceptionally extensive and beneficial to schools.

The goals of the development project of the "communication pilot municipality" of Paltamo have been recorded in its municipal plan. The project in this remote village was started in autumn 1996. The goal was to use the strategy to create the framework for distance learning and teaching, to develop especially young people's mastery of IT and to make possible the use of new services based on it in the activities of the municipality and small businesses. The first phase was devoted to the creation of the technical infrastructure. True to its name, the second phase, "Instruction, research and development," is concentrating on the development of school practices. The funding comes mainly from the municipality's own budget. Outside funding support has also been received from the Regional Council of Kainuu, the European Union and the National Board of Education, among others.

**This survey is based on reports prepared by Liisa Huovinen, Päivi Häkkinen, Sanna Järvelä, Jari Koivisto, Hanna Salovaara and Jouni Välijärvi* (Sitra, No. 191, 1998).

With respect to further training, all of the model municipalities have the same problem that shows up in the evaluations of other development projects as well: it is moderately easy to organize the basic technical training of teachers, but it is much more problematic to plan and carry out pedagogical training. More information and expertise in adapting ICT to pedagogical purposes are needed so that successful training and development projects can be organized. Despite the fact that curriculum development and further training are still at their very beginnings, goals have been set for them.

Oulu's reputation as a technologically oriented city is reflected also in the plans for implementing ICT in its schools. Oulu's schools are purchasing equipment and building information network connections systematically; however, this kind of approach was not observed in connection with pedagogical practices and teacher training.

Coordination. As far as the infrastructure of the educational technology is concerned, school IT requirements are taken care of centrally in most municipalities throughout the country. This practice has been implemented no later than at the time the schools are networked, as it is not purposeful or even economically possible to allow schools to implement individual and different technical solutions as far as networking is concerned. Thus steering groups have been created in municipalities in order to coordinate school IT activities. In the sample municipalities, active steering groups in IT projects have also been functioning as the responsible entities for the development of instruction based on the implementation of information technology in the entire municipality. The steering groups have, however, tended to emphasize IT expertise more than pedagogical expertise.

General goals have been presented in the municipalities' plans for funding and implementing the instructional use of IT, and the schools have generally had to take them into account when they develop their own curricula. The important task of the steering groups is to ensure that the study and understanding of ICT form a systematic continuum for the student. In this respect the sample municipalities still have a lot to coordinate. The same is true also of the students' opportunities to enjoy equal access to technology to help in their studies at the various schools. There are great differences between schools when it comes to equipment, let alone pedagogical solutions. It is quite al-

right that there are differences in emphasis justified by the different directions the schools have taken, provided that a certain commonly accepted basic level can be guaranteed.

The municipalities have thought it important that the municipal survival strategy and the school's IT strategy be unified so that the development is efficient and the schools' needs are appropriately taken into account. The CygnNet network is an example of this kind of activity. The University of Jyväskylä and the municipalities in the surrounding area are participating in the development of this network. The Regional Council of Central Finland project "Pedanet" operates in close cooperation with CygnNet. This has given rise to several network projects in the town, as well as international projects. In Paltamo, which is striving to become a "communication municipality," the unification of strategies means, among other things, editorial cooperation between the media upper secondary school and the newspaper *Kainuun Sanomat*, and the organization of media camps in the summertime.

Commitment to the strategy. On the political level the commitment to the strategies seems to be strong in all the cases studied. The commitment of schools' administrative personnel, the above-mentioned steering groups, the principals and the teachers is at least equally important to the achievement of real results. Successful pilot projects are strengthening the commitment of both the decision makers and those who have to carry out the decision. The following statement, made in connection with Paltamo, may also be appropriate elsewhere: "In the future, the key person's responsibility in the developmental work should be distributed to a larger group."

However, because not everybody is this enthusiastic, gentle persuasion is sometimes needed to break the resistance to change.

When the time comes to review and update their curricula, the schools in Helsinki will have to revise them in such a way that they clearly reflect how each school is going to give its students the knowledge and the skills presupposed by the information society in the use of ICT and how it plans to use ICT in instruction. The school plans vary considerably, and in all municipalities there are schools that have placed a strong emphasis on this matter.

Equipment. In the municipalities in the sample, the economic situation is such that it is not easy to reach the national goals or averages in equipment and network connections. Reducing the investments or the expenditures in ICT would, however, lead to the students ending up in a worse position than the students in other municipalities. Therefore it is important that the National Board of Education monitor the equality of students' access to ICT in various municipalities and continue the program for funding equipment in a way that evens out the differences.

Further training. None of the sample municipalities has been able to shift the main focus in its further training away from skills in IT to pedagogical training. The turning point is expected in Helsinki, for example, next year. So far, pedagogical training has mainly been offered only in the national training program "Finland towards an Information Society."

Support for information technology. In the spring of 1998 there were 18 support persons in Helsinki. As 50 are needed, 36% of the goal has been reached. The goal is to meet this need by the year 2000. In Jyväskylä the support resources include from one to two hours per school per week, which is about 10% of the need. At every level of instruction there should be at least one full-time support person. The schools in Valkeala have one full-time support person at their disposal, as well as other school resources. Twice as much support is necessary. Oulu has five support people, but from eight to ten people are needed. Everywhere, too few resources have been allocated to the maintenance of the school's information systems, which has the result that a lot of the investment is not being used to the full or is not used at all.

In order to correct this situation, cooperation with businesses and extensive training for support personnel are necessary.

Programs and learning materials. The municipality of Helsinki has not acquired learning materials in any appreciable amounts; however schools have acquired them with their own funds. General purpose software has been purchased centrally. In Jyväskylä the situation is weak with one exception. In Valkeala, schools have been able to

acquire 50% of the learning materials they feel necessary, and in Oulu only 20% has been acquired. Based on this information, it seems that the acquisition of software and materials has been unsystematic and random, which is why there has not been any training in the materials, and therefore their use has not been very extensive, either.

Student access to the networks. Helsinki has provided all of its schools with guidelines for the use of IT. The students have to make a specific promise to follow the prescribed rules. The aim is that every student has his or her own e-mail account and password with which he or she can access the school network. In addition, the students get the right to use the Internet. In Jyväskylä the use is relatively free and there has not been a lot of misuse, possibly because of efficient advising and inspection. Tight restrictions are not supported. In Valkeala some precautions have been taken, partly because of information security and partly because of funding. Oulu has introduced an access permit, in addition to which teachers also monitor Internet use.

Future plans. All the sample municipalities were careful in presenting their development plans for teaching the use of ICT, especially when it came to funding. A clear trend is that an effort will be made in the years to come to sustain the current level of funding, but that level cannot be surpassed. Everywhere, the reduction of the funding possibilities is seen as a threat. Nevertheless, investment in the acquisition of computers and networks remains very strong, at least for the time being.

However, it seems obvious that the total investment in the abovementioned municipalities is still too small to achieve in the near future the goals set. Training continues to be strong, and the emphasis is shifting from the study of technology to the acquisition of pedagogical skills. The corresponding turning point is being approached throughout the country. Pedagogical development and investigation projects have been started everywhere. Little by little, even outside of Helsinki, the budgets are including money for research. Expenditures for ICT are already substantial enough to justify the expectation that the development projects will be evaluated and studied again at a later date. Funding is needed for training with a pedagogical emphasis, for development based on research, and for the development of

expertise. Here, the university towns are, of course, in the most advantageous position. Closer contact with universities and comparable advanced institutions seems to be taking place, or at least it is gratifying that this aspect is being included in the programs of other non-university towns.

Prospects for the improvement of instruction

Although development projects yield information on the direction of the anticipated improvement and on the problems and threats to be overcome, they first and foremost provide information about new possibilities. In addition, with the help of development projects, the schools are finding out in practice what the new technology has to offer to instruction.

As late as in the beginning of the 1990s schools might have acquired computers without having worked out any advance plan for their use. Now the situation is different. Schools cannot afford to get computers without having planned in advance how to use them. Thus in practice every computer purchase is or should be part of a wider IT development plan for its application in the school's instruction. Not all of the experiments succeed, and neither does their use in general even approach pedagogical optimality—on the contrary, the developmental work and the naturally suited use of IT are in the process of establishing themselves.

For evaluation purposes, an effort was made to find development projects in the comprehensive schools and the upper secondary schools that represented innovative applications of ICT and that would permit them to develop new kinds of learning practices. These projects have been evaluated on the systemic level, taking into account the nature of learning processes and teaching practices.

Even though an effort was made to select the projects to be evaluated so as to emphasize their pedagogical innovations, it was discovered that in reality the developmental work is taking place too much on terms dictated by the technology. As far as learning processes and

teaching practices are concerned, the goals that were set for the projects have not been reached. Real change in teaching practices is slow, and it usually requires outside support. In addition, one can see from the project evaluations that development in the schools requires a new kind of working culture from the teachers: the development projects often affect only some of the teaching staff.

At this point, we will mention only a couple of examples. GLOBE is an international science education program in which, among others, one elementary school in Eno, a rural community in eastern Finland, is a participant. The report on this project was written by Päivi Häkkinen.

GLOBE (Global Learning and Observation to Benefit the Environment) is an international environmental education network which links students, teachers and researchers. This originally American project has spread all over the world. In Finland 133 schools participate in it, and the National Board of Education is coordinating the project. The common goals of the program include 1) to increase environmental awareness everywhere in the world, 2) to influence the increase of global scientific understanding, and 3) to improve the level of studying sciences and mathematics. Every GLOBE school has a kind of weather station where the daily rainfall, temperatures and cloudiness are measured. In addition, water is being monitored, vegetation is being diagnosed and satellite pictures are being interpreted. The sciences have not been separated; instead, side by side, meteorological, chemical and biological phenomena are being investigated. The students get acquainted with the scientific expert culture by being in contact with experts.

In all phases of the research projects of this program, ICT is a varied and necessary tool. For example, the Internet is being used to share the observations and research results with other schools and researchers. The measurement data is collected into a database which schools can use, for example, to compare the weather and the temperature in different parts of the world (cf. http://www.GLOBE.gov.).

The elementary school in Eno is a Northern Karelian school of 200 students and 10 teachers. There are three reasons for the school's participation in GLOBE: 1) the network has to do with the environment and it has a broad base, 2) it creates an authentic reason to use the Internet in instruction, and 3) international contacts are made

with its help. In Eno it is believed that the further away from urban centers the schools are, the more innovations are needed in instruction. They also believe that IT gives developing areas new opportunities to improve their instruction and to benefit from international cooperation.

The school in Eno was one of the first Finnish schools to be accepted into the program. Two teachers were trained in 1995 when the program was introduced among the sixth graders. Lower classes have also increased their participation in the program. The project is headed by a teacher who also works as a national GLOBE trainer, and the goal is that all teachers in the school will receive GLOBE training. This program also joins all the schools in Eno to each other. Ten teachers in Eno schools have already finished their GLOBE training.

In addition to its GLOBE network the school cooperates with the University of Joensuu and the Finnish Meteorological Institute.

There are separate projects within GLOBE, and GLOBE can also be used in other school projects which are summarized below.

1. In the spring of 1998 the school joined about 200 other schools and researchers from all over the world in a project called "Kids as Global Scientists '98" that had to do with climate and atmosphere (http://www.oneskyp.unich.edu/kgs98/). The Internet and a special CD-ROM program were used in the project. The students got to know the CD-ROM program, which included, among other things, ready-made basic maps, they introduced themselves to one another and were divided into groups which had their own special areas and discussions on the Internet. The groups made measurements during a two-week period. The information was shared globally between schools.
2. The school gives out information on its activities on a regular basis. A remarkable part of the publicity is put on the school's home pages and in the net journal *The Globe World*, which comes out three to four times per year. The home pages and the journal can be found on the Internet at http://koti.kolumbus.fi/~enonvene.
3. Cultural and international education is one of the school's areas of emphasis. An effort is made to accomplish this by participating in the GLOBE program and by using information networks. The school won the third prize in a competition put together by Microsoft and the National Board of Education called the "Road

Ahead Prize," whose aim was to advance creative ways to benefit from the Internet in learning and to unite students in various communities. The jury appreciated the fact that the school had started as a scientific program and had gone on to cultural and international training, and it also appreciated the success of the activities to make Finland better known.

4. During the academic year 1997-1998 the school launched a project called "The Winter Research Project," the goal of which was to do research on winter, both locally and globally. The participating schools are close to the 62° North latitude. The Alaska Meteorological Institute, the Finnish Meteorological Institute, the University of Joensuu, and the European Forest Institute provide support to the project. In addition to surveying physical conditions, the project also studies how people experience winter in different parts of the world north of 60° latitude. ICT is being utilized in the project to create WWW-based questionnaires to access knowledge from, among other sources, the GLOBE database, to communicate with other parties involved in the project, and to report results.
5. A continuation project is being planned called "In One Network," whose goal is to develop models for collaborative learning and the use of networks. Learning entities and teaching methods have been planned with people from the Finnish Meteorological Institute and the Universities of Joensuu and Jyväskylä, among others. The equipment of the Eno primary school includes 10 PC's for use in the network. Most of the computers have been placed in a space that is used for teaching when necessary and that otherwise is to be used freely by the students. The technology can be regarded as good. So far, enough computers, additional equipment and videoconferencing equipment are available for use. The funding comes mainly from the municipal budget, but there is also some outside support. The fact that the school actively uses GLOBE and has a clear role in it has made it easier to get funding.

The involvement of the school and the whole municipality in the application of ICT seems to be both positive and challenging. The Eno schools have a common communication strategy to which the municipality is committed. The schools have continuously obtained more computers and a local network, and some have installed a fixed

Internet connection. The cooperation between the Eno schools at different levels is further strengthened by the planning of a teaching module based on the shared GLOBE program and then the actual implementation of the module.

Eno's strength is its open communication culture and communication between the municipal schools. The school is especially active in initiating cooperation and communication. The school's internal activities are characterized by strong cooperation and communication. There are already so many participants involved in the cooperation between the schools that opposition to change has also been observed. To counteract this opposition an effort has been made to encourage teachers to use IT through in-service training. The most active teachers have been training people in charge, who have then been training the teachers in their own schools. In the beginning, the GLOBE project was not taken into account in the general planning but was implemented during geography and biology lessons. In the general plan for the academic year 1996-1997, two hours were reserved for GLOBE instruction in the sixth grade, and last year one weekly lesson was allocated to the fifth and sixth grades. In addition, the most enthusiastic participants have formed a GLOBE club. Now one hour per week has been reserved for ICT from the first grade on. In addition to using computers during the lessons reserved for IT and GLOBE, they will be used in various other subjects and projects.

The schools' activities have received both national and international attention. In recognition of its activity, the school was the very first Finnish school to be placed on the international pages of *GLOBE Stars*.

It is quite obvious in the school that the new learning culture that has developed from working on the project has stabilized to become the dominant culture. The students find it natural to work in research projects that use interdisciplinary technology. Several of the schools' learning projects involve active work, discussions and interaction. Participation in the GLOBE program has brought appropriate contents into their activities. In this way contacts have also been created with various expert cultures.

The implementation of learning projects is not without its problems, even though working on a project in an elementary school is

often easier than in upper grades. In the learning and working culture of the primary school in Eno one can clearly notice positive activity changes. It is, however, difficult to measure the depth of the changes that have been made on the level of learning processes. The goal has been to work in projects and to understand learning. So far, however, no long-term inquiry learning projects have been carried out—projects that would have advanced from making observations, through information construction and interpretation, all the way to reporting findings. In the international communications of the schools, keeping in touch has received more emphasis in both cultural and international training than the conscious support of learning processes. The GLOBE activities, good attitudes, and a culture of cooperation are conducive to the support of projects that develop the use of ICT.

*The second example concerns the experiments that have been conducted with the use of laptop computers in the lower secondary schools of Vantaa, Länsimäki and Helsinki-Vesala.**

The Länsimäki lower secondary school in Vantaa was chosen to experiment with laptop computers for three years between 1994-1997, and the Alppila and Vesala lower secondary schools in Helsinki for the academic years 1995-1998. In the Länsimäki and Vesala schools, one starting seventh-grade learner group was chosen to receive laptops for their personal use all through lower secondary school. Although the municipalities had a central role as funders of the experiment, the role of the Helsinki Education Department was somewhat more extensive. The IT Centre for Schools was responsible for training the teachers, for providing consultation and for conducting research. The National Board of Education and the Ministry of Education also participated in funding the experiment in the beginning phases.

A consultant was shared by the schools to coordinate various aspects of the experiment.

The goals were first defined in a relatively general way; however they became more precise during the experiment. At the beginning, the experiment in Länsimäki was more focused on technology: the

*The evaluation report for this research was prepared by Liisa Ilomäki, who directed and followed the experiments through the four years of their duration.

school got laptops in order to discover what kinds of experiences students could have with them in school use and what changes would take place through their use in instruction as well as in learning. The goal of the Helsinki Education Department was to develop an environment for learning with the help of new technology and to find out how the learning process, the curriculum and the teachers' work would change. The setting of concrete goals was the responsibility of the schools.

The instruction was to be developed so as to emphasize the students' activity in the learning tasks. The tasks would be extensive and would relate to real situations and they would be done using problem-solving and inquiry. In addition, the collaborative knowledge construction of the students and the development of their metacognitive skills would be supported. The consultant's job was to help the teachers to develop their skills in IT. The goal was to train teachers who would evaluate and develop their own activities and who, in collaboration with others, would be able to sensibly reform their own instruction and mutual collaboration.

In addition to the basic equipment for the experiments purchased by the municipalities, some additional computers and other equipment and programs were bought by the schools themselves. Some computers were reserved for teachers and for temporary use by other groups. The basic software was Microsoft Works, but during the experiment the users moved on to Office. In Länsimäki the users became enthusiastic and bought additional equipment, CD-ROM materials and other programs. Among others, Toolbook was used to a great extent.

IT support was provided during school hours in Länsimäki. At first, the IT teacher and the homeroom teacher of the class involved in the experiment were responsible for all the technology in the school, but the workload for the IT teachers turned out to be unreasonable. During the first year of the project, a technical support person was responsible for IT in the Vesala school, a person who had been hired with the help of employment subsidies. During the second year, the IT teachers and during the last year the school got help from a person in charge hired by the school office to work one day a week.

The teachers' needs for training were studied first, and training was arranged on that basis.

- The schools themselves were trained to use the programs, for example.
- The schools' IT center received a lot of training, especially at the beginning of the experiment. The goal was to develop pedagogical applications with the use of some IT applications, not the mere learning of technology. Meetings were organized exclusively for the IT teachers.
- Training was provided by the education departments of the cities.
- The teachers also participated in, for example, training organized by their own professional organizations.
- In Helsinki, the teachers received subsidies to hire substitutes, in Vantaa they did not.

In the beginning, small-scale individual experiments were started. Typical first-year experiments included tasks in process writing (both in the mother tongue and in foreign languages), the use of teaching programs to train skills, and the completion of small spreadsheet tasks. Numerous process-writing tasks got the teachers and the students acquainted with receiving feedback and with publicizing and evaluating work portfolios. Some joint projects were also organized. In art the students got acquainted with a painting they had chosen in a certain art museum, and then wrote about it based both on their information and their experiences. Then they practiced scanning and layout, and turned their work into a joint publication. The first multimedia tasks were done in the teaching of religion.

During the second year more extensive projects were developed—projects that were interdisciplinary and in which the goal was to develop investigative process-oriented teamwork. In the more extensive projects the students worked with their laptops outside of school and were independently responsible for their own investigations. In Länsimäki the project lasted several weeks. This was the so-called virtual period, during which the students spent one day a week away from school working on their project. In pairs the students produced research material on the basis of the problems they had identified, and they edited a publication based on their research.

Other more extensive projects were the history of the school, various multimedia projects in several subjects, and other tasks involv-

ing finding and producing information. Other sources used were CD-ROM materials and the Internet.

The third school year can be described as the phase during which the experiment was institutionalized. The consultant became less important, the teachers themselves came up with ideas for various experiments. In addition, they started to use new forms of work in the instruction of other classes. Teachers outside of the actual experiment participated in some projects as well. On the other hand, people started to show signs that they were tired of the experiment. One of the innovative projects was in mathematics, involving a process to solve problems posed by the students; another concerned distance learning of religion based on WWW materials.

One clear improvement in the instruction was the fact that phenomena outside the school became the subject of learning to a greater extent. The portable computers made this possible and, indeed, almost necessary. As the character of the tasks set by the teachers changed, the students became better equipped to work independently, to set their own goals and to evaluate their own work. The tasks of a process nature supported the development of metacognitive skills by themselves, and the teachers also acted consciously toward the development of these skills. The teachers concluded that the students' ability to develop their own independent information processing and production developed better than that of the students in the other classes.

Because cooperation was necessary for many tasks, the students got used to working with others. The students knew how to work efficiently in groups, and responsible attitudes toward the work were developed. The cooperation changed in such a way that the special skills of the students started to be emphasized (for example in multimedia tasks), and a sensible division of labor came about based on the different expertises.

Because the students were able to use computers both at home and at school, everybody's knowledge of IT grew considerably. Several students developed a special expertise in some area. In addition, a small group of boys emerged in both of the classes whose skills in IT were already expert at the student level. They are headed toward becoming professionals in IT, and they devote large blocks of time to tasks to develop IT. They followed the literature, entered networks with other enthusiasts and carried out IT projects for others as well.

It seems that a community of teachers has developed in the schools whose goal is pedagogical reflection and development. Even those who had felt somewhat estranged at the beginning of the experiment participated in the discussions, gave projects to be evaluated, and improved their cooperation with those in the experiment. They were joined by other teachers who did not have more than a couple of eighth or ninth graders who had a laptop. The discussion environment was open, enthusiastic and full of ideas for improvement. However, some teachers who were instructing classes that were involved in the experiment did not participate in this activity.

New practices cannot be established if teachers cannot adapt them to their own thinking and activities. The actively participating teachers developed practices that involved the sensible use of IT. However, some solutions were made difficult because of administrative factors in the school, for example the divisions into subjects, scheduling and the teachers' working hours.

Because the tasks given to the students changed, the teachers' duties also changed. The majority of the teachers reported on the changes they had observed: the students and the teachers work as equals. The students may know more about certain things than the teacher. The teachers were aiming at creating authentic teaching situations, and they felt that exactly this kind of working should get more training.

As a result of this experiment, the teachers improved their IT skills to a great extent. After the experiment, the teachers said that IT was a natural tool, that difficulties could be overcome flexibly and that IT was being used in sensible ways. Teachers no longer needed help in their everyday tasks, and they also knew how to help other teachers.

The creation of an official experiment group, which is responsible for the project throughout the entire period, is a means to help other teachers to join in. This kind of a group could also supervise activities after the experiment and aid in extending the influence of the experiment to affect the activities of the whole school. Such a group is not so vulnerable, for example, when there are changes in personnel or when members get tired out. These kinds of clearly defined working groups were not part of the above-mentioned experiments. In this respect, the experiments were not fully successful.

Some of the experiences gained in the experiment may remain inside the schools only. Their effects on the schools are most likely

relatively good, and the teaching solutions developed in the experiments have now also been used by other teachers. The image of the schools as innovative users of information technology has strengthened. So far, it is difficult to estimate what the influence of the experiences is within a school. Those teachers who started to reform their ways of teaching during the experiment are going to transfer what they learned to other areas of instruction.

The teachers in these schools have acted as trainers, and the schools are active in developing instruction in their own municipalities. Therefore the schools' experiences with the use of laptops will most likely spread to other schools, and the experiences will be consciously exploited.

The technical problems were substantial because networking the schools did not go at all as planned. In addition, there were many user problems with the laptops which the maintenance personnel could not flexibly solve. At worst, only every third computer was in use, and students had to wait for weeks to get their computers serviced. The Internet links did not work during any of that time, and because of the missing links the experimentation with ICL's "Teamware" software, which was one of the goals, was done only partially. On the other hand, the schools supplemented their equipment and programs so that they were very good compared to what is available in an average Finnish school. Even though there were also technical problems in Länsimäki, the maintenance was organized more easily because the IT teacher became accustomed to dealing with the hardware providers directly. In addition, the laptop Internet connections were taken care of with modems so that there were no larger problems. Some of the maintenance problems were, of course, due to the heavy use of the hardware; however, fine-tuning done by the students, software they had got from elsewhere and settings that they had changed sometimes made it difficult to use the computers in instruction.

One of the technical problems is also how to organize technical support. Stable Internet connections, local networks, many additional devices and an abundant number of computers cause more work than one IT teacher can handle in addition to his or her own teaching. Furthermore, many tasks require special skills which the IT teacher does not have. The support can be divided into two types of activity.

On one hand, a teacher must receive guidance and assistance in the use of IT. On the other hand, a way has to be found to take care of the ever more complex technical environment. In general, the skills of an IT teacher are enough for the first task, but outside help is needed for the second.

The schools need a lot of other kinds of outside support, too. Fortunately, it was also available. Continuing training was organized pretty well in the form of cooperation between the people responsible for ICT in the schools and the IT Centre for Schools. Especially in the beginning, the group made plans for training relatively regularly. At the same time, the teachers organizing the experiment networked effectively and got used to continuous cooperation.

It proved extremely important to bring in an outside consultant to the schools: this person brought another point of view to the project and helped the staff and teachers organize their thoughts, expectations and activities.

The use of laptops in schools seems to liberate the learning process and provide opportunities to develop learning that is based more on authentic problems and phenomena. The work of the teachers changes, and most teachers find the pedagogical and information technological change inspiring. Through its participation in these projects the teacher community has developed into a pedagogical and learning organization. On the other hand, the teachers' further training and other forms of support were quite extensive and were based on cooperation with the university. Getting the equipment alone would not have changed the pedagogical learning environment, however; support was necessary to bring about this kind of change. The challenge in schools is how this trend will continue and be extended to include all of the teachers.

*The distance-learning project in upper secondary schools in the Oulu area, which is based on multimedia instruction, is posing several structural and pedagogical challenges**.

In this project, an opportunity is being created to receive upper secondary school instruction in two municipalities next to Oulu, a provincial capital. Project learning centers were built in the neighboring communities with teaching spaces equipped with ICT equip-

*The project was evaluated by Sanna Järvela and Hanna Salovaara (Sitra No. 191, 1998).

ment. They make it possible to provide distance learning with the help of videoconferencing and WWW learning environments. These learning centers are also used for training people who work in agriculture or small-scale enterprises.

The goal was to develop a training systems model for multimedia instruction, a model that suits upper secondary instruction, especially in remote communities. The intention was that the small schools will network, both with each other and with schools in bigger centers, in order to use the facilities in the bigger schools. Another central goal is to support the students' independent and individual learning.

The cooperation takes place mainly between learning centers in the remote communities and in the upper secondary school in Oulu. This upper secondary school acts as the main school for distance learning centers, and *it* is the school which the students belong to administratively. The instruction is transmitted from Oulu and also from some other cooperating schools. The teachers have contact teaching periods in both Oulu and in the distance learning centers. There are 35 teachers participating in this project, and all the upper secondary school subjects are represented. The distance upper secondary school is being funded by the remote municipalities, and the instruction is being purchased from the town of Oulu. The municipalities use their regular state subsidies for education to purchase this instruction, but these subsidies do not cover all of the expenses.

A project planning officer has been hired to carry out the project, especially its administration, and another person has been hired to tutor the students.

The planning began in the Fall of 1995, and the first students were registered in the Fall of 1997. The project will come to an end in the Spring of 2000, when the first students will take their matriculation examinations. By then, the distance upper secondary school of the Oulu area is supposed to be firmly established as part of the area's municipal school systems. The equipment was purchased with EU funding, and EU funding is also being used to develop an entrepreneurship module. At the moment, the distance upper secondary school has no additional funding.

In practice, the students proceed according to a modular upper secondary school, in which instruction is divided into courses rather than grades. Most courses are taught by the teachers in Oulu, and

some are purchased from other nearby schools. The teachers train themselves how to design and teach their courses effectively and how to use ICT as a tool in distance learning.

The students have substantial responsibility for their own advancement in this open and distance learning environment. Indeed, one of the project's goals has been to develop the students' ability to learn independently; this ability has not been seen as a prerequisite for participation. The tutoring system has been designed so that students can acquire the study skills required by open and distance education, and consists of the support of the tutor, the teacher and peers. The teachers are responsible for the tutoring needed for their own courses, whereas a tutor helps students with issues that have to do with studying in general. Because the students study more often without a teacher present, peer tutoring is also very significant. Several courses have been reserved for tutoring. Experience has shown that students need a lot of tutoring in the early stages of upper secondary school.

During their own training the teachers have been made familiar with a new concept of learning and a new teaching culture that suit open and distance learning. But, on the other hand, they have also been familiarized with how to conduct traditional courses with the help of applications that are based on ICT. More and more responsibility for tutoring is being shifted over to the subject teachers. One of the goals in the teacher training has also been to give teachers the skills to support the independent study activities of the students and their acquiring of learning skills.

The planning of the instruction started with a model in which the contents of each course were divided into three parts: the materials that are needed for contact instruction, for distance instruction, and for independent study. In the beginning, the planning for tutoring remained minimal because planning how to use the technical equipment had a higher priority. Based on these experiences, this training has been developed further, and course planning has become the central theme. The teachers' activities are additionally supported by evaluations that take place at the beginning of the course periods. At first, the evaluation was focused on the activities of the students, but now the focus has shifted more and more to the self-evaluation of the teachers' own activities. The contact lessons are delivered in the learning centers. The tests and other tasks that require the presence of the teach-

er are taken care of during the contact instruction period. Some of the contact teaching is given on Thursdays, when the students are in Oulu. Most of the contact instruction takes place at the beginning of the courses when the procedures and goals are being agreed upon and when the contact between the teacher and the students is being created.

Some of the lessons of the distance upper secondary school involve independent work, which takes place during the hours marked down in the timetable. The tasks are relayed to the students in videoconferences, through e-mail or in a WWW environment. Independent work can be writing essays; answering questions based on given materials; or, for example in some scientific or mathematical subjects, it can be problem-solving in groups. The results of the independent tasks are sent to the teacher by e-mail or by fax, or they are produced on WWW pages. Tasks can also be dealt with during the contact instruction or the videoconferences.

Videoconferencing is the form used most frequently in the instruction of the distance upper secondary school. The instruction is sent to the rural sites from the schools responsible for various courses in Oulu. The students take turns being responsible for using the equipment during lessons. The videoconferencing instruction consists of lecturing by the teacher and tasks given by the teacher. The tasks are designed to activate students, to make the learning more varied and to divide it into periods. With the help of videoconferencing an effort is also being made to create social situations that are similar to those in contact instruction and in which the teachers' tutoring can, at best, be supportive of individual students and similar to contact teaching. The systematic use of the WWW environment began in the spring of 1998. The system chosen for use was TELSI (Telematic Environment for Language Simulations), which was developed in the Further Training Center at the University of Oulu. A course on how to use TELSI was arranged for teachers and students. The WWW environment is being used for the students' independent work. TELSI is mostly being used for course material distribution, giving independent tasks that have to do with the courses, and for conveying individual feedback to the students.

The participating municipalities have to be committed not only economically but also attitudinally to the distance upper secondary

school project. The distance upper secondary school supplements the basic services and the school systems in both of the municipalities. However, the attitudes toward the distance upper secondary school vary according to the municipality. The funding municipalities feel the distance upper secondary school to be both a burden and an opportunity. The commitment of the local people to the distance upper secondary school has also varied between municipalities. For example, students at one of the schools felt the interest of people from one of the local communities to be inspiring. In the other municipality, even negative attitudes toward the distance upper secondary school have had a deleterious affect on the students' motivation and commitment. The difference between the municipalities can also be seen in the willingness of small entrepreneurs to participate in the entrepreneurship training that is part of the project.

One challenge to the municipalities is how to integrate this form of instruction into the rest of the municipal school system. It is easy to regard the upper secondary school based on distance learning as a separate unit from the municipality's own school system. It would have been important, however, to be able to take the demands made on studying in a distance upper secondary school into account in advance. Attention could have been paid already in the lower secondary school to the development of study skills, among other things. Cooperation between the lower secondary schools is being developed. One goal is that preparations for implementing the working procedures in the distance upper secondary school would start in connection with various subjects in the lower secondary schools as soon as possible. So far, there is no contact between the distance upper secondary schools and the other schools in the municipalities.

The students of the distance upper secondary school are still trying to find their place in the school community, as are the teachers who work there. The students in Oulu have not accepted distance upper secondary students as part of their school without reservations, and even though the students visit the school once a week they still feel somewhat alienated. Instead, the distance students feel that they belong to the same group. It is also difficult for the students in the distance upper secondary school to create their own identity because of the lack of a peer group. An effort has been made to support integration into the social community of the upper secondary school

by organizing parties and participating in the traditional upper secondary school celebrations. In the future, attention must be paid to helping the students perceive themselves as upper secondary school students, not only as distance students.

Some courses in the distance upper secondary school are purchased as services from several other upper secondary schools, and the teachers of these courses vary in their commitment to the task. This has not supported the long-term comprehensive planning of instruction.

The studying environment is planned according to the course, and efforts are being made to find effective ways to use technical equipment in the upper secondary school. The fact that various tools are being used side by side makes the instruction more versatile, but, on the other hand, the establishment of shared practices would lend clarity to the activities. Changing the forms of study, getting acquainted with technical environments and learning new ways to work require a lot of time of the students and teachers.

Studying in a distance upper secondary school seems flexible and free when looked at from the outside. However, the students have to be strongly committed to working, and therefore it is not easy for some students to study at a distance upper secondary school. The beginning phase of the studies is especially critical. It involves learning new ways to work and learning how to work independently, planning the use of time and facing new situations without continuous checking to see if the students are actually learning. That is why some students have stopped their studies at the very beginning. However, self-directedness and the mutual involvement of the group in the success of its studying develop with the advancement of the upper secondary school. Because of this learning environment, the students who graduate from the distance upper secondary school will have in their possession skills that are necessary for success in the information society. Among them are, for example, versatile skills in searching for information, the ability to cooperate, responsibility, spontaneity, and skills that have to do with planning one's own learning.

The distance upper secondary school has been seen to offer more challenges to boys than to girls as a form of schooling. The boys' commitment to working has been weaker and the students who have dropped out have mainly been boys. In everyday work the problems

come out, for example, when computers and network links are used for purposes that have nothing to do with learning, such as playing games. The model of traditional instruction should not simply be transferred to open and distance education. In some areas the development of practices in the Oulu project has been successful, but these new methods are still problematic to some extent. For example, in videoconferences the students have felt that the instruction proceeds according to such a rigid plan that it does not allow them time to think about the contents, to make their ideas more focused or to ask questions.

One should dispense with the model of "the talking head" and practice more interaction.

In the project a new kind of tutoring culture is being developed between the teachers and the students. The students send those tasks that are part of independent study to the teacher to be checked, and most of the time they get personal feedback via e-mail. Both the students and the teachers find continuous personal feedback good. However, one cannot yet say that an actual interaction culture has been established because the interaction to a great extent is still one-way, from a teacher to a student. For example, in the videoconferences some students find the participation threshold very high. Instead, e-mail has been found to be a good tool for interaction.

Distance upper secondary school students work mostly among themselves. The social community that has been created there is very significant as far as learning is concerned. However, a community that supports learning has not evolved by itself: a conscious effort has been made to create collaborative learning. The students' cooperation in the project can be seen in their schoolwork. For example, the students create tasks for one another, they analyze problems together, and they try to share their knowledge.

The model for a distance upper secondary school that was developed creates opportunities to improve regional equality in Finnish educational services. Studying at a distance upper secondary school gives students skills to guide their own activities, to study and to cooperate—skills that are necessary in studies after the completion of school and in working life. The model does not suit everybody. The active students capable of directing their own activities can benefit from the opportunities offered by a distance upper secondary school; however, those students who need a lot of guidance and are not well

oriented towards studying are less suited to learning at a distance school. The teaching methods and the pedagogical solutions in the distance upper secondary school still need further development. Because the project is going to continue for some years, evaluation and development procedures are a fixed part of the project.

*The development work in schools needs outside support. A good example of this kind of network support is a Pedanet project in central Finland *.* The Pedanet project was started by the Regional Council of Central Finland, the municipalities in central Finland, the University of Jyväskylä, the Jyväskylä Polytechnic, and Sonera Inc., all working in cooperation, and it is being funded by the EU Social Fund. Pedanet aims at efficiently using the pedagogical opportunities in the schools in central Finland.

The goal of the project is to promote the comprehensive preparedness of the schools in central Finland to benefit from ICT in developing instruction and in cooperation between schools. The goal is that all schools and other institutions of education in central Finland, involving nearly 60,000 students, will have an easy-to-use and pedagogically rich school information network in operation by the end of 2000. In the project an effort is being made to use pilot projects to disseminate promising ideas for the instructional use of ICT. In different areas of central Finland there are many ICT projects for school use. With the help of the Pedanet project an effort is being made to prevent uneconomical investments and communication problems by increasing coordination between the projects. The central goals in the Pedanet project are:

- to activate and support schools when they plan, implement and evaluate pedagogically functional and profitable development projects,
- to further the conditions in small schools so they can benefit from ICT when they develop their instruction and make the cooperation more effective as part of the village community and
- to find out the possibilities and conditions of use of a unified information network as a tool of cooperation between schools as they develop their instruction.

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*The project is being analyzed for the purposes of the Sitra evaluation by Päivi Häkkinen and Jouni Välijärvi (Sitra No. 191, 1998).

School projects in different regions have been put together to construct a development network in which the key person in each project participates. Some projects aim at reforming teaching methods, contents, materials or other pedagogical usages in schools. In addition, other projects involving cooperation between several schools are being carried out for practical purposes, such as, for example, to increase the number of optional subjects or courses by developing network upper secondary schools. In some projects attention is being focused on increasing the interaction between the school and the surrounding community. Another goal is to activate new projects. The projects are being organized to be independent to such a degree that the schools can plan and implement them for the most part unaided. The aim is, however, to offer projects the necessary additional resources. Every project has its own support group and a person in charge who, among other things, reports on how the project is progressing, transfers results to the information network and is responsible for the use of resources according to the agreement.

An effort is being made to spread the know-how and innovations that spring up in the schools' development projects to other schools as well. As soon as the physical network is completed, the focus will shift to the support of interaction between schools. The functional principles in the pedagogical development work in Pedanet are openness, publicity and interactivity, which means that the experiences of the project schools are brought into use by other schools while they are still fresh.

One of the central starting points in the Pedanet project is to link research with planning and implementing the pilot projects and with evaluating and disseminating the results. Producing new research data and conveying them to schools and research communities are essential to carrying out the project. For the most part, researchers from the Institute for Educational Research, the Further Education Center and the Research Institute of IT of the University of Jyväskylä are participating in the Pedanet project. An effort is being made to link research to all projects so as to place them in the context of the international discussion of how to benefit pedagogically from information networks. The support for the schools' projects takes the form of training teachers and students, expert services and improving the teachers' working conditions. The teachers can, for example, be

offered the opportunity to leave their schoolwork for a certain period in order to work on their own projects that are part of Pedanet.

Pedanet progresses through pilot projects. The pilot projects have been chosen in such a way that they cover all study areas and all school levels as well as possible. Pedanet is, however, open to fresh ideas and to the schools' suggestions for new development projects. It is essential that in the projects there is both an idea that clearly promotes learning and teaching and a vision of where the use of ICT is supposed to lead. The pilot projects focus on

- studying natural sciences in project form
- information networks as learning support for history
- physics as network studies in the upper secondary school
- the networking of village schools and making the instruction more versatile
- creation of a school online environment
- increasing the number of optional subjects and courses in a network school
- the development of foreign language instruction in elementary school
- cooperation between school levels—from the daycare center to school
- teacher-training in field schools.

In the network projects even very different organizations are required to have the ability to work together. The strength of the Pedanet project is the effort to combine culturally, scientifically and functionally different interest groups. The strong regional emphasis is on central Finland, and the prospect of developing their own area motivates many cooperative sectors. In addition, especially the commitment of the University of Jyväskylä to the project, the development funding from the Province of Central Finland and the support of the European Social Fund (ESF) have made it possible to start the project quickly. However, the joining of public and private, scientific and commercial as well as humanistic and technical interests also has its problems and competitive settings as well.

One of the starting points in the Pedanet project is also the commitment to maintain long-term developmental work. In the project it has been understood that the creation of lasting changes and the

establishment of teaching practices in schools is a lengthy process in which it is also important to commit oneself to research development in order to get ahead.

There is no actual support for school equipment purchases or other information technological resources coming through the Pedanet project. By offering special support, for example expert and training services, schools and municipalities are being encouraged to actively engage in securing their own funding.

While the services are being developed, one cannot but take a stand regarding the physical solutions of the network as well. The planning of a functional physical network requires the economic and practical cooperation of several different sectors. As far as the regional information network linking various regions is concerned, there have been problems, for example in the competition between different actors. An absolute prerequisite for long-term developmental activities is a school practice-based approach. As has been emphasized in the project, even this has its problems if taken too far. The ability in some schools to handle IT and to develop constructive attitudes is still so small that on that basis it may be impossible to come up with ideas for innovative and pedagogical solutions that use ICT. Thus, teachers need to interact with researchers and developers. In order to produce and establish lasting changes in learning processes, the schools must be self-directed from the very beginning.

One goal in the Pedanet project is to create an open interaction culture in the area of central Finland which enhances the spreading of ideas within schools and between them. However, these ideas must not be solutions that are too complete. It would be most important to create the kind of interaction through which the transfer of tools for thinking and also for the reporting of problems would become a natural part of the schools' everyday routine.

Many pilot projects in Pedanet focus on furthering cooperation and interaction between teachers or schools using ICT. These are often very important from the practical point of view; for educational equality it is important, for example, to be able to offer instruction in less commonly taught foreign languages also in the sparsely populated areas.

In Pedanet and in other school network projects it would, however, also be important to pay more attention than previously to the

use of ICT in the light of the learning theoretical starting points: how can learning environments and teaching practices be constructed — learning environments that are based on networks and that support reflective activity and understanding learning. In order to bring about lasting changes in this respect, active interaction is, however, needed between teachers, students studying to be teachers, teacher trainers, researchers and those working on developing ICT, such as support persons, consultants, advisors, designers, producers of material, etc.

The case-study evaluations show that the goals in the development projects are often set so high that they cannot be reached without outside support and guidance in organizing the means to achieve them. Technical support is easier to arrange than pedagogical or research support.

The support of outside consultants seems to have a clearly positive influence on the planning, implementation, results and the dissemination of the results. The more systematically the questions of the development work can be formed and the results recorded, and the more conscientiously informed attention has been paid to evaluation and reporting, the more successfully these results can be exploited. On the other hand, research and outside evaluation may discover that the achieved results are often more superficial and of shorter duration than was believed in the initial enthusiasm.

The experiments show that it is possible to learn how to use ICT fluently and in many ways to support normal schoolwork. In addition, the students' motivation has clearly improved in work based on IT. However, the experiments have not succeeded very well in establishing, let alone disseminating, new practices adhering to the new learning concepts widely accepted by teachers and which are in accordance with methods aimed at improving comprehension and the construction of shared information.

Therefore, in order to achieve lasting results, both the owner of the school as well as all parties involved in the project must commit themselves to it. Sufficient outside expert support must be secured as well. Even though IT cannot yet be used naturally and extensively in order to gather information, introducing ICT in schools has improved cooperation enormously within schools, between schools and between the schools and society in general. It is a sign of progress that with the growth of information networks, studying is not based

on ready-made learning materials as much as it was previously. Instead, more than ever, many kinds and many levels of information are being sought in real life outside the school. In addition, the results of one's own work are being publicized more often than before and are being evaluated together with that of others. The schools are becoming part of networks and a more extensive expert culture that is being built to improve schools and instruction.

5 TERTIARY EDUCATION*

MINISTRY OF EDUCATION SUPPORT FOR ICT IN HIGHER EDUCATION

In addition to the normal budget funding of institutes of higher education, the Information Strategy was used in the following ways for developing information technology in the service of education and research in 1996-1998 (Armi Mikkola, Sitra 189, 1998):

In each of these years, a sum corresponding to over 3 million Ecus has been granted for the purpose of updating and increasing the IT hardware at the disposal of university researchers and students and for developing information networks. The appropriation has been divided between the universities as part of their performance agreements and is to be used for various acquisitions. The use of this appropriation has varied, and it has partly been used to make up for gaps caused by overall budget cuts. It also seems that the appropriation has not been systematically used to equalize student access to IT in areas where IT resources have been weakest.

University operations budgets included about 8.5 million Ecus in 1996 and over 14 million Ecus in 1997-1998 for increasing education and research in information and communication technology as well as in electrical and electronic engineering. The universities have increased their educational provision by increasing their student intake in these fields. Research has been supported by acquiring new hardware, for example.

In 1998, the university sector directed 0.6 million Ecus towards the virtualization of open university services and the development of network-based career planning and work placement services. The universities have also been given an annual appropriation correspond-

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**This section is based mainly on the 1st and 2nd sub-reports of the project, which have been edited by Jarmo Viteli (Sitra No. 189 and No. 190, 1998)*

ing to 0.4 million Ecus for developing learning material and teaching methods in certain prioritized areas. For the purpose of advancing the Information Strategy Program in teacher education, 0.1 million Ecus was granted to the universities in 1996, and this money was predominantly directed towards developing the role of distance teaching in practice teaching. This appropriation was increased to 0.2 million Ecus in 1997 and 0.3 million Ecus in 1998. In the performance agreements, about 0.3 million Ecus annually have been allocated to the teacher training schools for implementing the Information Strategy Program. In addition, continuing education in information technology for teachers has annually received about 1.5 million Ecus of state support.

Implementing the Information Strategy Program in teacher education has been hampered by problems in purchasing hardware and software. The universities have directed a relatively small proportion of their equipment purchase appropriations towards teacher education with the result that the departments providing teacher education cannot provide their teachers and students with sufficient access to hardware.

Research libraries have utilized the opportunities provided by information technology in a many-sided way. University libraries form a central part of Finland's system of research libraries, and their joint information network provides the core of the computer systems of research libraries as a whole. An annual appropriation of 0.5 million Ecus has been granted for the development of network-based communications. Among the important projects being funded in this area have been the virtual library project and a project for creating electronic publications and distributing them through information networks.

The Academy of Finland has launched an information research program for 1996-2001, which includes 24 interdisciplinary cooperation projects with a total of over 50 research groups participating in them (with a total budget of about 8.4 million Ecus).

In 1996, nearly 5 million Ecus from the Ministry of Education and in 1997 slightly more were earmarked for improving and developing scientific computing and for operating the Finnish University Network (FUNET). In 1998, the funding for the universities' joint computer services amounted to over 6 million Ecus.

This money was used to provide scientific computing services for university researchers and communications services for the universities. In addition, the Ministry of Education spent a total of nearly 3 million Ecus for acquisitions in 1996 (for instance for the purchase of a new supercomputer) and in 1997 a total of a little over 1.3 million Ecus.

According to Markus Sadeniemi (Sitra 189, 1998), the Finnish University Network (FUNET) has worked in close cooperation with universities, telecommunications companies and the ICT industry. Not just computer and telecommunications professionals but all university students can use the services provided by the network. This fact has probably had a significant bearing on Finland's presently being the country with the highest level of networking when measured by the per capita number of computers linked to the Internet.

At present, all of Finland's research and arts universities, most of the polytechnics and the most important research institutes—a total of about 90 organizations—have joined FUNET. FUNET services are provided by the Centre for Scientific Computing Ltd., a company owned by the Finnish Ministry of Education. The primary starting point for the development of information network services has been, and will continue to be, the needs of research and teaching.

The needs of teaching are largely the same as those of research. In their assignments, students largely do work similar to that of researchers, although the scope of their work is more limited. Specific requirements placed by studying are largely related to distance learning, which is becoming a viable alternative both as a supplement to traditional teaching and as a primary teaching method in continuing education for those who are already in working life.

The working environment of researchers has been fundamentally changed as more and more information becomes digital. Information services are perhaps the most important and most rapidly developing area of network services from the perspective of the university and research communities.

Essential areas of service provided by networks are factors related to the organization and cataloging of knowledge. Through the "National Electronic Library" project launched by the Ministry of Education, relevant and well-organized material will be made available. This includes science library catalogs, compilations of

articles from scientific journals, and reference and databases from various fields.

Another area which needs development, though, is automatic search methods for dealing with the vast and poorly organized information content in the networks. From the Finnish point of view, it is essential that a search robot would "understand" at least Finnish and Swedish in addition to English.

We should also promote scientific publications utilizing the network and make information sources belonging to the public administration more open to the public and available for the needs of education and research.

In distance learning we need an easy way to construct interactive distance teaching, we need the possibility to produce teaching material which is made available in the network, and we must provide the possibility of studying from one's own home. From the point of view of technology, this requires the possibility of transmitting video and sound through the network. With present network speeds this is possible to a limited extent, but if a couple of hundred students would simultaneously try to use this technology it would be stretched to the limit.

During the past decade, traffic in FUNET has grown at an annual rate of 150%, or, in other words, it has doubled every nine months. This growth has been made possible by the unbelievable rate of development in the information transfer technology of telecommunications networks. FUNET has always utilized the latest available technology, as the fastest equipment available today will not be able to handle the information trafic volumes which will need to be transferred in a year or two.

In the beginning of 1998, the backbone of FUNET network was sped up to 155 Mbit/s. By the end of 1999, it is estimated that the speed will need to be 622 Mbit/s and in 2001 already 2.4 Gbit/s.

Speed requirements for connections abroad are of about the same order of magnitude as those for domestic connections. Nordunet, a cooperation body jointly administered by Nordic research network organizations, has been taking care of Finland's connections with international research networks. Although cooperation has made it possible to obtain significant savings in the costs of international telecommunications, their growth will present a significant problem in the coming years.

Open competition in the telecommunications field has lowered line capacity costs significantly. However, as the next few years will bring a temporary shortage of transatlantic line capacity and efforts to disband European telephone monopolies have only just begun, the prices of international connections will not come down nearly at the same rate as traffic volumes are increasing. It is expected that the situation will improve only after some three to four years.

The speeding up of networks and the emergence of new network services are also placing other kinds of new demands on the technological services provided by the networks. For example, the transfer of high-quality video demands a whole other magnitude of network capacity compared with traditional e-mail transfer or the transfer of WWW pages. In the United States, the Internet2 project of leading universities and the federal government's Next Generation Internet (NGI) venture are the most important undertakings in the field. It is essential that the research community in Finland, together with Finnish industry, make a significant contribution to these development projects.

Universities on the road to an information society

Implementation of the university survey

The assessment of tertiary education focused on research and arts universities and polytechnics and was implemented in cooperation with the Finnish Higher Education Evaluation Council (FINHEEC). The goals were to survey and assess:

- the information society strategies of universities, and
- the educational uses of information and communication technologies at universities.

Answers to the following questions were sought from universities, their teachers and students:

– How and to what extent is ICT used in teaching and learning in higher education?

– What added value does ICT bring to teaching and learning?
– What obstacles stand in the way of implementing ICT?
– How do different user groups view the future and the possibilities of developing ICT in teaching and learning?
– How does ICT support contacts between higher education and the business sector?

The university assessment was carried out using questionnaires addressed to university central administrators, teachers and students. In addition, a large number of case studies were collected in order to obtain more detailed information concerning innovative uses and their effects. The questionnaire addressed to central administrators was sent to all research and arts universities, fourteen of which replied.

In the first stage of the survey, a questionnaire on the educational use of ICT was sent to the teachers and students of 16 different study lines, faculties or departments. Among them were teachers at the Faculties of Medicine, Education and Law at the Universities of Helsinki, Turku and Tampere. In addition, representatives were chosen from the Helsinki School of Economics and Business Administration, the University of Arts and Design Helsinki, the Sibelius Academy, the Tampere University of Technology and the Helsinki University of Technology. A total of 326 questionnaires were returned. Of the respondents, 147 (45%) were female and 179 (55%) were male. Twenty-three percent (70) of the respondents were of professorial rank.

The student questionnaires were distributed using discretionary samples with the objective of getting an adequately comprehensive overall picture. The material was collected at lectures, mostly from second- to fourth-year students. The students were drawn from key faculties of 11 different universities or institutes of higher education. The total number of respondents was 1035, of whom 37% were male and 63% female.

Of the 14 universities which answered the survey sent to research and arts institutes of higher education, 10 had devised an ICT strategy, and in 9 of these the strategy also covered the educational use of ICT. The emerging picture clearly showed the extremely high importance of ICT in different university operations. A strong general tendency

was to develop information management, as evidenced, for example, by the increase in the number of information managers in the universities.

Assessing the practical significance of these strategies was beyond the scope of this survey, but supplementary conversations with the respondents revealed that these strategies, along with the measures they suggest and their areas of emphasis, have thus far only partially been realized in university decision making. The rapidly growing need for new ICT resources has been mainly addressed through separate project funding, as in the special funding allocated under the strategy document of the Ministry of Education: "Education, Training and Research in the Information Society: A National Strategy" (1995). According to the respondents, internal resource reallocation and choices of areas of emphasis within the universities have thus far not been realized in practice in the way they were planned in the strategies.

Technological infrastructure

Although the universities have made sizable investments in information technology in recent years, there are still too few computers at the disposal of students. The survey also revealed that the number of computers at the disposal of students varies greatly between universities. At worst, there were 50 students per computer, and at best about 5. The average was a little over 14 students per computer, which is roughly the same figure as in lower and upper secondary schools. In polytechnics, the relative number of computers at the disposal of students was clearly higher, with only a little over 3 students per computer. Their situation was thus about the same as in vocational schools. Understandably, differences between various areas of education were great within vocational education as well. In many areas, technology is a central subject of learning. In these areas, students must have constant access to computers, and the student/computer ratio is already approaching 2. The fact that universities fare less well than institutes of vocational higher education is at least partially explained by the fact that in universities, the highest priority has been to arrange high-quality computers for the entire research and teaching staff.

The situation among teachers is relatively good. At most universities, teachers have their own personal computers. According to the respondents, half of the machines were very up-to-date and the rest were relatively up-to-date. The university networks were seen to function well and to become congested only occasionally. The teachers feared, however, that the situation might rapidly deteriorate unless more comprehensive measures were implemented to develop the networks. The universities also thought that they were able to offer their teachers excellent access to the latest technical accessories, and adequate access to their students. Scanners are available, as are digital cameras, at many universities. Videoconferencing connections are generally available. E-mail and the WWW can be accessed from home, but connecting from home to the local network is only possible at a few universities. The ICT acquisitions of teachers and students are usually supported only by selling old equipment and by offering reasonably-priced software licenses.

In general, universities today have a relatively good and well-functioning ICT infrastructure. Teachers have nearly enough personal computers at their disposal. The greatest needs are in the area of student workstations. Another problem is insufficient technical and pedagogical support services. The rapid growth of operating expenses is seen as a serious threat which has not sufficiently been taken into account in the overall budgeting of the universities. This could bring usage fees or limitations on usage unless other solutions are found to the problems of growing connection costs and other operating expenses.

The development and assessment of teaching in the universities has improved significantly in recent years. It has, however, proven very difficult to include the quality of teaching along with research as criteria for cost-effectiveness. Increasing the use of ICT as an aid to teaching and learning opens up opportunities for modernizing teaching and making it more efficient.

How do teachers and students view their possibilities for using ICT? According to the survey, university teachers have excellent opportunities for using information technologies in their work: 91% percent of the teachers had a computer at their disposal both at home and at work; 48% of the teachers who responded also had a network connection from their home computer. A majority of the students also had the possibility of using a computer in their home (see Table 7). A higher percentage of university students has a computer than is

the average for Finnish households. The prevalence of computers among students is roughly the same as for the highest income class in a survey conducted by Statistics Finland (see Nurmela 1998). It seems that, in general, male students have somewhat better ICT equipment than female students. Gender differences were most notable in network connections, which male students had at their disposal nearly twice as often as female students.

Computer at home	Male		Female	
	Frequency	Percentage	Frequency	Percentage
None	87	23.1	193	29.5
Yes, but no network connection	148	39.4	326	49.8
Yes with network connection	141	37.5	136	20.7
Total	376	100	655	100

Table 7. Home computers of university students

ICT SKILLS OF TEACHERS AND STUDENTS

Twelve of the universities said they organize training in information technology, although it is difficult to estimate the number of teachers who have participated in this kind of training. Training in information technology tends to be so decentralized that it is difficult to obtain accurate information about the numbers of participants. University administrators estimated that 25% of their teachers had participated in training on the basic use of information technology, 19 % in training on network use, and 5.5% in the pedagogical use of information technology.

Both teachers and students have a relatively good mastery of the basic skills of using information technology (see Table 8). We must emphasize, however, that among those who did not respond to the survey there is probably a higher percentage of those who do not know how to use information technologies at all or at least not as well as those who responded.

Type	Teachers		Students	
	Mean	Standard Deviation	Mean	Standard Deviation
Word processing	4.3	.78	4.0	.82
E-mail	4.2	.95	4.0	1.0
Operating systems	4.0	1.0	3.6	1.1
WWW browsing	3.9	1.1	3.8	1.1
CD-ROM material	3.2	1.4	2.8	1.3
WWW as learning material and for finding information	3.0	1.3	3.0	1.3
Drawing/Image prosessing	2.8	1.2	2.8	1.1
Spreadsheets	2.8	1.3	2.8	1.2
Presentation graphics	2.6	1.4	2.2	1.2
CAL programs	2.6	1.3	2.0	1.2
Database programs	2.5	1.2	2.2	1.1
Online help	2.3	1.3	2.4	1.3
Producing WWW material	2.2	1.3	2.0	1.2
Games eg.	1.9	1.2	2.0	1.9
Business applications (bookkeeping)	1.8	1.1	1.8	1.0
Videoconferencing	1.8	1.0	1.4	.79
Simulations	1.7	1.1	1.6	.90
Groupware	1.7	1.0	1.5	.85

Table 8. Basic ICT skills

The averages contained in the table do not reveal the extent to which students possess the kinds of highly-developed expertise in information technology which could be utilized in the development

of new learning environments. Some of the case studies we collected of highly-developed uses (for instance in the field of medicine) show, however, that information technology expertise possessed by individual students can be a significant resource in the development of teaching applications. The problem often lies rather in the attitudes of teachers and even in their fear of losing authority. We can also see a similar gender difference in the self-evaluations of university teachers and students on their own information technology skills as we saw in the figures on the home use of information technology. Both among students and teachers, males say they have better skills in the use of information technology than females.

According to the survey, teachers mainly use information technology to prepare lectures and assignments, maintain contacts with other members of academia, acquire and process new information, and to conduct their research. Students mainly use information technology to complete their individual assignments, communicate with each other and their teachers, and acquire new information.

Obstacles to using ICT

Based on the answers obtained from the administrators in institutes of higher education, we can assume that at present a majority of university teachers use information technology in their own research, in their communication with other teachers or researchers, and in various bureaucratic tasks. Actual use in teaching is still quite limited with the exception of certain subjects where it has been necessary to integrate information technology as an integral part of the teaching (for instance in basic studies in statistics).

What, then, are the reasons behind the limited use of ICT in teaching? The administrators thought that the main obstacles to using ICT in teaching were factors having to do with skills, support, time and attitudes (see Table 9 below).

Insufficient technical resources or limited possibilities for using them are not considered to be an obstacle to ICT use. It is significant that teachers see themselves as generally lacking the required skills. Other research also supports this finding. Support structures presently offered to teachers do not seem to yield the desired results and are clearly insufficient in scale. Providing both pedagogical and in-

formation technology support to teachers is an essential prerequisite for the development of ICT use in teaching.

Reported obstacles to use	Mean	Standard Deviation
Teachers' lack of time	4.1	.98
Taechers' ICT skills	4.1	.66
Lack of pedagogical support	4.0	.78
Lack of technical support	3.9	1.1
Teachers reserved attitudes	3.7	.99
Student workstation	3.4	1.1

Table 9: Obstacles to using ICT according to university administrators

The most important obstacles in the way of using ICT in the view of university teachers and students are presented in Tables 10 and 11.

	Mean	Standard Deviation
Teachers' lack of time	3.7	1.1
Lack of pedagogical supports	3.6	1.1
Teachers' ICT pedagogical skills	3.6	1.1
Teachers' ICT skills	3.6	1.1
Lack of technical support	3.3	1.3

Table 10: Obstacles to the use of information technology according to teachers

Teachers said that a shortage of time was the most important obstacle to using information technology. Other obstacles that emerged were shortcomings in their own skills and insufficient pedagogical and technical support. Shortage of time, which was considered to be the most important obstacle, is generally related to the ambivalent situation university teachers find themselves in. In evaluating the performance of the academic community at large and in shaping the

career development of an individual academic, the university establishment has one-sidedly been emphasizing research and scientific merit, and hence all investment in developing teaching has been viewed as superfluous and as taking time away from the more important scientific work. Taking teaching merit into account in the assessment of an individual teacher's performance and career development would be an important prerequisite for utilizing the possibilities offered by ICT in the development of teaching. The universities should also develop new ways to provide teachers with pedagogical and technical support in the use of ICT in teaching.

	Mean	Standard Deviation
Student workstations	3.5	1.2
Students' lack of time	3.4	1.1
Students' ICT skills	3.1	1.1
Course overlap	3.1	1.2
Insufficient course hours	3.0	1.2
Teachers' lack of time	3.0	1.2

Table 11: Obstacles to the use of ICT according to students

The students emphasized quantitative resources and curricular factors—both areas which teachers do not consider to be significant. It is interesting that students also emphasized time limitations as an obstacle. In principle, ICT could save them time and help them carry out their assignments and learning tasks more efficiently. This claim is thus likely to be connected to the level of their own personal skills. Many students probably think that they do not have time to learn the necessary ICT skills with all of the things they need to do anyway, even if these skills would later make their studying more efficient and save them time. They also waste time if they are forced to wait in line for a workstation. Obstacles students experience should be overcome by increasing the number of computers assigned to student use and by planning study programs better.

Advanced practices and new directions in technology use

The evaluation shows that ICT has thus far not had a particularly profound effect on how teaching at the universities in general has been carried out. This does not mean, however, that new teaching practices have not been created through utilizing these technologies. Many individual pilot projects show that when coupled with innovative pedagogical thinking, technology opens up interesting possibilities for revitalizing university teaching.

As part of the assessment of the educational use of ICT at institutes of higher education, a large number of case studies of innovative projects were collected. These case studies have been published (in Finnish only) in sub-report 2 (Sitra 190, 1998). On the basis of these case studies it may be concluded that new technology has been utilized in a versatile way in the different academic disciplines. Technology was not only used to facilitate the same teaching which was already being provided; in many projects ICT functioned as a tool enabling wholly new kinds of learning processes. An example of such processes are collaborative learning projects carried out with the help of groupware. These have been used, for instance, in the teaching of computer science and medicine.

For example, a project carried out at the Department of Computer Science at the University of Tampere aimed to research, develop and assess the use of network-based conferencing tools as a part of university teaching. (See Hietala, Sitra 190, 1998):

It used to be that discussions with a tutor deepened and sharpened a student's knowledge, but as the numbers of students have been increasing, their opportunities for genuine discussions with their teachers have been reduced. During lectures as well, typically only a few eager students participate in the dialogue, and sustaining it becomes difficult. It is an important prerequisite of high-quality learning, however, that the personal ideas and theories of the students are worked out over the long term and in a process where they have the opportunity to argue their views, receive comments and engage in a dialogue with their peers and their teachers. Especially at the university level, successful leaning is re-

lated to the objective of developing critical and reflective thinking, where dialogue has an important role. Information networks and especially conferencing tools seem to offer an obvious solution to these problems. They free the pressured students and teachers from the constraints of time and place, but at their best they also support persistency, the developing of one's plans and doing and reflecting on things together.

In this project, conferencing tools have been experimented with and developed for eight courses at the Department of Computer Science, at the intermediate as well as the advanced level, and also in the open university. A total of over 300 students attended these courses, which were taught or led by four different teachers. The project has produced two WWW-based systems which continue to be experimented with and developed further. While planning these systems and the entire studying process, attempts have been made to encourage all the students involved to participate in the discussion.

The experiences gained from the course and the conferencing tools have mainly been positive. Expanding upon the course's traditional seminar format to include discussion over the network resulted in a marked improvement in the quality of student papers. The arrangement enabled the teachers to change from being disseminators of information into being tutors, and it has transferred more of the responsibility to the students themselves.

It turned out to be a problem getting students motivated. If students do not see themselves as benefitting enough from the system, voluntary discussions die out. On the other hand, establishing certain minimum requirements often lowers the quality of the discussion. For the courses to succeed, an innovative approach is needed to plan the network tasks and to awaken the motivation and inspiration of the students. In the course in question, students themselves participated in advancing the discussion and also learned from each other. We feel that the present arrangements succeeded reasonably well. However, it was necessary for the course leader to intervene directly when a few students "fell asleep" during the discussion. Another problem encountered with these types of courses is the evaluation of student performance and the criteria to be used in grading.

Based on our experience thus far, it is essential to combine the use of these systems with doing things together and with a discussion about the work the students themselves have done, and on the other hand with

counselling the students to take responsibility for sustaining the discussion and to learn from their peers. At their best, these conferencing tools enable the use of modern learning and teaching strategies, but they also require that the teacher has pedagogical insight and dares to take a step towards a new kind of tutoring and assessment culture.

Similar projects have also been carried out in the teaching of medicine. The Faculty of Medicine at the University of Turku has been experimenting with an approach where the focus is not only on what kinds of learning processes take place in the mind of an individual student, but also on the collaborative construction process (see Lehtinen et al., Sitra 190, 1998). In other words, the objective is to organize student groups which resemble the kinds of scientific communities which create new knowledge through active interaction.

The University of Turku educational technology unit has developed a computer-supported collaborative working and learning environment. WorkMates is an application functioning on the WWW, enabling learning based on collaboration between students and teachers free of the constraints of time and place. The teacher can open a new WorkMates session for a group of students by specifying the students who can log into the system. The teacher can also customize the working area being opened for the group to serve the learning objective in question, for example by adding notes to guide the work, by preparing material in WWW form for the student group to work on, or by compiling suitable links to databases and other sources.

WorkMates provides the students with the tools for producing, editing and commenting upon documents. When creating a new document in the system, the user can specify the rights to its use in various ways. WorkMates also includes tools for creating collaborative databases, doing searches, administering the activities of the student group, and a specific window through which the students working in WorkMates can browse the information services of the Internet and flexibly utilize them while compiling documents or databases or when commenting upon work done by other students. The first versions of WorkMates have been taken into use both within the university and in open university courses.

At the introductory level, this model has been developed and experimented with in conjunction with the teaching of virology. The contents

of the basic course in virology are presented on WWW pages created by teachers of virology, which include links to various databases (e.g., current epidemiological statistics). The students get to practice by solving patient cases, at first coming up with their own solutions individually. At this stage, the tutor can follow the work of each individual student and comment on their results and answer their questions. The students are encouraged to interact with each other, but each student must also produce an independent case-analysis. In the next stage, the work of each student is published for the other members of the group, and after that each student must summarize one patient case in a way which allows the group to come to a consensus.

The students utilized WorkMates in the intended fashion. All students created their own documents and read the documents made public by others. The group adhered to the timetable, and everyone managed to finish their document. The goal was that all the students in the group would participate in the creation of collaborative documents and would comment upon them, although the creation of these documents on each individual patient case was always the responsibility of a single student. At first, the students hardly commented on the collaborative documents, but as they were encouraged to do so by the tutor, they did begin to comment on each others' work.

Although the students felt this approach increased their workload when compared to traditional courses, they were on the whole very satisfied with this computer-supported collaborative learning and with WorkMates. In a questionnaire distributed after the course, 8 out of 10 students fully agreed with the statement "I learned better on this course than on normal lectures or small group courses," and the rest agreed to some degree. The students felt that computer-supported collaborative learning suited this type of course very well. Technical problems were experienced mainly when trying to connect to the university computers from outside campus.

In the feedback session, the students spontaneously brought up many worthwhile observations. For example, the students said they had been searching for information in many different sources rather than in a single textbook when they were writing their answers, and they found this to be a good and interesting learning method. They also experienced it as positive that in WorkMates everyone had to work equally and nobody could just coast along with the group without doing any

work. The students also praised the method of studying based on patient cases, as they thought the situations felt real. Although a particularly lively discussion did not emerge in WorkMates itself, the students said they had talked about the assignments a lot while working at the workstations with their course mates. Writing the answers on the computer felt meaningful, as there was a real audience receiving them, i.e. the text they were producing mattered. Computer-supported collaborative learning based on case studies, framed by the systematic provision of theoretical background information, fulfilled its objectives. It resulted in genuine cooperation between students, and produced learning where reflection upon real case studies was integrated with the acquisition of theory as well. This was manifested in the interpretations produced by the students, and traces of it could be seen in the comments students made on each other's case analyses. The experiences provided by the first experimental use of this system were extremely positive, but also yielded significant information from the viewpoint of further development of the applications and procedures.

Another important pedagogical possibility which emerges in many of these case studies is connecting university studies with real problem-solving situations outside of the university. These can be carried out either by technical simulations or by maintaining contacts with the outside via information networks. Examples of this can be found, for instance, in language teaching.

Teaching offered at the Languages and Communications Department of the Helsinki School of Economics and Business Administration (HSEBA) emphasizes language and communication skills required by the business world (Tammelin, Sitra 190, 1998). The course contents are drawn from authentic business world situations, the communication needs inherent in them, and the special vocabulary needed in such situations.

Since the end of the 1980s, The Department of Languages and Communications of HSEBA has striven to integrate new information and communications technologies into teaching. In recent years, courses in various languages have especially utilized ready-made teaching software, information networks and e-mail. From the viewpoint of developing new learning environments, the department has benefitted significantly

from ICONS (International Computer-Mediated Negotiation Simulation) implemented through e-mail and computer conferencing and led by the University of Maryland in the United States. The simulation increased student motivation and interest, especially in relation to working together and assuming responsibility themselves for the success of the course.

The goals and content of the new Environmental Communications Course were formulated as follows:

From the viewpoint of learning languages, the objectives were to improve the written communication and argumentation skills of the participants by using computer conferencing and to develop oral skills in English through videoconferencing. The course contents were connected with the environmental management study module at the Department of Management, i.e. environmental issues and their management in businesses, especially when viewed from the perspective of communication. Specific topics in the course were communications conflicts related to environmental issues in the Finnish forest industry and communications issues related to environmental ethics and values.

During the course, the groups held three monthly hour-long videoconferences, with the conference chairpersons being selected by the participants from among themselves. The framework for the first two videoconferences was provided by simulated situations. The topic of the first conference was the clearcutting of forests, and the course participants took the roles of the various interest groups involved (the state, private forest owners, the pulp and paper industry, foreign buyers of paper, environmental organizations and consumers). The topic of the second videoconference was a simulated virtual seminar, hosted by students from Lappeenranta who represented the three largest Finnish pulp and paper companies. Students from Helsinki took the roles of invited seminar participants, representing paper buyers from England, Germany and France. The last videoconference no longer had a simulated situation as a starting point, but the students were representing themselves in a free discussion of environmental ethics and values, with the student group from Helsinki having prepared a case example to serve as a starting point.

In the final course evaluations, the participants emphasized that the course had focused on real-life problems and that the use of media technologies had provided the opportunity to focus on these problems in a way different from that provided in traditional classroom teaching, a

way which they felt stimulated active participation. The evaluations stressed the fact that the use of technology had enabled the participation of people representing different viewpoints. The participants' need to acquire new knowledge increased considerably during the course. This need, however, was not connected so much to the media technology being used but to the tasks and assignments that were a part of the course. These required the use of the kind of up-to-date information which would not have been available in printed books, for instance. The students used the Internet as a tool for finding information, but they also used direct telephone contacts to businesses and experts.

The examples described above give us some clues about the direction in which university education is developing. It would seem that the application of ICT can enrich traditional university education and narrow the gulf between traditional academic studies and the changing demands of working life. With innovative use of technology, universities can train their students in the key skills called for in modern working life, such as teamwork, networking, internationalization, project management, communication, solving complex practical problems, etc., without compromising on their basic task of academic education.

Most of the case studies also show that developing a teaching application aimed at changing education in a more profound way calls for such great investments that it is not possible without the financial, pedagogical and technical support of a university or some outside party. It seems clear that universities need to have some kind of a unit for pedagogy and educational technology which would provide university teachers with training and guidance in these areas. In some of the projects, it has proven beneficial to recruit students interested in developing information technology and pedagogy and ask them to participate actively in the planning and implementation of learning environments.

A central issue in using ICT to develop university education is how to disseminate innovative ideas and models to other interested teachers. Here it is important to enhance cooperation and the sharing of experiences between different departments, faculties and universities. We need more local and national projects where ICT-based learning environments are developed for wide use in university edu-

cation. This in turn means that we need to pay more attention to turning applications developed for the internal use of a single university department into products which can be used more widely. The development of educational technology should not remain an isolated interest of individual teachers, but should become an integral and essential part of improving the quality of university education.

ICT IN POLYTECHNIC TEACHING*

In the 1990s, Finnish vocational education was completely reformed, leading to the creation of a wide network of polytechnics, or what are known in Finnish as *ammattikorkeakoulu*, AMK institutions. Part of the non-university sector, the polytechnics offer higher education degrees with an occupational emphasis. Polytechnic education is designed to meet the changing requirements and needs of industry and commerce and qualify its graduates for different expert functions. In 1998-1999, there were 33 polytechnics, of which 20 had received permanent status under the reform process.

Education, Training and Research in the Information Society: A National Strategy, a strategy document completed in 1995, contains the views of an expert advisory group appointed by the Ministry of Education, and their suggestions on how the utilization of information technologies can improve the quality of education. The strategy views knowledge as an important resource and notes that the development of technology enabling the creation and communication of knowledge will have a profound influence on the structures, contents and working methods used in education. An objective for the polytechnics is that those receiving polytechnic degrees will have deepened their information technology skills in their specific field through studying, research and practical experience in working life. In addition, education should secure a sufficient supply of ICT professionals.

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*Antti Kauppi and Leena Vainio were responsible for this section of the project, and this report is based on their findings (see Sitra No. 189 and No. 190).

The economy has continuously become increasingly dynamic and complex. The needs of clients in various fields and in the markets are constantly changing. At the same time, the internationalization of the economy enables rapid global movement of both products and capital. The production of goods and services has become increasingly automated and the importance of ICT has increased.

In the future, people will succeed in working life if they possess both extensive and in-depth knowledge, can make creative and innovative decisions, and can, in cooperation with others, produce new solutions to meet changing needs. A central objective of the polytechnics is to produce just such experts.

New working methods and technologies will come whether we are ready for them or not, but people are often slow to change their working habits and ways of using technology. The new culture of work increasingly consists of mobile work, work distributed across several locations, part-time work and also more and more networking outside of the work organization. In the future, however, assisted by new forms of ICT, work should run smoothly irrespective of distance. In spite of this, workers should be able to feel that they belong to a working community and are committed to common goals.

A central prerequisite for change is the smooth adaptation of technology and of the new possibilities for communication and information processing which it brings. The utilization of new applications of information systems means that information becomes a commodity shared by all, and the new tools create the possibility for direct feedback and discussion.

Changes in the forms of work signify a profound change for the organization of workplaces and education. Work has to be defined in a new way, since being at the workplace or educational institution at a given time is no longer the most important criterion of work. Easy-to-use monitoring and feedback systems and measures to assess work must be developed. Decentralized work and study will lead to new kinds of systems for finding and managing information—and we must also assure that the technology is reliable.

As ICT becomes increasingly central in working life, the polytechnics also need to more comprehensively outline their information society strategies, their teaching and their use of ICT as a part of education.

Implementation of the polytechnic survey

At the level of central administration, the polytechnic survey targeted 16 Finnish language polytechnics with permanent status. Their information society strategies were surveyed with a questionnaire addressed to the administrations or information managers of the institutions. The questionnaire was similar to the one sent to university administrations. Fifteen responses were received.

The educational use of ICT was also surveyed with questionnaires sent to teachers and students at the polytechnics. Target groups for these questionnaires were selected from five polytechnics located in different parts of the country and representing various fields of study. The questionnaire targeted the areas of technology, commerce and administration, health care and social services, tourism, natural resources and the arts in proportion to their relative student intakes. All in all, the questionnaire was given to 1,200 students and 350 teachers.

The student questionnaires were given to students in their second, third or fourth year of study during a general lecture or similar event. The distribution of teacher questionnaires was agreed upon separately with each polytechnic. The questionnaires attempted to find out how ICT was used as a tool, a way of working and as a learning environment, and how the polytechnic's focus on working life was manifested in the use of ICT. In addition, a more detailed look was taken at a number of innovative educational approaches which utilized ICT.

A total of 1,067 students and 180 teachers responded to the questionnaire, or roughly 89% of the students and 51% of the teachers. The respondents represented the different polytechnics and different areas of study relatively accurately. Of the respondents, 48% were male and 52% female.

A majority of the students had a computer at their disposal at home (see Table 12). At the polytechnics, we can see even more clearly the gender difference which was noted with the university students: male students clearly have at their disposal more and better-equipped computers than female students.

Computer at home	Male		Female	
	Frequency	Percentage	Frequency	Percentage
None	77	14.3	226	38.8
Yes, but no network connection	315	58.6	281	47.5
Yes with network connection	146	27.1	85	14.4
Total	538	100	592	100.7

Table 12. Information technology at the students' disposal at home

Information society strategies and resources for their implementation

Of the 14 polytechnics which responded to the survey, 11 stated that they had a general ICT strategy, and three of these sent a copy. The strategies outline the areas that need development in the near future, the measures to be taken to reach the objectives, and the equipment resources to be acquired in the next few years. Nine of the strategies included a section on developing the use of ICT in teaching.

The survey asked who was chiefly responsible for organizing the training for the teaching staff. Primarily, the personnel themselves seek out the training they need. Training organized by the institution was nearly as important. According to the administration, the teachers at the polytechnics have a basic mastery of ICT and network skills (roughly 90% reported knowing how to use these technologies). By contrast, only about one in five teachers reported having the skills to use ICT for pedagogical purposes.

According to administrators, the greatest obstacles to the use of ICT are the teachers and the lack of technical and pedagogical support personnel. Teachers' lack of time and reservations about the use of ICT seem to be the most significant obstacles. Another significant obstacle is a lack of time among the students. For the students, however, attitudes or skills do not present an obstacle to ICT use. With the teachers as well, insufficient skills in the use of ICT are not nearly as important an obstacle as are their attitudes and prejudices. An even

greater obstacle is insufficient technical and pedagogical support with respect to ICT use. Hardware resources do not pose a significant obstacle. On average, there are fewer than four students per computer. There are about three computers for every four teachers. The computers are relatively powerful, and nearly every one is connected to a network. The network capacity is generally viewed as adequate, although there are times when the lines are congested. In some fields, a lack of suitable teaching software limits the possibilities of using ICT. All in all, the technological foundation is good at the polytechnics.

	Opinions of Polytechnic Administrators		
	Average	Standard Deviation	Number
Teachers' lack of time	4.2	0.80	14
Teachers' reserved attitudes	3.8	1.05	14
Lack of technical support for teachers	3.0	0.96	14
Lack of pedagogical support for teachers	2.9		14
Lack of instructional software	2.9	0.95	14
Teachers' lack of ICT skills	2.7	0.73	14
Students' lack of time	2.7	1,20	14
Lack of technical support for students	2.6		14
Students' workstations	2.5	0.86	14
Teachers' workstations	2.2	0.58	14
Software licenses	2.1	0.92	14
Library information services	2.1	0.95	14
Students ICT skills	2.0	0.78	14
Server capacity	1.9	0.86	14
Connections outside of the university	1.9	0.86	14
Students' reserved attitudes	1.8	0.89	14
University internal networks	1.7	0.86	14

Table 13. Obstacles to Using ICT According to Polytechnic Administrators

At most of the polytechnics, the ICT support system is organized in such a way that the hardware functions relatively well, but few resources remain for pedagogical support. The teachers' shortage of time also means that even where support is available, it does not reach the person needing it at the right time.

Ten of the polytechnics surveyed organize ICT education for their students. At five of them it is offered jointly to the students and the staff.

Current level of ICT skills

When evaluating basic ICT skills, we can note that both students and teachers are best at the basic skills of word processing, e-mail and browsing the WWW. In all these areas they on average estimated their own skill to be good. Poorest skills were reported with respect to groupware, videoconferencing, audiographics and games, simulations and real-life applications related to the professional field in question. In these areas the respondents on average reported having minimal skills.

When we compare students' and teachers' evaluations of their own competence, we can see that teachers clearly felt more competent in the use of presentation graphics, videoconferencing and computer-assisted instruction programs than did students. Students, by contrast, clearly felt more competent in the areas of drawing and image-processing software, in using the WWW as educational material and to search for information, in making their own online help manuals for software, and with games related to their specific professional field (such as business enterprise games).

If we look at gender differences, we see that in nearly all areas males viewed themselves as more competent than the females viewed themselves. Only in the area of word processing do men and women rate their skills almost equally.

	Teachers		Students	
	Av.	St. Dev.	Av.	St.dev.
A. BASIC SKILLS AND TOOLS				
Operating systems	4.1	1.01	3.9	0.94
Word processing	4.1	0.72	4.2	0.74
Spreadsheets	3.2	1.24	3.4	1.15
Catalog/Database programs	2.5	1.16	2.7	1.13
Drawing and image processing	2.8	1.13	3.2	1.14
Presentation graphics	2.9	1.28	2.6	1.31
Time management programs	2.5	1.22		
B. COMMUNICATION				
E-mail	4.3	0.70	4.1	1.00
WWW browsing	3.9	0.89	4.1	0.94
Produce WWW material	2.2	1.11	2.3	1.28
Other Internet use	2.4	1.10	2.6	1.27
Groupware	2.0	1.09	1.8	1.01
Videoconferencing	2.2	1.25	1.6	0.95
Audiographics	1.8	1.04		
C. ELECTRONIC LEARNING MATERIALS				
CD-ROM material	3.1	1.34	3,0	1.41
CAL programs	2.7	1.29	2.2	1.20
WWW as learning material and for finding information	3.1	1.14	3.5	1.18
D. BUSINESS APPLICATIONS				
Games eg.	2.1	1.17	2.4	1.26
Simulations	2.0	1.25	1.9	1.06
Business applications	2.2	1.28	2.3	1.18

(scale: 1 = poor skills, 5 = excellent skills)

Table 14. Differences in ICT Skills Between Polytechnic Teachers and Students

Comparisons between the different polytechnics also reveal statistically meaningful differences. If we compare different areas of study, we may note that students of technical fields and transportation as well as commerce and management evaluated their skills higher than others in almost every category. These differences were also statistically significant. Only in the category of e-mail use were there no noticeable skill differences between students in the different fields. In addition to the students of technical fields and transportation and students of commerce and management, students of the arts evaluated their competence in the use of drawing and image-processing software to be better than did students in other fields.

ICT USE IN STUDYING AND TEACHING

Polytechnic students mainly use ICT for doing various independent or group assignments, reports, introductions and presentations, or project work and research. ICT is also used somewhat over the average in the acquisition of new information and source materials as well as in information processing and communicating with other members of the academic community. New technologies are least utilized in the planning and evaluation of studies.

Teachers, in turn, use ICT most in preparing their lectures and presentations, in preparing assignments and in communicating with other members of the academic community. ICT is also used more than average in the acquisition of new information and source materials and in information processing. On the other hand, ICT is on average used very little when evaluating the quality and credibility of information, and not very much more in areas such as assessing one's own performance and teaching, in the planning and scheduling of teaching or in the implementation of individually tailored study modules or training periods.

AREAS OF ICT USE	Average	Standard Deviation
Working independently on assignments	4.0	0.93
Doing surveys, papers, essays	3.5	1.00
Aquiring new knowledge and background material	3.4	1.03
Communicating with other members of the academic community	3.3	1.40
Doing project and research work	3.3	1.13
Doing groupwork	3.3	1.02
Processing information	3.1	1.24
Increasing the pace of study	3.0	1.28
Increasing the efficiency of study	2.8	1.17
Linking studies with practical work	2.5	1.16
Communicating new knowledge and background material to others	2.5	1.13
Developing new ideas	2.4	1.14
Combining work and study	2.2	1.20
Planning studies with other students	2.2	1.10
Evaluating the quality and reliability of information	2.2	1.01
Receieving and soliciting guidance	2.1	1.03
Getting feedback on studying	2.1	1.01
Keeping in contact with others	2.1	1.08
Scheduling work and studying	2.0	1.16
Evaluating own work	2.0	1.03
Implementing an individualized study plan	2.0	1.02
Getting feedback on teaching	2.0	0.96
Planning and implementing training periods	1.9	0.98
Evaluating the achievement of others	1.7	0.90
Planning studies with teachers	1.7	0.87

Table 15. ICT Use, Mean and Standard Deviations for Polytechnic Students (n=1124)

AREAS OF ICT USE	Mean	Standard Deviation
Preparing lectures and presentation	4.3	0.91
Preparing assignments	4.3	0.93
Communicating with others in the academic community	4.0	1.22
Gathering information and material	3.7	0.97
Processing information	3.6	1.21
Increasing the efficiency of teaching	3.3	1.17
Giving information and material to others	3.3	1.13
Planning teaching with other teachers	3.3	1.27
Evaluating student achievement	3.3	1.15
Keeping in touch with working life	3.3	1.22
Giving students feedback	3.2	1.14
Developing new ideas	3.2	1.20
Doing research	3.0	1.40
Linking teaching with practical work	2.9	1.23
Planning studies with students	2.8	1.16
Receiving feedback on teaching	2.8	1.06
Increasing the pace of study	2.8	1.23
Doing groupwork	2.7	1.21
Planning and implementing training periods	2.7	1.36
Implementing an individualized study plan	2.7	1.28
Scheduling work and study	2.5	1.42
Evaluating own performance	2.5	1.20
Evaluating the quality and reliability of information	2.3	1.10

Table 16. ICT Use, Mean and Standard Deviations for Polytechnic Teachers (n=200)

In comparisons between teachers and students, teachers say that they used ICT more than the students. When we compare ICT use between male and female students, we can see that female students say that they use technology more than male students when working on their assignments, while male students use it more for combining work and study and for communicating and collecting information. Commerce and administration, tourism and technology, and transportation students report the highest use of ICT in managing their studies and doing their assignments, while students of commerce and administration, technology and transportation as well as the arts report the highest use of ICT in combining their work and studies. Health and social services students seem to use ICT for communication and information acquisition less than students in other fields.

Obstacles to ICT use

Polytechnic students experience the greatest obstacles to their use of ICT to be the limited numbers of their own workstations as well as a lack of time. Other significant obstacles are factors related to the curricula (small numbers of teaching hours per course, course overlap and their being broken into excessively short units), teachers' shortage of time and lack of skills in preparing study material, and insufficient ICT support. Polytechnic teachers see the greatest obstacles to be their own shortage of time, their own weak technological and pedagogical skills, and insufficient availability of technical and pedagogical support.

Students do not feel that they lack access to information technology at home or suffer from network problems, nor do they complain about library and information services being inadequate or see their own reserved attitudes as a problem. Teachers do not view the following as substantial obstacles: internal networks in the polytechnics, library and information services, the number of workstations for their private use, degree requirements, course content objectives or one-sided teaching methods.

Does ICT bring anything new to polytechnic education?

The best way to get an idea of the possibilities brought by ICT to the qualitative development of teaching at polytechnics is to look at case studies of innovative teaching experiments. Most of the progressive practices found at polytechnics were connected to building links between industry and commerce, or to learning projects which the students themselves implemented and were responsible for. As an example, we shall look at a project carried out at the Wetterhof unit of Häme Polytechnic (Kauppi, Koli & Vainio 1998).

The marketing communications project was launched in the fall of 1997 and ended in the Spring of 1998. Together, students independently planned and carried out an exhibition of marketing communications: they secured funding and publicity, and they produced the textiles for the exhibition as well as the exhibition catalogue. In addition, the project will produce a CD-ROM. Teachers were used as experts, with students commissioning teaching and guidance as needed, and students also made contacts with outside experts.

The project was constructed around the students' own objectives, and they found a way to fit the project into their own curricular requirements and the need to earn credits in specific subjects. The planning and implementation of the exhibition required contacting businesses, inviting bids on brochures, organizing the financing etc. The students also viewed the project as an opportunity to introduce themselves to potential employers.

The project group also had to solve various internal issues by itself. It was not always easy to function in a group, and the ability to make compromises and seek consensus was required.

During the project the students documented the project phases in various ways. They compiled project files classified by subject on the polytechnic's server. They kept a log of what had happened during the week. The project also had its own diary in which students recorded what they had done. All the students possessed basic ICT skills at the start of the project. The students said that without e-mail it would not have been possible to carry out the project in the timetable given for it, for e-mail

enabled quick contacts when needed to people both within the project and elsewhere. The telephone was also used when needed. Communication with outside experts was mainly via e-mail.

Project activities, presentations and other results were saved in a form which enabled everyone to read and work on them. The products of the individual project members thus gradually also became products of the entire group—with the hallmarks of individual students no longer visible. The Internet turned out to be an important channel for getting information for the project; what could not be found in books was found on the Internet.

During the project, ICT was also used for producing textiles and for compiling and laying out the catalogue. All of the students interviewed had a computer at home and had put their network connection to a lot of use. Often it was only late in the evening at home that they really had time to concentrate.

This case is in many ways a model example of project work. The students were deeply committed to the project. As a group, they learned cooperation and collaborative problem solving as well as self-discipline and the courage to take upon themselves challenging tasks. In addition, the project produced high-quality results, both from a professional and an educational viewpoint.

ICT was used as a natural tool for learning. ICT was used daily and integrated seamlessly into the project work, except for the project administration software which turned out not to be suitable for an educational environment.

From the viewpoint of teaching and guidance, a definite plus of project work was the strong commitment of the students to the process and the resulting development of their general competencies such as autonomy, cooperation, problem solving and decision making. However, on the basis of the material which accumulated through the project, it is difficult to assess the development of their professional knowledge or to see to what extent the project work involved the integration and assimilation of more generalizable professional knowledge. It is also possible that contacts with industry and commerce were limited to the practical organizing tasks related to the exhibition and the exhibition catalogue.

It proved to be difficult to integrate project work into the curriculum. For one thing, students had clear difficulties managing their time. Since the curriculum itself was relatively inflexible, it became "nearly impos-

sible" to schedule time for the project. Evaluating the collaborative results of the group was also problematic. The most central issue, however, turned out to be getting the polytechnic community to support innovative and successful learning practices: how to get the other teachers and students to understand the significance of project learning or even to make an effort to become familiar with it.

Open and distance learning were prominently featured in some of the polytechnic case studies. These projects especially took advantage of being able to cooperate and divide the work between different educational institutions. An example of this is the "InfoRoad" project in which the North Karelia Polytechnic, Oulu Polytechnic, Kemi-Tornio Polytechnic, Jyväskylä Polytechnic and the Helsinki Business Polytechnic participated (Kauppi & Vainio 1998).

Supported by the National Board of Education, the InfoRoad project was launched as part of the "National Information Society Initiative." Outside funding covered about half of the project budget and was used to cover planning and administrative costs, the development of learning material and the additional training needed for teachers in order to launch the project. The courses were carried out through the regular budget.

The project's objective was to increase the resources available to an individual polytechnic and to use open and distance learning to give students freedom from the constraints of time and place. The project offered different polytechnics joint courses, produced learning material for open and distance learning, and experimented with various technical and pedagogical solutions. A central objective was to use IT and information networks for transmitting study material, for studying and for guidance.

Each polytechnic prepared and implemented a three-credit course which was made available to all computer science students at the participating polytechnics. Thus each polytechnic could offer 15 credits of teaching, even though it had only had to prepare material for three credits. Modern open and distance learning methods were utilized in implementing the courses. The ICT infrastructure was somewhat different between the polytechnics. All of them utilized e-mail and multiple-location videoconferencing. The number of videoconferences varied between

one and three per course. In addition, information networks and WWW pages were used and discussion groups were established. Groupware was used in Joensuu and Jyväskylä to increase interaction between students. Distance teaching was mainly used, with the videoconferences providing common contact periods. The teacher mostly maintained contacts with students through e-mail. Learning material and assignments were distributed via WWW pages and mail.

The InfoRoad project provides a model example of the power of cooperation between polytechnics. A cooperation project emerging from personal contacts has created a model which enriches the educational offering, expands expertise and develops the competencies of a given polytechnic in an interactive way. Internal cooperation within a single polytechnic or even cooperation between two polytechnics would not have provided such varied opportunities for sharing experiences.

At the early stages of developing the project, pedagogical approaches were given relatively little attention. Very traditional teaching methods were applied with the new tools. In further development and when implementing corresponding projects, collaborative planning by a wider group of experts would certainly improve learning outcomes and lead to better solutions. On the other hand, this area is still new to those involved, and from the viewpoint of learning we also need these kinds of experiences in order to develop our activities.

One of the project's benefits was that distance learning enables a larger number of students to participate in a course. Course availability was likewise improved. However, a danger inherent in open and distance learning is that individual students might be left on their own. Distance learning requires guidance and feedback from the teacher, and there is not always enough time and opportunity for such feedback. As the student groups increase in size, care must be taken that sufficient guidance is offered both by arranging for feedback within the group and by making sure that there are sufficient teacher resources.

Teachers felt that their workload increased substantially during the project, and thus we still need to find ways to ease it. It is not foreseeable that there would be additional money either to hire more teachers or to pay existing teachers for their overtime. New ICT applications are likely to require new practices which would enable keeping the workload of an individual student and teacher within reasonable bounds while also improving the quality of education.

The project involved creating a virtual classroom for learning where traditional school-type studies could be done more autonomously. From the viewpoint of developing skills needed in the workplace, it would be beneficial to focus education even more on the problems in working life and to construct learning environments which resemble practices common in the workplace.

The use of different kinds of simulations and virtual environments is increasing in all types of education, but based on the case studies collected here they seem to have an especially important role in the development of vocational education. An example of this is the Virtual Hospital Project (Kauppi & Vainio 1998).

In the Virtual Hospital, students of the various medical professions can together practice caring for a virtual patient; they make treatment and rehabilitation plans for virtual patients, prescribe drugs and follow treatment instructions. The Virtual Hospital functions in a computer network with the aid of software designed for planning and documenting treatment. The project attempts to answer the needs of vocational education both at the secondary and tertiary levels.

Participants include several health care and social service vocational institutions in the greater Helsinki area. Initiated by Arcada, the Institute for Health and Social Services, the project began in the fall of 1996 with the support of National Board of Education.

A prototype of the simulation program was developed in 1997-1998, and a small-scale experiment using it has been conducted by two groups of students. Actual use is planned to begin in the fall of 1998. The objective is to offer health care and social services students at various levels an opportunity to practice "real" health and social services planning and documenting through computer networks. As the simulation is guided by the teacher, the degree of difficulty of the problems can be adjusted to correspond to the levels and needs of the student group, and multiprofessional cooperation trains the students in the forms of collaboration which they must be able to master when they enter working life. The idea is that students work in a common learning environment irrespective of where they physically are.

Simultaneous network use of patient history software attempts to simulate real-life circumstances of health care work, where nurses (or

here students) tend to a patient in shifts. After coming on, the student evaluates the patient's condition and adjusts the treatment plan accordingly.

Now that the communications problems which plagued the project in the beginning have been solved, it is possible for other educational institutions to use the database on Arcada's server. At Arcada and the Helsinki City College of Health Care a few individual student groups have experimented with the software. First- and third-year students participated in the trial. The simulation was tested in conjunction with elective IT studies and the care and caregiving study module.

The software frees the students from the constraints of time and place and thus brings a welcome change to normal teaching practices. In the background are new constructivist ideas about learning. The program creates a framework within which students can construct their own learning. Everything is not provided in a ready-to-use format.

ICT is used as a forum for social interaction and personal reflection. When using the software it is always possible to take the learning needs of an individual student or group of students into account. The student turns to literature for advice, and study teams engage in conversations on the network in closed discussion groups. In these discussions students reflect on the reasons behind decisions they have made. An essential feature is the commitment of the students to their tasks. The learning environment aims at supporting students' systematic problem solving approaches and planning skills, their ability to base their plans and decisions on multidisciplinary theoretical knowledge and their ability to find information from available sources.

From the viewpoint of learning, searching for new knowledge and having discussions with various experts seem like an optimal solution. Only actual use will show whether students commit themselves to working with the program and how the multidisciplinary approach will be implemented. Only through working on a genuine multidisciplinary team can we see the obstacles which may arise from the program itself and also from the group dynamics. The teacher's role in guiding the learning process will become very important. The learning process will also be improved if students take the project seriously and work to make the situations as realistic as possible.

Using the program will fundamentally change a teacher's work. The teacher will be required to monitor and maintain contacts with individ-

ual students, and will also need to monitor the student team's participation in the discussion group. The teacher's workload might grow to be quite significant depending on the number and activity of the caregiving teams.

The program also forces changes to the curriculum. It requires coordination of study modules both within and between institutions in such a way that groups which might enrich one another would use the program simultaneously. The curriculum must also allow enough time for sufficiently intensive utilization of the program. It is quite possible to use the program within individual study modules or in various kinds of projects combining different study modules.

The project has not been carried out in close cooperation with professionals in the field, but the skills needed in work are practiced with the program, and as a by-product the students become familiar with the use of electronic patient histories. Similar patient history databases are used in health care, and the objective at the educational institutions is to become familiar with the basic principles of their use. The simulation is thus used as training for work.

Progress has been hampered because the teachers planning the program faced severe time constraints. Originally, the outside funding was not to be used to hire personnel. The problem was solved when an agreement was reached that project funds could also be used for project-related planning work by teachers, but not for planning normal teaching. From the point of view of developing and implementing the program this was problematic, especially since the program was being used specifically to teach the subject contents of the teachers' own teaching work. More time and resources will be needed for fully reorganizing the teaching.

Most of the project costs are related to planning the learning environment. It is estimated that in the early stages nearly 400 teacher working hours will be needed for preparing patient cases, planning the studies and producing the user's manual, all of this in addition to normal curricular planning. Using the simulation changes the teacher's work so radically that the traditional definition of work based on teaching hours no longer functions. The educational institution should therefore create new models of defining work which better correspond to changing work methods. Otherwise there is the danger that those who are eager to develop new and innovative teaching methods are crushed under an increasing workload and become frustrated, as they do not get adequate compensation for the work they do.

To conclude, the program's pedagogical structure provides a framework for cooperative learning and a possibility for solving authentic problems. The students have been eager to use the program.

The learning environment was very different in all the cases we looked at, although there were several common denominators: attempting to make learning more efficient, constructing learning around tasks, assignments and projects, and tying learning more closely to authentic work environments. The cases we have looked at show a clear tendency to transcend traditional classroom teaching methods. ICT has thus become a tool which enables meaningful forms of work. All of these solutions also involve the active cooperation of the students.

Using ICT also changes the teacher's role: rather than simply being a lecturer, the teacher becomes both a writer and a commentator as well as an organizer and enabler. As individual network-based learning becomes increasingly common, teachers might find themselves sharing the same time and place with their students less and less frequently. In the cases surveyed, however, cooperative learning was emphasized more than the individuality of the student or teacher: either the teachers organized a learning environment which guided cooperative group learning through the use of learning assignments, or they constructed a situation which the students used to plan their projects. Studying was based on group work. However, groupworking possibilities offered by ICT could have been utilized in this work to a much greater extent than was done.

Although the learning assignments were authentic and life-like in many respects, the learning environment itself was constructed within the framework of an educational institution. In many cases this meant that the educational institution provided a secure setting for doing the assignments and projects, but sometimes the rigid boundaries of the educational framework became more pronounced. All in all, in the future we must pay more attention to constructing assignments and learning environments which arise from authentic work situations, and to better utilizing learning material made by the students themselves.

Student feedback centered around the need to have better guidance when working with assignments and projects. Teachers are often overwhelmed if they have to provide individual guidance to a

large group of students. We should think more about ways to get students to provide each other with feedback, as well as how to better integrate courses with each other, which could increase the possibilities of offering and receiving feedback.

All the projects showed that increasing the use of ICT requires changes in the curriculum. Even the project as such can change it. Cooperation with working life also helps to keep the teachers' professional skills up-to-date, making it easy to reform course contents and to teach new ones. Teaching is complemented by a group of experts with whom close contacts are maintained in conjunction with various projects.

Time management problems were clearly visible. The curricula created scheduling problems, and the evaluation of groupwork results was also problematic.

The educational community has not yet learned that a lot of know-how and new stimuli for developing activities can be found within their own walls. Developing ICT use seems to be easiest in the polytechnics teaching technical subjects, where projects done by others are looked at more than elsewhere. The greatest obstacles to the use of ICT seemed to be found in the cultures of the educational institutions. The teachers are accustomed to thinking about their work as subjects, courses and lectures, and it is difficult to adopt a working culture based on a different kind of foundation. Project-type work would require teachers to adopt a more holistic, cooperative and flexible approach towards their work, as well as a more determined outward orientation.

Cooperation with workplaces is one of the starting points of vocational institutions. Their educational objectives are linked to the requirements of and anticipated trends in working life and the economy. These institutions expect to cooperate closely with experts in working life, and thus their educational aims are determined by the needs of the economy. Thus ICT projects should also stem from the needs of workplaces and listen to the requirements of the economy. Cooperation would also bring more authentic problems to be solved in assignments and study projects, and would also give the opportunity to develop the professional know-how of the educational institution.

ICT IN TEACHER EDUCATION*

In their report on educational technology, European industrialists emphasize the importance of teachers in learning and education. They do not wish to replace teachers with technology (ERT 1997). The personal relationship between teacher and student will remain important even though the role of the teacher will change in fundamental ways. ICT will facilitate support for individual learning and make it easier to provide timely feedback. In addition, new technology shifts the emphasis away from lectures, where students passively take in information which they are then expected to parrot back, towards more active ways of acquiring information. ICT also frees people from routine administrative tasks.

Teachers are seen to have a key role in making ICT accessible to people of varying backgrounds and ages. The report states:
Teachers will operate at the leading edge of modern technology and will therefore need to update continuously their technical knowledge in the use of ICT. This will demand a major and continuing investment in time and money. If it is done well, then this training should help motivate teachers to take full advantage of opportunities presented by ICT.

Finnish educational strategy statements also emphasize the importance of teachers and appeal to the importance of teacher education. A report by the Ministry of Education on the state of information strategies in Finland mentions in reference to teacher education that thus far only about 25% of the personnel at teacher education institutions and teacher training schools have been able to participate in more extensive ICT training. (Ministry of Education 1997, 13). The report makes the following recommendations:

- Teacher educators should be provided with better economic possibilities to receive training than is presently the case. In so doing, the varying needs of teacher education in different fields should also be taken into account. The availability of suitable learning material is also important.
- It is also important to ensure that subject departments organizing teacher education, departments of teacher education and teacher training schools have sufficient and up-to-date IT hardware and

*This section is based on Hannele Niemi's section of the sub-report (Sitra, No. 189 1989).

that the new space requirements arising from this are taken into account.

Likewise, already in 1994, a report on assessing and developing degrees in education suggested that ICT should be included in every degree in the field of education. It was considered especially important in teacher training, where future teachers should acquire the skills for using and developing technology as a tool for teaching and learning.

Teacher education was chosen as one of the specific target areas of Sitra's survey. The survey attempted to reach various groups of students studying to become teachers. Classroom teachers, subject teachers and kindergarten teachers were chosen from the Universities of Helsinki, Oulu and Jyväskylä, and polytechnic students from the Hämeenlinna and Jyväskylä Polytechnics. The questionnaire was administered to all students close to graduation in conjunction with lectures or examinations. The numbers of teacher education students participating in the survey are seen in the following table grouped by their specific teaching field.

Students groups	f	%
Classroom teachers	245	11.3
Subject teachers (languages, humanities, science and mathematics and arts)	212	9.8
Kindergarden teachers	53	2.4
Teachers in the vocational sector	71	3.3
Other university students	513	23.7
Other polytechnic students	1075	49.6
Total	2169	100

Table 17. Students Participating in the Survey Grouped by their Specific Teaching Field

ICT Skills of Teacher Education Students

The ICT skills of teacher education students were surveyed with a questionnaire which included some open-ended questions. In general, teacher education students were somewhat less skilled than other university students. This finding might partially be explained by the fact that the subjects they represent do not as such include as much technology as do technical fields or medicine, for example. At present, their ICT use is mainly limited to word processing and e-mail, and not everyone can even use these. In the use of communications technologies other than e-mail, such as the Internet, videoconferencing or group-ware, the teacher education students have very little or no competence. Also the skills needed to produce electronic learning material and use computer-assisted instruction remain weak for most of those getting a teacher's degree.

The students of vocational tertiary teacher education institutions distinguish themselves very clearly from other groups of teachers in teacher education. In most areas of ICT application, they are somewhat more competent than subject student teachers or kindergarten teachers. When compared to classroom student teachers, however, the differences are slight except with regard to specific work-related applications, where students of vocational tertiary teacher education institutions are understandably clearly ahead of all other teacher groups. The fewest skills in this area are displayed by those studying to become kindergarten teachers.

Students said that they lack ICT skills. They strongly indicated that they need to get more opportunities to practice ICT use—with the first step being relatively easy and flexible access to computers. In addition, the students requested more courses, support and teaching in this area. Many expressed the wish that this survey would lead to an improvement in the situation, and they asked those conducting the survey to pass on the message to the administrators and those planning the curricula. All of this reinforces the picture which had emerged in earlier surveys and studies (Niemi & Tirri 1997).

Significant obstacles to ICT use in teacher education

The greatest obstacle to the use of new technological applications is the small number of workstations available for students. This is an especially significant problem for kindergarten student teachers. Subject and classroom student teachers likewise highlight the lack of equipment as a big problem. Students at vocational tertiary teacher education institutions, on the other hand, have better access to equipment, and as a group are statistically different from the other groups.

Another clear obstacle is that most students do not have the skills necessary to produce electronic study material, and this applies to all the teacher education student groups in the survey. Education in this area needs to be improved. In the future, teacher educators will have to design and often also produce network material for various kinds of projects. Ideally they can be assisted in this task by their students, who themselves will benefit from the experience. Student teachers need much more support and guidance in this area.

Lack of suitable hardware makes it impossible to practice new skills. On the other hand, lack of guidance and time are also clearly evident. The fourth most important obstacle according to the students is their own shortage of time and the fifth is the teacher's shortage of time. Using ICT thus becomes more like an extraneous burden, with the student teachers seldom getting to practice its teaching applications and applications in open learning environments with students. Student teachers also have few opportunities to produce learning material, which has a qualitative bearing on their own learning.

In what areas do teacher education students use ICT?

The survey asked how often students use ICT and how significant it is in their studies. It turned out that there was a strong correlation between how often ICT was used and how important it was. Those for whom using technology is important use it a lot and vice versa. The ones who use these new opportunities a lot usually also find them significant. The value of ICT is first and foremost in the support and

help it offers in doing tasks and assignments related to studies, such as surveys, introductions and presentations, papers, project work or research. ICT is also important in processing information and getting new information and source material.

Another practical use of ICT is in communicating with the learning community, and in that context especially giving and receiving feedback. In combining work and study, however, the new technology does not yet seem to have found a clear use. ICT does not as yet offer much help in planning studies, in making them more efficient in cooperation with tutors or fellow students, in constructing an individualized study program or in accelerating the studies.

The answers given by students to open-ended questions closely paralleled the findings in the quantitative data. The answers reflect a clear concern about there being too little training in ICT, and that what there is is fragmented and cannot be integrated into the rest of their studies. Although most of the students have some sort of basic skills in word processing, as future teachers they expressed concern over how they would be able to apply the new technology in the classroom with their students.

The students also expressed concern about the quality of their education. They especially emphasized that ICT teaching must be organized in such a way that the participants would understand the matters being taught and would have the opportunity to practice them under supervision.

Teacher education teachers answered a questionnaire that was similar to the one given to students, but it was modified to apply to their work. They mainly use new ICT for writing and communicating, but also to some extent for information processing and research. However, for planning their teaching—especially in cooperation with their students—or for the actual implementation of teaching, they use it relatively seldom. Most active ICT users were the teachers of classroom teachers and of vocational teacher education. Teachers at teacher training schools used ICT the least.

What have we learned from innovative ICT practices to develop teacher education?

Although there seem to be numerous shortcomings in teacher education, a number of relatively innovative projects are under way in several places. For the purpose of assessing teacher education, we therefore tried to find practices within the teacher education establishment where ICT has been used in an innovative way and where a new kind of teaching and education culture has been developed. Here follow some excerpts from Timo Lappi's assessments (Sitra 190, 1998).

Telematic Distance Learning Teaching Practice

Since 1995, telematic distance learning has been implemented in instruction at the teacher training school of the Department of Teacher Education at the University of Oulu. The main objective has been to introduce students participating in the project to the use of videoconferencing equipment, to specific pedagogical and didactic considerations of telematic distance learning and to produce the learning material needed in class. The goal was to evaluate the usefulness of telematics in teaching and teacher practice. Municipalities were also becoming interested in distance learning, as they believed that the new technology would guarantee sufficient school services and would give schools more choices, especially in sparsely populated areas. Thus the building of a cooperation network for distance learning was begun, and in the academic year 1997-1998 it included five upper secondary schools and six upper-level comprehensive schools. These schools have now acquired distance learning equipment and are willing to take teacher education students who can then practice distance learning education.

Teacher trainees can choose telematics as an option during their teaching practice. The scope of this study module is four credits, with two credits granted for theoretical studies and two for practical training in the use of distance education, both in the distance schools and in the teacher training school. The following stages are included in the study module: initiation phase, work in the distance schools, and telematic practice classes in the teacher training school.

Teacher education students thought that it was necessary to have practice in distance teaching. They believe that telematic teaching is going to become increasingly common in the future and that all teachers should possess the necessary basic skills. As a whole, the students thought the training was successful and they were satisfied with the new ideas and experiences it had brought them. It had been an excellent opportunity to become familiar with a new kind of learning environment.

The Kilpisjärvi Project

The Kilpisjärvi project was a research, experimentation and development project for classroom-type distance learning launched by the Teacher Education Department of the University of Helsinki. In this project, which ran from 1994-97, teachers of the Helsinki Second Teacher Training School taught a tiny group of students in the Kilpisjärvi upper-level comprehensive school through videoconferencing. The objectives were to research the possibilities inherent in classroom-type distance learning implemented by videoconferencing and to develop distance learning didactics.

At Helsinki Second, the project was tied to teacher education and teacher training by giving prospective teachers the opportunity to get a feel of distance learning. The project was funded by the Ministry of Education, the University of Helsinki, the Provincial Government of Lapland and the municipality of Enontekiö.

An interactive approach made possible by videoconferencing was the underlying idea of the project. A lesson was clearly structured to consist of a presentation by the teacher, a phase where the students worked on the material, and a phase where the students presented their work and received the necessary guidance and feedback. The role of the teacher was above all to facilitate, support and guide learning.

When a teacher is simultaneously teaching a contact learning group and a distance learning group, the interaction is dependent on how well the teacher is able to take both groups of students into account and to treat them equally. The students at the Kilpisjärvi school did about 17 % of their upper-level comprehensive school studies through distance learning with their classmates in Helsinki.

From the perspective of teacher education, an important part of the training has been the quick utilization of the latest research results in the work of the teacher trainees. Approaches used in the training have

included alternating contact and distance learning periods and utilizing several different levels of telematics.

The Archipelago Distance Learning Project

The Department of Teacher Education at the University of Turku and the Turku Teacher Training School started a project of telematic teaching in the archipelago in the Fall of 1994. The starting point was the need of the archipelago municipalities to provide schooling services to children living in outlying areas where natural and climatic circumstances can vary widely. The municipalities participating in the project financed their own equipment purchases and communications expenses. The Turku Teacher Training School participated in the planning work for constructing the distance learning environment. In 1996, the telematic teaching project changed into a project to enhance the information society in the archipelago, with the number of participating municipalities increasing as well. At present, there are seven municipalities participating in the project.

The project has managed to meet the needs of the archipelago area. The method of organizing teaching used in the project has proven feasible. The project has introduced more features to the local culture which could be defined as information society skills, such as problem-solving ability, flexibility, and the ability to manage the constant presence of technology.

Through the project, archipelago children get the same opportunities to study as children on the mainland. As one of the objectives of the project has been to develop teacher education and make distance learning a part of its curriculum, teacher trainees could, on a voluntary basis, conduct some practice lessons as distance teaching to the archipelago.

Partner schools from the various municipalities participating in these projects have been very interested in distance learning and its development. Teachers of these schools have felt that practicing distance teaching has given them new ideas and inspiration. Without the positive attitude and financial contributions of the municipalities, however, practice distance teaching will not work. The municipalities should thus receive added value from distance learning and networking, either in the form of being able to maintain sufficient levels of educational services, by increasing the selection of elective subjects,

or in a wider perspective by using them as a tool for developing further training for teachers and the school institution itself.

The teacher education students also felt that practice distance teaching was necessary. They believe that telematic teaching will become increasingly common in the future and that all teachers will benefit from having basic skills in this area. Distinct arguments for telematics are the availability of teaching and a more varied selection of available subjects. An undeniable advantage of telematics is that the teaching of a single teacher is delivered to several places irrespective of the distance between them.

Although a visual display unit will not replace a teacher, some of the teaching in remote areas could be carried out with the use of ICT. Continued hardware development along with lowering prices will influence the spread of distance learning.

This new technology places great demands on teachers. Lessons must be planned with special care. Students will not concentrate for long on a mere talking head, so planning and implementing successful and good distance teaching is quite a challenge. Teachers therefore also need continuing education to improve their skills.

However, it is not possible to keep piling new tasks and demands on teachers without getting rid of some of the old ones. Distance learning will radically change the job profiles of teachers, and in the future these profiles might vary a great deal from teacher to teacher. More work will also be needed for planning and preparing lessons, and this work must be included in assessing a teacher's workload. In future contract talks, teachers and employers must find ways to make pay structures more flexible to account for these new and different demands on teachers. Moreover, distance learning requires wholly new forms of organization for education and work in schools with respect to lessons, procedures and the structuring of teaching into periods. Current practices are too rigid.

Schools must also be able to provide sufficient support services. People hired to service the hardware and maintain and develop the software and information and communication systems should also be qualified to train others to use ICT and ideally also be able to give pedagogical support.

Making ICT a part of teacher education

Including ICT in teacher education studies requires changes both in the curricula and changes in the teaching culture of teacher education. This is clearly manifested in the experiences of the Hämeenlinna unit of the University of Tampere as reported by Martti Piipari (Sitra 189, 1998).

ICT teaching is offered in basic courses and as 15- and 35-credit minor subjects. It has been considered important not only to provide all teachers with basic skills but also to offer them the opportunity to continue all the way to advanced studies. The goal is to educate teachers who have the skills needed to apply ICT in their teaching, with a number of them possessing the more advanced skills needed, for example, to work as support persons in schools or educational institutions and to lead development projects.

The students are highly motivated to participate in ICT courses, especially in the 15-credit minor. They find that the education supports their other studies, since it provides them with good basic skills in information processing and in using software. It has been especially positive to notice that gender equality has been achieved in the students' participation in the education, as these studies have increasingly interested female students as well. In terms of developing the hardware and software environments, support from cooperating partners has been crucial. The activity has also been directed outside the educational institution; especially the work of ICT minors who helped organize the National Conference for Interactive Technology in Education increased the range of ideas participants had on the educational applications of ICT.

Teacher education is still in the relatively early stages of adopting ICT and teaching people how to use it. A substantial problem in the universities has been a shortage of computers and especially the number of student workstations. This is also clearly reflected in the students' skill levels. Kindergarten teacher trainees faced the largest hardware shortages and also had the lowest skill levels, but subject teachers also lacked many basic skills. An additional problem is that technology has not been integrated into the normal study program, but becomes an additional burden on top of many other requirements.

Experimentation and new practices where ICT has been courageously applied to teacher education have been motivating and important experiences for the participants. One of their foremost merits has been the cooperation of teacher education departments and their practice schools with partners outside the university, such as local schools and local business. The projects have usually been launched through the initiative of enthusiastic individuals, and they have required relatively substantial resources for the necessary technology as well as management and coordination. Many of the projects have only become possible through the support and partnership of these outside partners.

These new practices have taught and also required a new operating culture, and this has also sometimes created problems of its own. It is not always easy to find sufficient flexibility either in the ways teaching is organized or in the teacher education curricula. At the same time, there has also been the danger that the projects and innovative practices enrich only their participants, without enabling other students or teachers to benefit from the experiences gained in the projects.

ICT IN UNIVERSITY CONTINUING EDUCATION*

University level continuing education attempts to meet the needs of working life on the basis of knowledge accumulated through scientific research. It is interesting to assess ICT use in continuing education, especially since we can assume that continuing education centers would rush out to implement any new education-supporting technology as soon as there was any scientific proof of its usefulness and any interest expressed in it by their clientele. Looking at continuing education centers would thus help us to predict general trends in ICT use. Secondly, since continuing education centers play a very central role in the further education of teachers, their influence on

*Seppo Collan (Sitra, No. 185, 1998) carried out the assessment of the continuing education centers.

the future development of the educational use of ICT could easily multiply.

The assessment is based on a questionnaire sent to the continuing education centers of universities and their sub-units. In addition, two case studies can shed additional light on ICT use in continuing education.

University Continuing Education is mainly carried out by their continuing education centers. There are close to 100,000 students participating in continuing education, and an additional 70,000 open university students. For the sake of comparison, we might add that Finnish universities have a total of about 150,000 first degree students. All Finnish adults and all organizations, from educational institutions to public societies, from associations to businesses, are potential clients of continuing education centers (Tuomi 1997).

In the 1980s, a cooperation network was formed to enable folk high schools and adult education centers to act as learning centers for university distance teaching. This development led to the present Finnish application of distance learning: multiform teaching (Collan 1997).

A significant development has been the creation of the Finnish Virtual Open University. Since 1998, each of Finland's 22 open universities has been able to provide information and tutoring services on the same website, which is now being expanded into a national vehicle for offering programs as well (http://www.suvi.fi/). This open university on the net, containing independent partners operating in a shared environment, is the only one of its kind in the world. At the same time, these independent partners, for example the open universities of Helsinki and Oulu, are adopting information networks in all of their activities, from support services to production. In other words, they are turning into virtual organizations (cf. Steinbock 1997).

The use of ICT in continuing education started in the second half of the 1980s. Training in the use of information technology applications created for work applications (the most important being educational applications) alongside ISDN-videoconferencing and information networks has brought ICT into continuing education. Work to develop new learning environments and the education necessary for using them (a 15-credit course in educational technology, a 15 credit-course in open and distance teaching and many others), pilot teach-

ing projects testing these new ideas and lastly the transfer of new practices into actual educational activities was begun simultaneously in several continuing education units (see the evaluations of the ICT Learning Centre and the teachers' in-service training project below).

Several of the continuing education centers have made the strategic decision to adopt ICT as a central element of open university teaching and further training. Some of the reasons behind this are the following:

- The challenges posed by lifelong learning, including the demands voiced by corporate clients to have access to continuing education and studies irrespective of time and place.
- Increasingly severe competition for clients, which especially through the advent of information networks has become global in scope. In many of the strategic outlines and development projects adopted by the centers, ICT is used in order to seek improved financial efficiency and higher-quality education.
- Limited expert resources. In many fields, finding new solutions was necessary in order to maximally utilize available expertise.
- The demand for educational equality. Open university teaching has traditionally utilized technology in ways making university studies possible in localities where there are no universities.

Implementation and Results of the Assessment

The assessment is based on an e-mail questionnaire sent to continuing education centers of research and arts universities in the spring of 1998, and on a couple of case studies. As questionnaires were sent to 15 universities, with 21 centers or units responding, the coverage was quite good.

Strategies. General strategic planning of activities is common in continuing education. Most of the centers who responded (15/21) have a documented general strategy, and of the remaining six, two were in the process of writing one. Half of the units have, in addition to their general strategy, separate guidelines on the use and development of ICT in their education, development and services. Surprisingly enough, a number of important so-called knowledge media units

which specifically utilize ICT nevertheless lacked a documented strategy in the area.

Available technology. The general level of ICT infrastructure was good, and in most of the units it can even be characterized as excellent. Technology is up-to-date, varied and there is enough of it, and the units are often themselves responsible for maintaining and developing it.

In practice, every employee has access to a computer that is hooked up to a network. In almost all the units, personnel can access e-mail and WWW servers from their home computers, and in nine units they can also access the local intranet. Students, in turn, have remote access to e-mail and WWW servers in half of the units, but to the local intranet in only one of them. In addition, most personnel have scanners, digital cameras, videoconferencing equipment and recordable CD-ROM players at their disposal. In addition, some of the units have data-projectors, digital videocamcorders and audio systems.

ICT Support Systems. ICT support systems at the continuing education centers are seen in the following table.

Activity	**No. of units**	
	Considerable significance	No significance
Register credits	20	1
Fiscal administration	18	3
Project budget and bookkeeping	18	3
Marketing client contacts	16	5
Centralized information management	16	5
Supporting /tutoring learning	14	7
Registration	9	12
Course evaluation/feedback	7	14
Time management	7	14
Evaluation and developing personnel skills as learning environment	3	–

Table 18: The role of ICT in the basic functions and support functions of the unit

Support for ICT use has been organized very well in the units who responded to the survey. For technical ICT support for personnel, all units but four had at least one computer support person or a person with a corresponding function. The units that did not have their own computer support person used the services of their university's computing center. In addition, many of the units also had educational technology support persons.

In more than half of the units the greatest problems in the organization of ICT were insufficient resources and time.

ICT Skills. There is a clear dichotomy in ICT skills. On the one hand, almost everyone knows how to use the basic tools, information networks, and traditional media and technologies. By contrast, only just under one in four has mastered modern media and technologies and their pedagogical use. Differences between units are considerable.

Skill Area	% of personnel
Basic tools	92
Traditional media and technologies	92
Information networks	85
Modern media and technologies	24
Educational use (distance and multiform teaching, preparing learning material, telematic learning enviroments etc.)	23
Special applications (simulations, CAI programs)	14

Table 19: Personnel ICT skills

The units saw the ability to use ICT as a very important factor for success: the mean value was 4.2 (with a maximum value of 5). Among the different ICT applications the most important were basic tools, networks and teaching applications. Traditional and modern media were also seen as important. Special applications, on the other hand, were not seen to be of any particular significance.

The importance of developing the personnel's skills in ICT was also emphasized. This was manifested by the large share of ICT in

this year's personnel training budget, with the average being about 26%. There were even three units which used as much as half of their personnel training resources for the development of ICT skills.

Skill Area	Average
Basic tools	4.81
Traditional media and technologies	4.71
Information networks	4.14
Modern media and technologies	3.95
Educational use (distance and multiform teaching, preparing learning material, telematic learning enviroments,etc.)	3.57
Special applications (simulations, CAI programs)	2.33

Table 20: The importance of different ICT applications

The use of ICT in main activities. The answers reveal that ICT use has an important part in unit activities. It is most important in support services and administration. In the actual "productive" work of the units, ICT is important in various services. In conjunction with open university teaching, vocational continuing education and product development, ICT was on the average viewed to be only "somewhat important." When it comes to product development, however, there was considerable variation in the answers. About half of the units view ICT as "extremely or very important," and the other half as "unimportant" or "almost unimportant." One interpretation of this finding is that ICT is only beginning to make its way into training and consulting services. Another possible explanation is a certain division of areas of specialization between the units.

Activity	Average
Fiscal administration	4.33
Information management	4.15
Project administration	3.65
General administration	3.62
Services	3.55
Open university teaching	3.25
Product development	3.25
Professional continuing education	3.20
Personnel management	3.10

maximum=5, extremely significant

Table 21: The importance of ICT use in the various activities of the units

Telematic learning and work environments. Twelve of the units either had or were constructing telematic classrooms or environments. Most often (in nine units) this was a well-equipped and versatile videoconferencing room, and some units had several of these. Computer labs equipped with Internet connections were also common.

At present, one or more commercial, WWW-based learning or work environments are in use in 13 of the units. Half of the units have developed their own WWW learning and working environments, and some of them utilize commercial groupware applications.

Cooperating partners and networks. For all of the units, the most important cooperating partners in the development of ICT and its applications were the subject departments and computing center of their own university, other universities, polytechnics, teleoperators, hardware manufacturers and dealers, and other companies in the field. Most units cooperated both with departments of their own university and outside businesses.

The degree of networking was not very high. Only nine units said they belonged to some national or international network. Even among

these, most only named one or two networks as being important for their work.

Product development of ICT applications and multimedia production. About half of the respondents (11/21) had a specific unit or team which specialized in the development of ICT and/or distance learning applications. The goal of product development was mostly to support the work of the unit or to develop the whole unit's operating concept with applications utilizing ICT. Another objective was to create learning, work and activity environments for other parties. The products developed were most commonly various information-network-based learning environment applications and learning materials.

More than half of the units were in some way involved in producing multimedia, which includes both network multimedia and CDROMs. It seems, however, that multimedia is only now entering continuing education. Based on the responses, there are presently six units in Finland whose most important product development area in adult education is the application of ICT to teaching, learning and other forms of activities: the Lahti Research and Training Centre of the University of Helsinki, the Centers for Continuing Education of the Universities of Oulu, Tampere and Turku, and the Lifelong Learning Institute Dipoli. In addition, the ICT Learning Centre, operating in conjunction with the Helsinki University Vantaa Institute for Continuing Education, concentrates exclusively on developing the pedagogical and didactic use of ICT.

ICT in Educational Activities. The most widely used pedagogical applications utilizing ICT in continuing education are open and distance education and contact teaching supported by the use of ICT. In nine of the units, their total share as measured by student numbers or by turnover is significant: 32-100%. More than half of the units, however, do not utilize ICT in their educational activities.

The following list shows the teaching and learning applications of ICT that are seen as the most important now and as becoming increasingly important in the future.

Areas of Application	Average (maximum 5, extremely important)	
	Now	In the future
Developing distance and multiform teaching	3.73	4.73
Linking with working life	3.65	4.56
Personnel training	3.61	4.47
Developing learning enviroments	3.58	4.50
Developing networking	3.56	4.32
Developing technical infrastructure	3.56	3.95
Developing teaching methods	3.47	4.50
Improving students skills	3.44	4.26
Developing library and information services	3.28	4.00
Participating in EU projects	2.83	3.63
Constructing learning centers	2.83	3.80

Table 22: Importance of the various areas of ICT applications

The obstacles to implementing ICT can be summarized rather simply: technical resources they have; skills and time to utilize them they have much less of.

There are dozens of projects either in progress or being planned for developing ICT use in teaching and learning. Most of them are in one way or another connected to information networks. Here are a few examples:

Digital Learning Environments, Telework and Technology, A Study of How to Do Project Work Using Information Networks, Groupware as Learning Environments, Developing the Use of Telematic Learning Environments in Teaching and Teacher Training, Information Network Instructor Training, Network Tutor, Interactivity in the Network, Virtual Open University, A Virtual Learning Environment in Small and Medium-sized Businesses, Virtual Campus, Virtual School and Virtual Office.

Case studies

We will present two different examples of important and influential projects done in the context of continuing education. The first is financed and contracted by the Finnish National Board of Education.*

The training program was planned and implemented by the University of Oulu Centre for Continuing Education, with other participants including the University's Department of Education, the Provincial Government of Oulu and representatives of local schools.

The training program was first organized in 1996-1997, and it will take place for the third time in the fall of 1998. The first training program involved about 500 teachers from Northern Finland and took place in 13 different learning centers. The second program had about 450 teachers at 15 learning centers. The third one will have 250 teachers participating.

The contracter defined the goal of the training as developing the teachers' ICT-related pedagogical skills so that they would be able to utilize new technology in their work. The Centre for Continuing Education had its own goals as well: the training would be used for developing a continuing education model which would target a large group but would take the participants' individual needs into account. Another objective was to expand a network of learning centers in northern Finland which had been formed earlier.

The training program was based on a model of so-called distributed education. There are learning centers in various localities where most of the learning takes place and which each have their own local tutor.

Education was based on the principles of project learning. It consisted of distance learning and taught participants how to utilize ICT in their teaching. Distance learning included videoconferencing lectures and independent work in a WWW-based environment. Studies tied to a time and a place included one contact teaching day at the beginning of the training and work guided by the local tutor. For independent projects and learning journals, the participants used an Internet-based environment called Project Tools for Learning (ProTo) which was developed at the University of Oulu.

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*Here, Seppo Collan, Hanna Salovaara and Sanna Järvelä assess a project done in the University of Oulu Centre for Continuing Education (see Sitra 190, 1998).

The lectures (30 hours) were transmitted to the learning centers with videoconferencing equipment. The participants also had the opportunity to view the videotaped lecture at a later time, if necessary.

The lecture topics were discussed in study circles, where teachers also practiced their practical information technology skills and discussed their projects in depth. There were 27 hours of these sessions. In addition, it was possible to receive counselling from tutors.

The participants kept a learning journal. This procedure prompted them to study according to their own objectives, as it helped them to focus on the subjects which they felt were important to them.

A teacher's project could either be a development project related to ICT or it could be work expanding on topics which had come up during the training. A favorite project was making home pages for the school where one worked. Participant portfolios containing all of their work and their learning journals were posted on the WWW.

Guidance also included peer tutoring, which was very active in some of the learning centers.

The project planners felt the greatest challenge was to create and maintain the tutor network and to mediate the shared goals to the tutors coming from different backgrounds and working in different localities. A well-functioning tutoring system was indeed crucial for the success of the training.

In the future, learning independently of time and place will function even better. The plan is to transmit some of the lectures through a so-called video-on-demand system. The project planners believe that in about five years the entire learning environment will be based on information networks, although the system of local tutoring will remain.

Challenges for further development are mostly related to a clearer definition of objectives and the development of contents and practices corresponding to them. Self-evaluation has not extended to the participants' learning process or to the effects of the training. From the viewpoint of future development, this would be essential. However, the National Board of Education has not supported this type of assessment or development work.

The model of distributed education proved to function well. Long distances meant that distance teaching was an economical and practical way to provide expert teaching. The training project brought a training network to northern Finland, where various localities have learning cen-

ters, local tutors and experts. Cooperation between the various partners has helped to develop the training model.

Without distance learning technology it would not have been possible to organize training for such a large group of teachers working in different localities. However, technology had such a dominant role in the project that it took attention away from the actual content of the education, the pedagogy connected to ICT. In the future, technology should be subordinated, becoming a more "transparent" part of the structures supporting learning.

Also, the project did not focus closely enough on actual teaching practices in the schools. In the future, participants should work together more closely to evaluate and develop each others' ideas and projects, for example in the work of the study circles. The presentation of concrete applications suitable for school use, and a more clear introduction of model pedagogical applications would enrich the contents of the training and provide teachers with proven models.

Project learning requires that participants familiarize themselves with the working method, and this meant that a large proportion of the tutoring resources were used for guiding the independent work of the participants. The working methods of multiform learning were new to the participants. Project learning enabled the training of a large group while taking into account the individual goals of each participant in their project works and learning journals. Multiform learning is well-suited to the training of adult learners who are both working and studying. These studies also required technological resources: this was a limitation for some, but it also prompted others to acquire machines for their schools.

The tutors were faced with a number of challenges: the large size of the learner groups, the learners' varying skills at the outset of the training, and maintaining the motivation of teachers who were participating in the training in addition to their own work. Study circle work was separately planned and implemented by each learning center, and experiences with tutoring consequently also varied. Successful peer tutoring enabled the utilization of the participants' own expertise and thus eased the workload of the actual tutors.

It proved difficult to ensure that videoconferenced lectures would allow for interaction between the participants and lecturers. Active participation of the participants should be encouraged and supported, and they should be provided with the opportunity to ask questions and present

comments. On the other hand, it is also true that lectures are mainly designed to provide expert information, and so discussions could take place immediately after the lecture. On that occasion, teachers did not have a discussion during the videoconference, but their journals contained a lot of reflection on the lectures.

The project topics were mostly practical, such as planning teaching or making home pages for one's school. Many of the projects lacked a pedagogical perspective, although it had been a stated objective. Reporting was also often a mere description of what had been taking place or how the person's project had progressed. The teachers should therefore be encouraged to include a clearer personal pedagogical perspective and framework into their project, and then reflect upon that in their reports. This would lead to an improved integration of theory and practice.

For some of the participants, writing a learning journal was a new concept. Many did not use their journals to reflect upon their experiences as they went through the project, as a large percentage only wrote their entire journals at the very end. Some of the participants had misgivings about publicly presenting their own thoughts. Very few members read and commented on each others' journals, as they clearly were not used to doing such a thing. Thus the discussion channel provided by ProTo was hardly used at all for collaborative knowledge construction, and genuine network-based interaction did not emerge. A challenge for the further development of the training is to find ways to utilize the discussion environment more efficiently and to make discussion a more integral part of the training as a whole.

Seventy-five percent of the participants completed the first and 89% completed the second training program. The most significant difference was in their lengths: the first training program took an entire academic year, whereas the second only a semester. Other reasons the second training was more successful were that the participants had better prior knowledge of its contents, it partly took place during working hours, and the participants' employers had already committed to the training by the time of registration.

Another proof of the training program's success is that already 250 teachers have registered for a 10-credit continuation course they will have to pay for themselves.

At some schools, ICT use increased dramatically after their teachers participated in the training. New projects, for example, have been im-

plemented. The training also led to cooperation between teachers and schools. The discussion channels, which were otherwise utilized very little, were being used to make contacts with colleagues. Some schools also made shared home pages.

The project's most essential achievement has been the development of a distributed education model based on multiform and distance teaching. Factors promoting the implementation of the training include the use of teamwork in the planning process, the utilization of experts in various fields and close networking in the area of northern Finland. The training model is especially suited to initial training in information technology, as it enables transmitting the contents to a large number of participants.

In the future, individual project work by teachers will have to be guided to become more school-specific entities which include a pedagogical perspective and which can remain in use as models of the pedagogical applications of ICT. The training program has to be developed to form part of a more continuous process of further training for teachers.

Our next example examines the role of university continuing education in promoting the pedagogical use of ICT. Here, we present Matti Sinko's report on one unit, the IT Centre for Schools. Although its history makes it in some sense a special case, this example nevertheless helps us understand the conditions and dynamics governing centers of continuing education (see Sitra 190, 1998).

The IT Centre for Schools (http://www.hyvan.helsinki.fi.kttk/), operated jointly by the Helsinki University Vantaa Institute for Continuing Education and the then Centre for Continuing Education (now the Lifelong Learning Institute Dipoli) at the Helsinki University of Technology, was founded in 1989 to promote the adoption of information technology in schools. Although the center was a pioneer in Finland, dozens of similar units were established in different parts of the world at the time.

The idea behind the Centre was that establishing information technology as part of schoolwork would require a specialized continuing education and development unit in Finland as well.

The National Board of Education did not fully agree with this view, and the implementation was thus left to the cities of Vantaa and Espoo.

These two cities have consistently helped to fund the Centre and have taken it into account in their own strategies. In recent years, the city of Helsinki has also begun to utilize the Centre's development and research know-how a great deal. In practice, however, the National Board of Education has all along commissioned specific educational and development projects. Much commissioned work and funding has also come from the Nordic Council of Ministers and more recently from the EU as well. The Centre's activities are therefore funded through projects and course fees.

Work at the Centre was started in four areas.

First, a 15-credit study module designed to qualify participants as teachers of information technology was planned. The result was 10 training programs by the end of the decade, training over 200 people—more than one fifth of the entire country's needs.

The second sector was organizing courses. The center organized many short courses for teachers of various subjects on the topic of computer-assisted instruction (CAI). The aim was to combine so-called CAI pedagogics and the teaching of practical computer skills. Soon thereafter, the perspectives of different subject areas began to be integrated into courses directed at specific schools or subject areas.

The third area was training in the design of CAI programs and providing follow-up consulting. It was also considered necessary to produce and supply printed and digital material. Teachers could also visit and take a look at the programs and learning material at other times besides during the courses.

A fourth goal was to encourage continuity and depth by developing a system of sabbatical teachers, which allowed about a dozen teachers to take a leave of absence from their work for one or two semesters and join the Centre's staff. The goal was that once they returned to their schools they could work to further develop the educational use of ICT both in their own schools and beyond. This has indeed happened.

Almost from the very beginning, Swedish-speaking teachers and schools were offered training services in their native language.

A lesson learned in the early years of the training programs was that despite all the work, very little actually happened in the schools outside of the IT lessons and computer labs. Also, computer-assisted instruction tied to teaching software hardly led anywhere, though offering instruction on using and designing teaching software increased the informa-

tion technology skills and insight of many of the participants. They also began to find support for their schoolwork and its development gradually in general purpose software.

In the early 1990s, the main idea was that information technology skills were most appropriately learned in addition to other studies. The center started organizing school-specific development projects supported by research. An increasingly large proportion of the training became tailored to the situation and needs of the educational institutions receiving it. Two projects, Utopia and Vocational Utopia, were also carried out; they were oriented towards the networking of educational institutions and the challenges presented by communication based on information technology. Later, two other projects based on laptop computers—"Laptop in the Rucksack" and "Distance School Desk"—were also conceived and implemented. The most extensive research project is the "Helsinki Project 1996-2001," an ICT implementation project for schools in Helsinki.

We learned that development work with an individual school rarely leads to good results unless outside support is also provided, and that this support was most naturally organized through networking within the framework of the project. The Centre tried to become a point of intersection for these various networks where one could find various kinds of support. The aim was also to widen the scope of the support services. Examples of this were the successful efforts to launch a national educational IT journal, the Journal of Teaching Technology (OTE).

An important strategic task for the Centre has been its acting as a link between Finnish and international know-how. Already early on, it established and maintained contacts with pioneers in the field, especially in England and the other Nordic countries. Among the organizational contacts, the International Federation for Information Processing (IFIP) has been the most important. For many clients the international contacts have provided high-quality excursions abroad and access to training organized for international experts in the field. The staff have more opportunities for training abroad, and these have increased the Centre's know-how. These experiences and the networks created had another positive effect, which was to make it easier to adopt to the EU project culture which came when Finland joined the EU.

Although the CAI programs did not pick up steam despite wide-ranging Nordic development cooperation and exchange of programs,

the training connected with them helped the participants develop their pedagogical ICT skills and helped the Centre to embark on the important work of training people in the production and assessment of multimedia learning material. The center's activity in various national and international learning material contests has also served the development of multimedia.

The largest assignment from the National Board of Education is the currently ongoing "Information Society" teacher training program. The Centre's role has been the training of over 600 teachers. The program's large scope has forced the center to make its training extremely efficient. A central prerequisite was learning a well-functioning combination of distance tutoring and contact teaching, as it has been necessary to minimize the amount of contact teaching.

The Centre has launched a couple of important new initiatives outside of the school world as well. The most important one has been the information technology workshop for young people at risk of becoming marginalized. This workshop was implemented in cooperation with the EU Social Fund, the greater Helsinki area municipalities and the Finnish Information Processing Association. At present there are three active workshops, each with 2030 young people participating for a period of six months. The objective is to help as many of them as possible get a jump up on their educational or working career. The participants are being trained in the professional use of ICT, and they learn by doing; work has been created by offering services to schools, organizations, businesses and private citizens. Their tutors have also been recruited from among the unemployed. This originally Danish idea seems to have taken root in our local city culture very well. Through this project the Centre has attempted to take responsibility for those who are being marginalized from the mainstream of the information society.

Another group which easily drifts into the margins of the information society are senior citizens. For a few years, the Centre, in cooperation with its supporters, has been running a project which has opened the way into the world of multimedia and the Internet for many senior citizens.

Another extension of activities partially beyond the scope of the school world has been the children's virtual library project, CHILIAS. This project was part of the EU Telematics Applications for Libraries program. The project developed the "Info Planet," an informal multinational learning environment for children. In addition, a package of learn-

ing materials will be produced to improve the children's information and library skills, and to provide resources for their school and recreational activities both at school, at home and in libraries. (See http://www.infoplaneetta.hyvan.helsinki.fi.)

We can summarize the Centre's activities as follows: The core clientele has consisted of general education institutions and their teachers. By training teachers, the Centre has quite consistently been working to create the prerequisites necessary for the wide utilization of ICT in educational institutions. Training activities have been based on years of long-term cooperation with teachers, educational institutions, local municipalities and the National Board of Education. The result has been training which is varied, modular and tailored to the client's needs. An annual training capacity of around 1,000 teachers is also quantitatively significant in a country like Finland. The effects of the training have been significantly increased by the fact that most of the clients have been able to participate in the training again and again over the years as their needs keep increasing and changing.

The comprehensive and varied educational provision has been based on an accurate knowledge of the clientele's needs and joint planning, on the one hand, and on a familiarity with the possibilities inherent in the field, on the other. The Centre has had an especially important role in the information technology strategy of the greater Helsinki area local educational authorities. By using school-specific training and development projects, it has been possible to aim at very specific changes in the operation of the school. It would be good, however, if more municipalities would take advantage of the Centre's services.

The Centre has offered and continues to offer training programs of national significance, such as training in the design and assessment of CAI programs and multimedia and network-based learning material.

At present, all the Centre's training programs are implemented as open and distance learning, based nevertheless on a strong tradition of contact teaching.

Growth in the supply of learning materials as well as changes in the nature and distribution of these materials present the Centre with new challenges, as it needs to support the users, intermediaries and producers of this material.

The proportion of development and research projects in the Centre's activities has grown decisively. These projects have brought new infor-

mation about appropriate applications of new technologies to teaching. Through the training activities it has also been possible to apply this knowledge more widely. The success of the research and development activities is weakened by their close ties to projects: resources are sought for a specific project and they, as well as the new knowledge and skills acquired through the project, vanish from the Centre unless the people involved can be linked to new projects. Living from project to project forces people to spend too much energy constantly hunting for new projects. Thus both the successful implementation of new know-how and reaping its benefits are often compromised when new projects take precedence.

For a further training and development center working mainly with schools, being dependent on paid services makes it difficult to operate. Nearly all our energy goes into keeping the training programs and projects running, and whatever money is available needs to be spent on constantly updating outdated technology. This has, among other things, led to a situation where the personnel do not seek enough further training for themselves. In the long haul, constructing its own research program would enhance the Centre's development.

On the other hand, the independent status of continuing education within the university organization has enabled it to react quickly and to seek flexible solutions, both of which are made necessary by the rapid advance of new technologies.

Both quality consciousness and quality control at the Centre have advanced as its activities have spread and funding for them has become harder to get. Despite stiffening competition, the Centre has succeeded very well, although continuous evaluation of its own activities and quality assurance could be made even more efficient. The Centre should therefore improve its self-assessment procedures. The need for continuous assessment is further emphasized by the fact that in less than a decade the IT Centre for Schools has grown from two workers into a further training and development unit with nearly 30 full-time employees.

6 THE PERSPECTIVE OF LIFELONG LEARNING*

The development of ICT is profoundly influencing all of modern society: social and political life, work and leisuretime activities and education. The old Finnish adage "you never stop learning" has taken on entirely new meanings in an age characterized by explosive developments in information technology. Expertise and competence must be constantly maintained and developed. In this section we look at the significance of ICT in the context of lifelong learning and the educational services and learning opportunities offered by technology outside of the school system. The field of lifelong learning is too wide to be assessed through extensive surveys, so we use typical case studies to try to outline the possibilities offered by ICT for supporting learning and helping individuals to control their lives more generally at various stages of their lives and in various situations. These case studies help us not only to see the present situation but also to predict future trends.

We focus our survey on three areas: 1) homes, 2) leisure-time learning opportunities outside of the home and 3) work-related training. The discussion will also be organized according to different age levels.

The National Strategy for Lifelong Learning states that social policy has too often viewed educational policy (which traditionally only deals with education organized by educational institutions) as the only area which influences learning. However, the effects of labor market, economic and social policies on people's learning can be very substantial. We should therefore be able to widen the perspective of educational policy so that it promotes learning more holistically . The strategy also notes that the activities of nongovernmental organizations should be developed, and work-related learning opportunities should be expanded. The possibilities offered by information tech-

**This section is based on the report by Irene Hein (Sitra, No. 192, 1998).*

nology should be utilized to create new kinds of learning environments. The strategy also recommends changes in instruction and in learning practices at schools to better correspond to genuine learning situations in real life.

There is a high degree of unanimity about the necessity of including basic information society skills among the basic civic skills. These could include, for example, the basic skills of finding and managing information, using computer technology and communicating through networks.

In practice, it is no longer possible to "opt out" of ICT, as it is already so ubiquitous and integrated into all other technologies. It is possible to refrain from buying a home computer and getting an Internet connection, as many people (willingly or unwillingly) do. But a home Internet connection is just one of the gates or interfaces to the extensive technology embedded in all other forms of everyday life, enabling it to run more smoothly. By striving for the general education and culture required by information technology, we can also address the beliefs and fears some of them unfounded which are connected with ICT. This will also help us to assess the threats and possibilities more realistically.

The relationship between ICT and gaining control over one's life can be looked at from two perspectives. On the one hand, increasing technological complexity and the explosive increase of information might alienate many people and make it more difficult for individuals to control their lives. On the other hand, ICT affords people opportunities for improving or regaining control over their lives.

ICT AS A HOME LEARNING AID

People have always studied at home. Young children, schoolchildren and students devote a relatively large proportion of the time they spend at home to studying, and studying is also not uncommon for both younger and older adults. Interviews conducted by Statistics Finland reveal that traditional sources of information, such as newspapers and magazines, books, radio, television, text television, video and telephone still have a dominant role as sources of information and means

of communication when compared with computers and the Internet. Nevertheless, people increasingly study information technology, and they use ICT to study other things in their own homes.

The same survey found that 32% of Finnish households had their own computer in 1996. Thirteen percent of households were connected to the Internet. We are probably not far off if we predict that by the time this book is published there will be a computer in 40% of all households and that about half of them will also have an Internet connection, meaning that about a fifth of all households will be connected. This prediction is further supported by the purchasing intentions of the people interviewed. The decision to buy a computer might also be positively influenced by initiatives such as the computer purchasing campaign declared in June 1998 by Finland's largest trade organization.

Families with children are more likely to have a computer than families on average. Children are also so direct and social that not having a computer at home does not present a great obstacle to using one. They can always go visit a neighbor who has a computer or go to the library, and more and more it is becoming possible to work or play with computers at school after school hours (Tuominen, 1997).

The same survey also showed that nearly every Finn in the 10-30 age group has at least some opportunity to use a computer and the skills to do so. From the data we can also deduce that among this age group about 22% reported using home computers for studying at least on a weekly basis. Most active in this respect were students and those who had just entered work. Also, people 30-39 years of age quite often utilized home computers for studying. People older than that used home PCs for studying and other activities much less. Children mainly played games with computers. Thus far, Internet use had significantly spread only among young men.

Regardless of their income level, young families consider the acquisition of a home computer important at least by the time their children have reached school age. It seems that with respect to using computers at home, age and gender are more important factors than wealth. Computer use at home in families with children has already often reached the stage where more and more families have several computers. Access to computers outside of school is so commonplace that it should be taken into account by schools as well.

In all age groups males use information technology at home more than females, and feel themselves to be more competent at it. On the other hand, among the older generations, especially among the men, there are plenty of those who have difficulties controlling the keyboard and the mouse. For learning computer skills, the home is an important place and family members are important teachers for each other. Nevertheless, the use of computers at workplaces has markedly increased the possibilities of women and the middle-aged to use computers. According to Nurmela (1998), the information technology skills usually acquired through work are so limited that they do not suffice to ensure that home use will spread beyond the circle of young men.

There are also great regional differences in the extent to which computers are used at home. In the Helsinki metropolitan area, as well as in other urban areas, home use of computers is much more extensive than in remote rural areas. Similarly, the role of workplaces in equalizing skills and access does not seem to work as well in remote areas as in the cities.

In general, Finns have relatively positive attitudes and little fear of new technologies and the information society. However, it is more common for rural youth to say that they have been excluded from the information society. If we apply Moore's curve (p. 230) to the Finns, we might see about one in five belong to the late majority or even to the laggards.

In the information society, as in all societies, people do not live, act and study only at home or at school. Workplaces and professional communities, social and political life as well as leisure activities are also important environments where people act and learn. The influence of digital technology and information networks on these areas of life is also changing significantly.

ICT IN PUBLIC LIBRARIES*

At the end of 1997, about 80% of public libraries used the Internet as a tool for their staff. Clients had access to the Internet in nearly two libraries out of three, and networking continues to progress rapidly. The latest survey published in the fall of 1998 indicates that clients already have access to the Internet in 80% of public libraries. The Internet link intended for clients usually contains at least WWW search engines and browsing. Compared to the actual demand, there are totally insufficient numbers of client terminals, and people must normally wait to use the terminals. Another bottleneck is that library staff do not have enough time to become familiar with using this technology and to advise and train the clients. A possible obstacle is also the firewalls of the municipal intranets and the lack of efficient connections (Verho 1997).

In 1996, only 8% of library collections were in electronic format. This material consists of music, audio books, language courses, movies and multimedia. However, at that time already one-fifth of all library loans involved electronic materials (Verho 1997).

In the Fall of 1996, a questionnaire was sent to public library staff, and those who answered it considered the following to be the greatest benefits of using the Internet:

1. searching for expert information, 78% of the respondents
2. ensuring equality for all clients in obtaining the information they need, 76%
3. improving the library's image, 74%
4. communication, 63%
5. information searches by clients themselves, 62%
6. searching and loaning from libraries at distance, 54%
7. library publicity, 50%

The following list shows the Internet interests of public library clients in Helsinki:

**This section is based on material gathered by Markku Juusola (Sitra, No. 192, 1998).*

	Average% for libraries in Helsinki
Searching for information	84
Contacts and communication	63
WWW browsing	59
Following current events	41
Entertainment	32
Searching databases	32
Following newsgroups	22
Real-time conversation (IRC)	22
Games	9
Shopping	7

Table 23. Interests of Internet users at Helsinki public libraries (adapted from Rannikko and Seittenranta 1997)

A majority (79%) of those who had been searching for information said that they had done it for their hobbies or freetime activities.

For the time being, traditional information channels reach out to more clients—but on the other hand, through the Internet the libraries reach clients who otherwise would hardly use public libraries at all.

There are also good examples of increasing cooperation between libraries through information networks.

Benefits and problems of searching for information on the Internet in public libraries

Library staff generally held that the greatest problem related to finding information on the Internet is the limited existence and poor quality of bibliographic descriptions of net material, or, in other words, of metadata. By the beginning of the next decade, when information networks will contain at least an order of magnitude more informa-

tion than at present, we will need much better indexing and annotation of net materials in order to perform efficient and accurate searches (Hakala & Hormia 1997). This need has been taken into account in the Link Library maintained collectively by the public libraries; it includes metadata about all the included links.

A survey conducted on the use of the Internet at libraries among library staff identified the following key problems:

1. shortage of time, which 87% of the respondents considered as causing quite a lot or a lot of problems in using the Internet
2. insufficient skills, 68%. Only 8% of the respondents considered their own skills to be sufficient.
3. technical problems, 57%.

Surprisingly, less problems were associated with money (41%) and with organizing training (34%). Thirteen percent of the libraries reported no problems relating to financial resources, and organizing training had been unproblematic in one out of four libraries responding to the survey.

A PAID OR A FREE SERVICE – AN UNCENSORED OR A CENSORED INTERNET CONNECTION?

Providing services free of charge has been a founding principle of libraries. There has been a general consensus against the idea of having libraries charge for their use. However, being connected to the Internet and utilizing it more and more widely costs money.

In the new library law, the organization of library and information services has been made the responsibility of municipalities. The law states that municipalities have to provide sufficient staff and up-to-date materials and hardware for their library services. The municipalities are themselves responsible for assessing the library and information services they provide. Using the library collections inside the library and borrowing them are free of charge under the new law.

At present, Internet user fees are charged only in rare cases and are very small. It seems that in over 90% of the libraries no fees are charged. The highest fee—3 Ecus per hour—is charged in two rural municipalities. According to the National Library Association, it is

likely that Internet services will not remain free of charge in the future and that individual libraries will not continue to provide free commercial network services. Some libraries see fees as a way of limiting use to only the essentials (Hintikka 1998, p.100).

That libraries would be totally free of charge is not to be taken for granted. At present, different European countries have different practices. Sometimes patrons have to pay for a library card, and in other cases there is a fee for loaning certain types of materials (videos, music). In all countries there are late fines and fees for reserving material, as well as other corresponding fees.

Fees, and specifically loan fees, seem to have the primary effect of steering library use in certain directions. In many countries, Finland included, there is a debate going on over free versus paid use of library catalog information, especially national bibliographies. Critics view it as unreasonable to charge fees for this information, as it has been produced by tax revenues and can be seen as cultural heritage belonging to all (Haavisto 1997).

Only a few libraries use filters for regulating Internet use in children's departments, and these have proven difficult to use. In discussions by the library staff, censorship has generally not been considered necessary.

The experiences of libraries concerning the use of "nonacceptable" Internet pages reflect the cultures of different countries. In the Nordic countries, the positive aspects of Internet material have been seen to be so great that the few excesses which have come to light have not created a wish to exercise control. In some countries, the free library use of the Internet has been questioned and there has been a willingness to use filtering software (Haavisto 1997). [See also pages 217-219].

Future visions

In 1996, Kristiina Hormia-Poutanen outlined future visions of library and information services in her survey of the present conditions and future plans of public libraries. These visions were related to new forms of learning, new learning methods, new views about learners and teachers, and new ideas about learning material and electronic information products. Libraries will be developed into learning centers

where students have extensive computer hardware, information searching facilities, printed and electronic information resources, workspaces and expert guidance and information services at their disposal (Hormia-Poutanen 1996).

Case Study 1: Kangasala

Many groups have been taught the basics of surfing the Internet and searching for information. Those visiting the library in order to be introduced to the Internet have included school classes (lower and upper-level comprehensive school), women's groups, retirees, and adults in general. Several Internet tutoring sessions have been organized specifically for immigrants. In general, the library has relatively little to offer these patrons, but through the Internet they have the possibility to follow events in their home countries in their mother tongue. The library home pages contain lists of links for locally residing immigrants with different mother tongues.

Case Study 2: "Flexible Studying in Information Networks," Forssa:

For students engaged in long-term studies using CD-ROM and Internet material, the library offers a research room equipped with computer hardware and network connections. An essential feature of this service is that students can come to the library when they need to and reserve study times according to their own schedule, even during the weekend.

User times resemble those of a reading room, but are much more flexible. In the research room it is also possible to practice using interactive software, for example language pronunciation drills, without bothering or being bothered by anyone. Thus far the research room has been used for studying Internet use, finding material for a thesis on catering services, and for studying English, German, Spanish, Italian and the rudiments of Greek. There are also Finnish courses for foreigners available, and these have also been used.

A nominal fee is charged for the service, which is comparable to rents commonly charged for research rooms.

Case Study 3: the Hämeenlinna City Library

The adult section of the Hämeenlinna City Library has three microcomputers (time limit two hours/person) and three microcomputers for

young people (time limit one hour/person). There is a continuous line for the machines. About 40% of the users are female, and 90% are students. No e-mail accounts are provided for library patrons, but the link library has pointers to free e-mail services.

The library has compiled a popular link library which gets an average of 4,000 registered visits each day. The most popular page is on doing a job search.

Based on these randomly chosen examples, we may conclude Juha Hakala's and Kristiina Hormia-Poutanen's visions of the future of libraries are slowly becoming a reality. They have recommended that Finnish libraries must embrace the operating principles of the powerfully developing network environment and the new opportunities it offers. Collaborative solutions which go further than what has previously been customary must be considered, and appropriate conclusions should be drawn from the fact that it makes little sense to produce in more than one place a service intended for common use in the network environment. In the network environment, being self-sufficient is not a virtue, and it might not even be sensible to have all the needed services established in one's own country, as the network makes it possible to use them from elsewhere and pay only for their use (Hakala & Hormia 1997).

Library staff have surprisingly quickly and easily been able to redefine their own professional profile and the whole field of library services to take into account the fact that libraries are becoming connected to the information network. Networking and cooperation have found new forms which fall naturally into the professional role of the libraries and librarians.

Differences between various library client groups are clearly visible. Especially for some young people, information technology is a part of their everyday experience, their social circles, studies, work and communality. The middle-aged and the elderly use Internet connections at libraries considerably less often because they have had negative experiences or have prejudices against the technology and software.

Librarians have easily adopted the new information search tools, although there is never enough time for training. Libraries already play an important role in spreading network literacy, but they could

do so even more effectively if librarians could relinquish some of their other duties in order to guide and serve Internet users.

Both librarians and library patrons considered it of utmost importance that libraries provide free access to the Internet. Especially the older generations need encouragement and help in order to start taking advantage of it.

It would seem justified to agree with those who argue that libraries should offer as much free use of the Internet as possible. If, however, we need to define areas of paid use and paid materials, we must have a continuous discussion about how to maintain a reasonable balance between the interests of authors and copyright holders on the one hand, and the user's right to free access of information on the other, as the amount of digital material continues to grow.

The role of liberal adult education

In principle, the Internet offers unlimited potential for educational use. The field of liberal adult education has an illustrious tradition in offering distance learning. Now it has taken radical steps to modernize this teaching, for instance through the Internetix project. Finland's Freenet has been another pioneer in the field.

Internetix (http://www.internetix.ofw.fi) is an open-access learning environment. Internetix material can be used for studying, self-instruction, distance learning, teaching, in-service training, in networking and for information searching. Internetix produces learning material and learning services suitable for varied learning needs for the Internet. A parallel goal is to develop the media literacy of the users and to provide them with the skills necessary for systematic distance learning.

Internetix functions in cooperation with educational institutions and educational organizations, and its goal is also to serve the needs of working life and in-service training. A vast number of subjects are offered on Internetix, including computer science, new media, communication, environmental subjects, entrepreneurial skills, natural sciences, women's history, Finno-Ugric beliefs and religions, etc. Study modules in tourism, methodology, futurology and entrepreneurship have been produced in cooperation with universities.

Anyone can use Internetix services according to their own interests, but one can also earn credit for completing a specific course, for example an upper secondary school course.

If a student wishes to get credit for a specific course, an assessment fee will be charged which pays for tutoring, assessment, feedback and a certificate.

When evaluating the education they received from the Internetix, the students bring up some of the same issues as is generally the case with distance learning; for example, they express the wish for contact teaching and also for quicker feedback. Feedback from a teacher seems to be very important for the students to experience their studying as meaningful.

The students at the Internetix Campus reported that they had chosen this learning route precisely because it is independent of time and place.

Freenet (http://www.freenet.hut.fi) is a free Internet e-mail and educational service for schoolchildren, teachers and parents. Students can keep a Freenet e-mail user id active after graduating from school, and in this respect the system differs from e-mail addresses provided by universities and educational institutions. At present, about 70,000 people have a Freenet id. Even municipalities networking their schools often suggest that their teachers and students get a Freenet user-id. Each day approximately 10,000 people log onto Freenet, and its WWW educational service attracts about 20,000 hits daily.

Freenet was launched in 1993 as a cooperative effort of the Ministry of Education, Sitra and the Helsinki University of Technology. At present, this information network service for schools is being maintained by three people. The present funding structure seems untenable in the long run.

From the start, one goal of Freenet has been to provide an equal opportunity for active learning to all, and thus to work to prevent social inequality and to increase interaction between various generations. Freenet also strives to be a forum for lifelong learning. Another objective is to develop a so-called virtual school, where it will be possible to carry out comprehensive school studies as distance learning.

Other providers of education on the Internet offer education similar to that provided by distance upper secondary schools and open universities.

Virtual school and virtual university projects in Finland might gradually develop into tools for lifelong learning as BioMedNet (see pp. 194) has for researchers in that field. In principle, they clearly attempt to fulfill one of the basic functions of electronic communities, which is filtering information pertinent to the needs of a particular target group from the immense supply of information available. However, virtual schools are not without their problems, including a lack of cohesion and commitment. It is important to bear in mind that no electronic community can replace genuine social contacts and that the examples of distance learning in this project have revealed the need for a lot of personal tutoring and contact teaching.

Projects targeting senior citizens

Equality in an information society demands that there are opportunities for learning ICT skills at all ages. At present, 15% of the population in Finland is over the age of 65, by 2015 their proportion will be up to about 20%, and by 2030 they will already amount to one quarter of the population. About 80% of people over the age of 65 have never had anything to do with information technology. If they do not receive any education in information technology, many of them will not be able to use any of the services based on it.

Although lifelong learning has been part of official rhetoric for some years, the needs of educating senior citizens have been overlooked in government actions. Volunteer activity has tried to meet these needs, and participants themselves have also paid for some services. Adult education centers, university centers for continuing education, open universities and summer universities are involved with teaching ICT skills to senior citizens. Compared to the demand, however, the available learning opportunities are insufficient. Senior citizens are often not able to afford the educational expenses, let alone to acquire machines and Internet connections for themselves.

From the perspective of lifelong learning, it is important that educational participation through the Internet continue to expand. This would also allow senior citizens to offer their expertise in their own fields to younger students alongside their own studying. Active information technology use by senior citizens is also apt to maintain their mental agility.

Regional and local networking projects

For some years, many municipalities have been engaged not only in building information networks but also in developing municipal Internet information services and means for residents to influence local decision-making processes. Strategic information technology planning has been utilized in order to achieve a balance between technology and services.

We shall take a brief look at the ways information networks can help people acquire information and control their lives, i.e. promote their ability to learn in a wider sense. Here we will examine one local information network project which has its roots in the so-called telecottage projects of the late 1980s.

In 1997, the Ministry of the Interior launched an extensive development project which involves several dozen municipal projects. The objective of this so-called participation project is to increase opportunities for citizens to influence local decision making, as well as to increase the openness and transparency of local administrations. ICT has an important role in many of the sub-projects. The project starts from the idea that the municipality is a central agent of civic society and that a community is responsible for its own well-being.

In some areas—for example in Helsinki—the recession, prolonged mass unemployment and the rapid growth of immigrant populations have increased the number of marginalized people and have aggravated social problems. In order to rectify the situation, new technology will be used for providing information, for facilitating local participation and for developing services intended for the disabled and the elderly. Some of the projects active in Helsinki include the Kirjakaapeli Library, which is an innovative cooperative venture by the City Library and the Centre for Cultural Affairs which operates in a recently renovated building in downtown Helsinki. It was the first public library in the world on the Internet. We will here give an example of one local project, called "Pihlajisto Home Street."

Pihlajisto Home Street was designed as a pilot project which would research and develop new channels enabling ordinary citizens to increase their influence in matters relevant to them and to find the information they need. The project plan states the following:

- The objective is to activate and support citizens' activities in their own environment and thus to create a sense of participation and belonging as part of their urban identity.
- Efforts will be made to promote the residents' own initiative in improving their urban neighborhoods. Opportunities for resident participation, dialogue and interaction between various parties will be increased.
- Problems related to the management and useability of information relating to different districts of the city will be solved from the resident's perspective. Where does one obtain information? How could it be made accessible to all in as simple and effective a way as possible?
- The objective is to create a tool which serves the development of the urban environment and which helps residents tell about changes taking place in their environment and address their suggestions for improvements to the responsible parties.

Funding has been obtained from several different sources including the cities of Helsinki, Vantaa and Espoo, The Association for the Finnish Local Authorities, the Ministry of the Environment, the Ministry of Education, and the Ministry of the Interior.

The most important objective is to strengthen the role of residents in developing their own living environment. The project leaders are architects who are especially interested in changes in the built environment and their influence on the everyday life of the area's residents. City administrations have also begun to notice the growing need for interaction between administrators and citizens.

A starting point for the project has been the view that the Internet will develop into an information channel that all will be able to access once the new technologies have become fully established. The project has created a home page for the Pihlajisto area, which, in addition to information, also contains forums through which the residents can make comments on matters, ask questions and present suggestions for improving their neighborhood directly to various parties, such as building management companies, urban neighborhood workers, and the architect at the city planning office who is responsible for the area. The Pihlajisto home page contains two different kinds of interactive pages:

- An internal and automatically updated discussion forum for the area, in which residents can engage in dialogues on all local matters that interest them. In addition, these pages will have a classified bulletin-board based on e-mail.
- A forum called Improve Pihlajisto, which is a link to city administrators. Questions and comments are routed to city administrators and planners who are committed to answer questions coming under their administrative area within a certain period of time. Both the questions and the answers are available for all to read.

As very few people in the neighborhood have their own Internet connections, an effort will be made to arrange for places where a computer is available for free use. In Pihlaljisto, the most natural place is the clubroom of the neighborhood association. Some funding has been used to get an Internet connection for the clubroom. Other suitable places for Internet workstations would be the neighborhood youth activity center, schools and the local pharmacy.

The Home Street project has identified the following areas that need to be developed:

- Producing material and maintaining the service: it is essential that content material is produced in cooperation with the neighborhood residents, local organizations and businesses and is based on the needs of the residents. Those designing the home pages should combine the talents of an editor and a researcher and possess leadership qualities. People from the outside who have launched the project cannot act as its leaders for long, and some neighborhood organization (club, association, or a group of active individuals) should assume responsibility for updating the home pages and coordinating new material.
- Technology and its availability: The first thing to do is to choose the Internet provider. Projects like this should involve someone who has adequate information technology skills and can use various software applications. At present, only a few people have an Internet connection from home. Therefore places need to be found where Internet access can be available to all residents: youth activity spaces, resident clubrooms, waiting rooms of pharmacies and health centers, libraries, grocery stores, daycare centers, schools, church premises, etc.

- Guidance in using the Internet and becoming familiar with it: It is essential that the neighborhood residents be trained to use the system and that guidance is continuously available. Guidance requires both a tutor and a space where the computer is located. Internet courses could be organized in area schools, for example, whose computer classrooms are available in the evenings. By making available interesting material related to one's own living environment, the courses could help to reduce the prejudices people have towards new technology and improve their possibilities for familiarizing themselves with it.
- Expandability: The Home Street pilot project is a useful model which could find applications elsewhere as well. Local businesses and organizations can join in the network with their own service pages. In the future, urban neighborhood home pages will form a network of home pages which will provide residents with a new perspective on their home city and neighboring areas.

7 INFORMATION NETWORKS AND DIGITAL LEARNING MATERIAL*

In ICT, the educational sector is not the engine of commercial utilization, and critical mass for applications is achieved elsewhere. When technological innovations become affordable, their adoption into wider use is largely determined by social innovations, or in other words, by whether marketing can create the demand for the new technology. From the viewpoint of teaching and learning, the integration of ICT has brought about three inventions which might prove to be social innovations in this respect. Lehtiö (1998) calls these the electronic book, the electronic marketplace and the electronic community.

The terms electronic, digital, computer-based or network-based learning material, which have been used elsewhere in this book, mean more or less the same thing. We also speak about network or web services or web communication, often meaning almost the same as what is meant by Lehtiö's electronic marketplace and electronic communities. In the following section, however, we shall use Lehtiö's terminology.

The fact that electronic books, marketplaces and communities all utilize Internet technology has many implications. For example, an electronic community might exist in order to publish a certain electronic book. Its participants might be located in different corners of the world, and even the different chapters of the final product might be located in servers thousands of miles apart—without any of this having much effect on the final product. Announcements and messages telling about the book might also be found on many different electronic marketplaces and its reviews on the pages of many different organizations.

**This passage is based on Pekka Lehtiö's report (Sitra, No. 193, 1998).*

The coming of age of educational technologies and electronic learning material

Electronic books in the form of CD-ROMs are a reality today in thousands of Finnish homes. It is likely that they are most actively used in families with children. The subjects range from storybooks and crafts books to games, dictionaries and other reference works. There are presently about 40 million CD-ROM stations in European households. However, in the 1990s WWW technology has brought a pivotal breakthrough in the way an electronic book can be produced, most importantly because by combining multimedia and the Internet, the pages of electronic books can be scattered all around the world and their readers likewise could be anywhere. It has also made it much easier to update their information.

Three strong traditions can be identified in the history of educational applications of information technology, characterized by varying ideas about the fields to which information technology can be fruitfully applied. Two of them—the tradition of systematic instructional technology (e.g. CAI) and the tradition of artificial learning environments (e.g. microworlds and simulations)—are directly related to the planning of electronic learning material. The third tradition, in turn, has attempted to bring such information technology tools as word processing, databases, etc. into use in the cognitive work of students.

Systematic Instructional Technology. These approaches have been rather widely applied in training in working life, and they have had an important role in the planning of learning material and in many of the computer-assisted instruction projects. Because of their areas of application, these projects have very often been geared towards creating entire courses. The applications have typically organized the subject matter into small units, and they have used branching software in order to continuously ascertain that the student has grasped the knowledge. In this approach, the electronic book replaces the teacher as the mediator of knowledge and the evaluator of learning.

Artificial Learning Environments. Developers of artificial learning environments believe that the real strength of information technology lies in its ability to produce new kinds of learning environments. For example, students participating in a neurophysiology course might hear about how neurons work and look at pictures of tissues and nerve cells in books or on overheads, but they only get a very limited view of where these tissues are located or how the nerve cells react. Many other phenomena essential to learning and understanding also only become clear through laboratory experiments which are very difficult to implement in practice. This is the very area where artificial learning environments come into play. An electronic book can present realistic laboratory experiments, giving medical students, for example, the opportunity to alter their treatment strategies and then study the results.

The use of artificial learning environments is not limited to natural sciences. For instance, an English-language CD-ROM has been published in Finland which offers students the opportunity to interview people on the streets of Cambridge on twelve interesting themes. Several artificial learning environments have been produced on the plays of Shakespeare, for example a Macbeth karaoke.

Electronic Communities as Learning Environments. In 1991 the Finnish student Linus Torvalds used the Internet to share parts of the Linux operating system which he had by then developed. A growing number of enthusiastic people from different parts of the world soon wanted to participate in the development of the system. At present, there are over 3 million references to the system on the Internet, and Linux user clubs now exist in over 50 countries and in each of the 50 American states. It may be said that Linux is a global information technology learning project which has been made possible by the Internet. It is an example of learning by doing, in which learning, doing and problem solving are integrated into a whole. It also shows that useful things can be produced through the activities of an extensive international network community. It is also very likely that for the people participating in the project it has certainly corresponded to professional studies in operating systems.

Electronic communities provide good examples of new learning environments which have emerged along with the development of

ICT. Many of these communities bring together researchers in the same field who work in different countries. For example, BioMedNet has over 100,000 registered members. Registration is free for professionals and students in the field of biomedicine. Once they have registered they can utilize many services, such as bibliographical databases. Searches do not cost anything, but there is a charge for the contents. BioMedNet also contains many tools for facilitating cooperation and communication between members. In fact, communication between the members of the community and the knowledge produced by it are the most characteristic features of well-functioning electronic communities. In this context we should repeat, however, that electronic communities do not replace social contacts. Many studies have shown that distance teaching, for example, works best when combined with significant personal tutoring and contact teaching days (Daniel 1996).

Electronic marketplaces help people reach their audience

The production of various practice assignments, theses, and projects is an essential part of studying. The fact that these products ordinarily find very little use after the author has gotten credit for them has unavoidably influenced the motivation of students. Present technology makes it possible to publish much more of this kind of work. Through the network the genuine audience expands beyond one's own classroom and school community and becomes virtually universal.

Rewarding high-quality achievement is also an investment which educational policy should consider. Some models for this can be found on the Internet. For example in 1997, the annual ThinkQuest competition attracted over 1,400 groups from 40 countries to compete in the production of WWW learning material. Similarly, the RoadAhead competitions organized by Microsoft have been popular in Finland as well. Over a million visits to the pages containing the best works entered in the ThinkQuest competition have been recorded.

One approach for publishing theses could be that once a thesis is made public, it is automatically entered in a national thesis competition with awards granted annually to the best works in each category. For this to succeed, the monetary awards would need to be sufficiently large.

Motives for creating digital learning materials

We can outline several reasons for producing digital learning material, including the following:

1) facilitating instruction
2) enriching instruction by using modern media
3) improving remedial teaching
4) producing and distributing learning material more economically
5) developing the quality of learning material and
6) developing new teaching methods.

Facilitating the Work of Teachers. Most of the different phases of teaching work can be significantly eased by using information technology, but only if equipment and digital learning materials are easily accessible and teachers are equipped with sufficient ICT skills. One of the main areas of competition between textbook publishers in the past couple of decades has been in easing the workload of teachers. This has manifested itself in the production of teacher's manuals, exercise books and overhead presentations. The webpages of textbook publishers already contain many links to servers which support teaching.

The marketing of textbooks in the future will focus on utilizing electronic communities. These communities will, for their part, also ease the workload of teachers. The pace of development will depend on the extent to which teachers use information technology tools.

The publishers of learning material will increasingly offer digital accessories for their textbooks, such as CDROMs and webpages or combinations thereof. These accessories also serve the goal of en-

riching instruction. Even now the most active teachers already use many products geared towards the consumer market, including for example electronic encyclopedias, language CD-ROMs and simulation games. However, the threshold for beginning to use digital learning material will become significantly lower if the material is closely integrated to the textbooks teachers already use. These products will come on the market without needing public funding if the schools have enough computers, and teachers are willing to utilize digital learning material.

Remedial Teaching. Creating effective remedial teaching material which would truly help in problem cases is a more difficult problem that calls for a significant development effort from those who are able to utilize the results of basic research, use the methods offered by digital media and carry out applied research with teaching methods, and on top of this are able to turn the results into a marketable product. An example of this in Finland is the Centre for Learning Research at the University of Turku, which has developed a versatile software product, Aleksi, as a tool for remedial teaching in reading skills. Aleksi software is based on basic research in reading and learning difficulties, and teachers using it have given positive feedback on it. However, it is important to note that few such groups are working in applied learning research in Finland.

For extensive and systematic remedial teaching software to be created we need both intellectual and financial resources. They do not emerge, as Lehtiö says, "as a result of shortsighted bureaucratic research programs where researchers chase after funding by moving from one topic to another while pretending to study whatever the agencies pretend to be funding."

However, the results of many studies indicate that remedial teaching is one of the areas where the use of digital learning material enhances learning outcomes. Software will not necessarily meet all the challenges autonomous learners will face in the future, but it might have a crucial influence with respect to subjects where gaps in basic skills and knowledge would otherwise put an end to learners' meaningful progress.

In the 1980s, when computers were first brought to schools providing compulsory education, the National Fund for Research and

Development (Sitra) launched a project with one of the objectives being to survey the utilization of international educational software intended for schools. Lack of established standards at the time made it impossible for the project to produce significant results. The current environment would be much more conducive to such a survey.

Economically Efficient Production and Distribution. Investments in digital learning material should also be made because this material offers more efficient production and distribution methods. Education is experiencing a budget crisis, and all means for keeping costs down should be exploited. Even though learning material costs make up only a very small proportion of the total costs of education, it is important to look for ways of saving money in this area as well. In particular, the production and distribution in a digital format of material with a limited distribution would certainly bring savings. Publishers are likewise ready to move into network distribution of small distribution items such as teacher's manuals, overhead transparency sets and other support products.

Developing the Quality of Learning Material. Digital learning material can be used to do many things which cannot be done at all with other formats. Material which is authentic in a new way can be brought to students, and learning material can offer several perspectives on phenomena and thus adapt to various learning styles. By simulating phenomena, learners can be offered an opportunity to interact actively with the information.

Improving the quality of learning material is an area of international applied research and development, and Finland must participate in it as it does in other areas of international research activities. Like other areas of applied research, it is an area where Finland must strive to effectively utilize international know-how. Our limited resources should be allocated to projects which both utilize the international provision in our small linguistic area and ensure our reasonable participation in the production of new knowledge.

Developing New Teaching Methods. The use of ICT in instruction has also been seen as an important means for creating new approaches within the field of education. Here the starting point has been the

relatively widely adopted view that basic education is no longer capable of providing students with knowledge and skills which suffice for their entire lifetime. As learning will continue throughout people's lives, the importance of self-directed learning will be emphasized. According to this view, education should first and foremost help students to become independent learners, with the transmission of knowledge being of only secondary importance. A related idea is that the nature of knowledge itself is changing. With respect to an increasing number of issues we must resort to problem solving under uncertain circumstances. Studying should provide people with the skills to formulate questions and find information in situations where nobody is able to provide ready answers.

The American CoVis project (Gomez and Gordin 1995; http://www.covis.nwu.edu/) is one of many international projects which have utilized ICT in this very sense for the development of new teaching methods. The project shows clearly the investment needed for achieving significant changes in educational methodology.

Projects such as CoVis cannot be launched with limited resources and at short notice, as they demand competitiveness in recruiting competent and enthusiastic people to carry them out. This is another category where we should focus on international cooperation and ensure that the best practices receive the attention they deserve. Finnish developers and researchers must actively participate in international development work, as information is best passed through personal contacts. It is notable in this context that one of the central findings of an extensive American survey, "Technology's Role in Educational Reform: Findings from a National Study of Innovating Schools" (Means & Olson 1995), was the difficulty the researchers had in finding examples of schools which would have succeeded in carrying out development projects like CoVis.

How to invest in learning material

The National Information Strategy for Education and Research (1995) takes a very positive stand in favor of digital learning material:

From a business perspective, Finland is a small market for content products of the information industry: multimedia, digital publications, teaching material and special products. Although relevant know-how concerning content is available, this type of production is often unprofitable when it is targeted solely at national distribution. On the other hand, the education and training sector as a whole is an important and exacting customer the demands of which can increase competition, thereby strengthening domestic suppliers. High-quality teaching material and educational entertainment—"edutainment"—products have market potential also outside purely educational uses: in homes, in pre-school education, and in clubs and leisure activities. In the areas where sound know-how exists, markets are not limited to Finland.

Both government and commercial companies can support the development of competitive digital information products and the creation of new markets. Production can also be increased through different financial arrangements which support the creation of know-how and business activity in the field of information products.

The question of markets for digital learning material is integrally connected to the need for balanced development of three factors: hardware and network connections, education, and learning material. For a genuine market for learning material to emerge, there has to be genuine use for it in the field. At present, the marketing potential of software is mainly limited to general purpose software, reflecting the fact that skills in their use are widely viewed as constituting the necessary basic information technology skills we should adopt as our goal.

The use of generic software in schools has also spread beyond the teaching of computer technology. In addition to computer courses, the writing of various essays and reports is the most commonly stated use of computers in educational institutions. This is in keeping with the goals set for the use of information technology in schools and with what teachers say about their own personal use of information

processing. However, when the National Information Strategy for Education and Research refers to the materials produced by the information industry it clearly means what is often referred to in English as "knowledge media" and what we have here called an electronic book. Contrary to what the Strategy seems to assume, our educational institutions do not constitute an adequate market for these products, and the consumer markets are clearly more important.

Within the educational system, the key issue for developing the markets is getting over Moore's chasm (see p. 230), i.e the early majority must become users of digital learning material and information networks. This cannot happen very fast, however, since all the prerequisites for practical utilization must be developed simultaneously. Hardware equipment which would guarantee that every elementary and secondary school student would have 25 hours a week of computer time and 10 hours a week in vocational schools is probably rather close to the minimum needed to persuade teachers to change their working methods. It is important to note that widespread utilization of computers requires adequate basic ICT skills both in teachers and students, and that teachers should also have the skills to apply information technology in accordance with their pedagogical objectives. The pedagogical application of information technology is not an area where universities and their continuing education units already possess the necessary knowledge base and are only waiting for resources to make it available in the field. Rather, we are talking about an area where a lot of cooperative projects are needed to test and analyze alternative methods.

"Educational object economy"

Products of the information society which are distributed through the net have some characteristics which differentiate them from traditional products. First of all, if a user copies a program from an Internet server, the number of available programs is not diminished by the act, and the supply on the small server will never be emptied. Secondly, if the program is intended for educational use, the client

might have more ideas about how to use that product efficiently than its producer did. For example, an active teacher will create the final use environment for a multimedia program, perhaps by selecting parts of it for use and leaving other parts out. Hagel and Armstrong (1997) have thus claimed that the most successful enterprises in the future will be those that succeed in constructing network communities where they can distribute their products and help their clients create added value for them.

Through Internet communities, the tradition in computer technology of distributing freeware is getting second wind. In the United States public funds are currently being used to support research and development activity aimed at producing 10,000 Java programs which can be utilized on the Internet and creating a free distribution system for them. The project was named "Educational Object Economy" to draw attention to the fact that the experiment is specifically geared towards developing the production and distribution mechanisms so that in the future these educational objects could be available both as free and as commercial versions.

An educational object is an information package related to a certain issue, and it usually consists of a software component and background information. It is usually relatively small, so it is easy to download from the Internet. It can be used directly on a WWW browser which is able to handle Java. These educational objects can be found at the site http://eoe.apple.com.

The educational object economy also attempts to create a fertile ground on which digital learning material businesses could thrive. The idea is that a sufficient number of small and easily accessible applications could provide the foundation for the widespread utilization of digital material.

Prerequisites for adopting new media in education

In his sub-report, Lehtiö outlined the framework within which the new media and approaches could be more widely utilized:

1) We need to maintain domestic information services which provide support material suitable for use in educational institutions in Finnish and Swedish as well as the original language the material was produced in.
2) We must improve the cataloging of learning material on the Internet.
3) We must maintain domestic servers able to distribute materials needed in schools on short notice.
4) We must temporarily store information on the educational institutions' servers as long as necessary.
5) Teachers must be provided with sufficient continuing education in the utilization of digital learning material.
6) Education in the basics of information technology must be provided for students early enough that they will be able to utilize these skills in all stages of their education.
7) A sufficient number of classrooms must be equipped with multimedia projectors.
8) Media libraries should be maintained in schools, and the services of computer support persons should be available through them.

Creating these circumstances requires that we have strong faith in the benefits thus gained, are committed to long-term development, and are able to make the required financial investment.

8 MILESTONE 1998 ON THE INFORMATION HIGHWAY

Based on all of the international and national source materials that we studied during the evaluation project, we can conclude that ICT in various forms has come to play an important role in Finnish life at present and will continue to do so in the foreseeable future. It has become an inseparable part of the economy in the production and marketing of tangible and intangible products, in social decision making and administration, in the transmission of information, communication, and in everyday life. As a result, Finnish society will have to select a strategy for the development, application and control of ICT—control that is based on human values. The influence of ICT is not only positive. It sometimes leads to confusion and to increased social vulnerability, resulting in a new kind of inequality and unreasonable challenges to learning. Finland should not be allowed to drift into an ever more complex dependency on new technology merely because circumstances favor its use. Instead, it is also possible to choose a conscious and ethically sustainable strategy to develop a culture that strongly benefits from ICT. This kind of policy orientation can be seen in references to Finland as an "information society laboratory," as in a recent report on future prospects which was issued by the Finnish government and referred to Parliament (Valtioneuvoston tulevaisuusselonteko 1997/2).

The changes caused by the development of technology are often surprising, and they proceed according to their own dynamics. No centralized decision making can clearly guide this process (cf. Steinbock 1998). The role of social decision making must be seen first and foremost as laying the foundation. This means not only preparing the technical and legislative conditions for the information society, but also ensuring that Finland will be mentally prepared for it. In this regard, important new ground has been broken in the report "Quality of Life, Knowledge and Competitiveness", commissioned by the government and prepared by the National Fund for Research and Development (Sitra). This report was presented to Prime Minister Paavo Lipponen in December 1998. This document can be found

in its entirety on the Internet at the following URL: http://www.sitra.fi.

Teaching and learning have a very central role in preparing people mentally for the development of the information society. From an educational point of view, any notion that Finland is a laboratory for the information society must entail that everyone is a part of this development and that the development of technology must not be allowed to create new inequality.

We base our, in this sense comprehensive, evaluation on the following simple analysis of the purposeful use of ICT in instruction and learning. The positive vision of the future development of ICT presupposes that:

1) the technical foundations of the information society are laid in such a way that they can be used in instruction and by learners with as few obstacles as possible,
2) people learn how to use technology as well as possible,
3) technology works to support learning processes that are not only mature, but also valuable to human beings, and
4) new opportunities to use technology are being studied and developed systematically.

In this vein the results of this report can be used to answer the following questions:

1) What kind of ICT equipment does Finland have now? What opportunities are there to use it in various parts of Finland and by different population groups now, and what is it going to be with the presently envisioned funding? What additional funding and new efforts are needed to carry out constructive visions? 4.1
2) How well can technology be used? Especially, how will key teachers master this new technology so as to make new pedagogical solutions possible? What should be the extent and quality of teachers' basic and further training in this respect? 4.1
3) Is there enough momentum to achieve a break-through of learning materials and learning environments using this technology, so that the investments will start to pay off? 4.1
4) Does the work done so far rest on a stable basis? 4.2
5) What kinds of teaching practices, learning processes and learning results have so far been achieved in learning environments that use technology? 4.3

6) Finally, what other changes are there in the whole field of teaching and learning, changes that have taken or will take place because information networks have made it possible to break through classroom walls? How well can the present educational system take into account and utilize the liberation and virtualization of learning environments? 4.3

How well are schools prepared to participate in the information society

Equipment and networks

By equipment we mean entities composed of computers and physical networks. Our understanding is that effective equipment consists of continuously maintained and well-functioning devices in appropriate work spaces used for teaching and studying. It is evident that when the student/computer ratio is favorable to this goal, there is so much technology that maintaining the equipment can no longer be made the responsibility of teachers. Questions of space also come up as more equipment is acquired.

The student/computer ratio, which is used as a basis for comparisons of computer access, is still so unfavorable in most schools that no significant changes in the teaching culture and teaching arrangements are evident, despite the fact that individual teachers and teacher groups use computers and network services great deal. However, one can already notice some change in many schools where IT is intensively used and in which groups are actively involved in developing it. The student/computer ratio (approximately 12.6 in the primary schools, 14.6 in the lower and 15.4 in the upper secondary schools) varies remarkably from school to school, and the ratio is usually bad in very big schools. The vocational schools are more fortunate in having one computer for approximately every 4-5 students.

Equipping programs in education should have the short-term goal of offering every student the opportunity to work with a computer one hour per day, in other words an average of six students per com-

puter. To reach this goal the amount of currently available equipment should be doubled. Equipping big schools with enough computers places a great burden on the municipal economy. Nevertheless, some countries believe that this burden can be borne. For instance pre-schools and twelve-year comprehensive schools in the US achieved a ratio of nine students per computer as early as 1995.

Achieving such goals will be difficult if the current tempo is maintained. One reason for this is that school computers are generally used more intensely than they would be for normal office work. Consequently a great many computers are continuously out of use because of insufficient maintenance resources. Increases in the ICT services targeted at the students will require more maintenance resources, and it will be necessary to develop ways to extend the life of the equipment to at least five years.

Their usability can also be increased by increasing the capacity of school networks and by adding high-capacity servers to them. By partly stopping purchases of so-called "intelligent" computers and by getting cheaper so-called "net-pc's," one could improve the ratio of computers to students. This technology is not yet readily available, but a couple of promising experiments are already being carried out.

Not all criticism of the insufficiency of equipment is justified. Instead, the pedagogical visions can often be immature when it comes to how the equipment can be flexibly used as an integrated part of teaching and learning processes. This observation, which has come up in international comparisons, is also valid for Finnish schools. Excellent results have been achieved in some schools with relatively little equipment. In some other instances, even giving personal laptop computers to students has not led to comparable positive results in teaching and learning.

Universities have not consciously set clear quantity goals. But the basic assumption is that students should have sufficient opportunities to use ICT whenever it is useful for study purposes. It seems that university teachers have very good ICT equipment at their disposal. In some individual units students have enough equipment for their use, but in most units the scarcity of equipment was felt to be a limitation to a purposeful application of ICT in teaching and learning. This shortcoming was partly compensated for by the fact that a large number of university students have a relatively good computer at home.

Depending on students to have their own computers, however, also has problems. It is already clear that with respect to ICT-based study methods, the students are in very different positions depending on whether or not they can use up-to-date computers and network links.

Soon the question will have to be taken up of whether students' full-time access to a well-equipped computer linked to a network will become a prerequisite for participation in university studies.

Based on research, it seems that polytechnic students have much easier access to computers than university students on average. The student/computer ratio in polytechnics was about four to one, while in universities it was a little over 14 to one (varying between five and 50). There were also differences between polytechnics, but the insufficiency of computers did not seem to interfere fundamentally with the use of IT in teaching and learning. Most polytechnic students also had home computers.

Purchasing computers and building networks for schools are nowadays systematic and long-term activities in most municipalities. About 80% of the municipalities have annually submitted applications to the computer and network purchase program which is part of the national program. This program provides funding to schools in the form of a 40% subsidy for purchases of computers and as a 50% subsidy for building information networks. The prerequisite for these subsidies is that the municipalities have a pedagogical plan. Based on the applications it would seem that the municipalities' visions of the pedagogical significance of IT are maturing with every new round of applications. This process has obviously contributed to the fact that many municipalities have invested a great deal more of their own funds in their purchase programs than the national program would have called for.

When compared internationally, Finland has come a long way in linking schools to information networks. In many municipalities there are already networks covering the whole school system, and other network projects elsewhere are well underway. It is apparent, however, that differences between municipalities will remain substantial for a couple of years. University and polytechnic networks are in good condition even though overloading caused by numerous applications and rapidly increasing use, as well as uncontrolled cost increases, are becoming a threat.

Computer use is determined by the placement and architecture of the technology

The layout of computers is part of the computer purchase programs. The purchase and placement of computers must be based on instructional goals. As the goal of the comprehensive school is to give every student basic skills in IT, a separate computer lab is usually equipped for this purpose. According to a survey done by the Finnish Book Publishers' Association (I.R.O. Research Oy 1997), there are computer labs in 98% of Finnish lower secondary schools. The same model is used in the majority of the large elementary schools and in most upper secondary schools. However, at all school levels there are microcomputers elsewhere, not only in IT classrooms. This decentralization is more common in elementary schools than in lower and upper secondary schools. Traditionally the devices have been placed in IT classrooms, and only as a second choice in other classrooms. The IT classrooms are instructionally justified for intensive work at a computer and for exploring matters that have to do with the use of computers and computer programs. Separate computer halls are practical when one wants to guarantee students good services and at the same time a moderately peaceful working environment. However, even under favorable circumstances, those teachers who do not teach IT feel that they are secondary users of computer labs. On the other hand, it is beneficial that the computers and the space reserved for them have a clearly identified person in charge.

Placing a certain number of computers in a regular classroom supports the integration of IT and instruction. In a classroom designed for various simultaneous activities, students can be divided, for example, into three groups: one of which works with printed material, the second with video and the third with computers. In this solution, the teacher assumes responsibility for the technical equipment. This kind of an arrangement suits many subjects and allows teachers to make better use of information technology.

Uniting the library and the IT classroom to create a school media center supports all of these goals, but it also presupposes the availability of resources to develop school libraries and to train and employ librarians. A functional media library is a space with a rather large number of computers where a teacher or a media librarian is in

charge of them and directs their use. Many media libraries also have equipment to utilize recordings and videos. Media library solutions have been popular, for example in many British experimental schools. At its best, the media library also offers opportunities to utilize IT to those teachers who do not necessarily want to get involved in the technology of a computer classroom. They can divide the teaching group into two and work with one group while the other group is working in the media library.

The placement of the devices is also linked to pedagogical thinking that can be advanced with the help of technology. Therefore it is not purposeful to set any one placement model as the general norm. Instead, each school will have to systematically study the pedagogical repercussions of various technical solutions and favor those that can be flexibly changed according to the situation and teaching need.

According to the reports, the schools have a fair amount of peripherals that are reasonably available to the teachers and students.

Pedagogical development projects

Development work based on international and national research in the field is the basic prerequisite for the progressive pedagogical introduction of ICT. Research and development work on the instructional use of IT has been carried out at several Finnish universities, and we even have some internationally successful interdisciplinary research groups. The first professorship in the field was established in Finland at the University of Joensuu in 1988, and several universities now have fixed term professorships whose area of instruction and research pertains to the use of new media in instruction. However, in the distribution of funding for the information strategy on instruction and research, enhancing the latest research on the instructional use of IT has not been taken into special account. For this purpose, research funding has to a certain extent been channeled through the Academy of Finland's research program on knowledge, which has meant in practice that the projects funded could involve philosophy, media

studies, information science, information technology, computer science, sociology, etc.

As indicated above, a great many schools are carrying out experiments and development projects. However, only a small number of these have a firm research basis. Many have sprung up and been carried out quite autonomously. This kind of development work, however, is valuable and necessary, and it indicates that in some areas ICT has already become an essential part of the school's normal work patterns as envisioned in the national programs.

In the projects the schools are usually represented by several teachers and student groups. Thus the pioneer work has already been done, and little by little it is time to enter a more advanced level. Schools can get support for their projects from the school budget, from the National Board of Education, from businesses, and the EU. Outside funding is available especially for extensive regional, national and international school-level programs. At the very least, the recent support levels should be sustained, as these projects are vital to changing the school study culture and developing the teachers' pedagogical visions.

There was no other information available on the allocation and impacts of the development project funding than the report on the development project funding of teacher training prepared for this evaluation. According to it, most applications did not contain very significant innovations with regard to pedagogy or information technology. However there are also some very interesting and varied projects among them which aim to effect significant qualitative changes in teaching and teacher training practices through the innovative use of ICT.

Big projects are most often carried out in cooperation with several sectors, commonly with universities and their further education institutes. The information available in these projects will have a long-lasting and extensive effect, especially when the results become sufficiently known and are applied to the further education of teachers.

Program quality and production conditions of digital learning materials

The learning material used with ICT is multimedia. This material can consist of programs which make certain working methods possible. It can be either authentic material which serves students in independent inquiry or materials that support traditional teacher-centered didactics.

In the future, finding the right balance between various materials and methods will become an important matter for discussion.

A look at comprehensive schools and upper secondary schools shows that the teachers' work is guided by the curriculum and, in practice, often quite powerfully by the textbook. As a rule, teachers look for learning materials that permit instruction to progress according to their curriculum. Most teachers will start investing in teaching methods involving ICT only when they feel they will be more useful than troublesome.

The development of digital learning materials has three elements: learning materials, equipment investments and teacher training. If there is no equipment, there is no reason to develop learning materials. If there are no learning materials, the use of the equipment is most often limited to making reports, to random searches for information and to hobby-related activities. Under all circumstances, teacher training is always worthwhile because it raises teachers' awareness of current social changes. But if they cannot use ICT equipment and new learning materials, their teaching is not going to change significantly. Teaching materials that serve schools well differ from commercially available ICT-based materials, in that the latter do not necessarily exist in a ready-to-use form, but have to be invented and developed. It seems obvious that in the future we have to define more exactly what we wish to accomplish with limited resources. Even though one strategic goal of a teleoperator may very well be to get "all the schools into a network," this will not suffice as the guiding principle of the national education policy.

It is obvious that of these three aspects, teacher training and matters concerning learning materials are the most difficult to handle. These

two aspects are closely related. No one can afford to produce digital learning materials for comprehensive schools, upper secondary schools or vocational training if teachers are not prepared to use them. On the other hand, teachers will not invest their time if there are not enough materials.

Production of domestic digital learning materials has always been an economic risk for producers. The risk is even greater when the material is expected to reflect greater pedagogical expertise, mastery of multimedia means and visual attractiveness. Only a few products might turn out to be successful, and the development must be publicly funded in one way or another.

The status of digital learning materials in the schools is not clear. Teachers have usually made continuous active use of only a few material packages. The reason for this may be that teachers are not used to them, in which case the situation can be corrected with training. But partly it is also that the pedagogical quality of the material offered is regarded as too low. Improving it requires improving the production machinery and the pedagogical thinking of the producers of the learning material, and, consequently, higher costs.

Materials that have been imported and adapted for local use are usually more successful in the market, but many times they have been produced for home or entertainment markets, so that school use is more limited. CD-ROM material, which is similar to an electronic book, is quite popular, but the school market cannot absorb very many products. Net materials are soon going to be marketed, and one must be prepared to pay for them.

For schools and students at the moment the nets provide some nationwide services, among others the EDU.fi service (http://www.edu.fi) of the National Board of Education, the distance upper secondary schools of the National Board of Education and the Otava College, and the Finnish Freenet, which was started first. DINE PM in the Mikkeli region and the Oulu region distance upper secondary school experiements are pioneers in their regions. The city of Helsinki is building an extensive network service for its schools—a network service that also offers teaching materials. Many municipalities have similar more or less ambitious schemes for their own schools. None of these services are finished yet, and so far they have not been very useful for students. National development work is clearly necessary,

as the resources of individual municipalities and institutions are small, and funding the services should be made very stable.

One of the most important foreign examples is SchoolNet (http://www.schoolnet.ca/) coordinated by Industry Canada. Its many subprojects now play an important role in the Canadian school system. SchoolNet has shown that partially shifting school support services into a network is a lasting solution that benefits schools, especially in a thinly populated country. Also the BioMedNet and CoVis projects (cf. Gomez and Gordin, 1995) are good examples of extensive and systematic projects to develop learning environments and communities.

Finland should create national network services aimed at schools, services whose products are well-grounded and effective from a pedagogical point of view, and whose funding is stable. The financing should be based partly on sales and partly on public funding. The status of the National Board of Education in the development, production and distribution of digital learning materials is currently somewhat unclear. It has had to take up roles that are partly difficult to combine, roles in which it is simultaneously a funder, an expert organization in charge of development, and a producer in the markets.

The Finnish school administration has participated in Nordic cooperation to develop and produce digital learning materials. This cooperation helped launch the production of CAI programs in the beginning phases of IT school use, and it produced practical models to design educational software. Considering the whole field, however, the impacts of this cooperation have remained rather minimal. This is partly a consequence of the fact that the cooperation was directed to the production of CAI programs. They were never extensively used in Finnish schools. Instead, schools have preferred more generic software. The later trend to train teachers and teacher educators has, for its part, had less significance than hoped because the results of pan-Nordic seminars have not been utilized systematically.

How can technology be used – is teacher training up-to-date?

Teachers must feel safe with computers in order to use IT in their own instruction. This presupposes that teachers use IT in their work and that they are fairly familiar with the school's technical environment. However, this provides only the basis for working. Further pedagogical training is needed to answer the many questions that come up in the use of IT in instruction. This, in turn, presupposes ongoing research, development and experimental activity.

In general, it is estimated that the total number of teachers using ICT in their work with students is the same in Finland as generally elsewhere: about 20% of teachers use it intensively and in a pedagogically significant way. More superficial or random use is of course much more common, as has been shown above. When asked in a survey done by the Finnish Book Publishers' Association about the obstacles to the school use of multimedia, the teachers mentioned the lack of computers as the first, the lack of money as the second, and the lack of teacher training as the third obstacle.

According to the teacher questionnaires in this evaluation project, inadequate mastery of the technology was the most limiting factor, along with the lack of equipment for the instructional use of ICT. This problem came out at all school levels. The ongoing development of technology and software means that teachers are being challenged to continuously update their skills. It is, however, important to note that insufficient pedagogical mastery of IT use was felt to be at least as big a problem as the inability to use the equipment itself. The fact that teachers learn to use the equipment and the applications by themselves does not automatically lead to their pedagogically purposeful use.

Teacher training is mentioned as a central concept in the educational information strategy. During the past few years some funding for teacher education institutions has been allocated to a certain extent to equipment and training personnel, but this has not yet had any great influence on the skills of the graduating teachers. Those future teachers who participated in the special courses of instruction technology (15 and 35 credits) have learned good skills,

but the proportion of these students to the whole student body is still very small.

Teacher education institutes should look for better solutions that will guarantee all students the opportunity to learn basic skills in the instructional use of ICT and the conditions to develop and maintain their own skills independently. On the other hand, teacher training units also have to offer an opportunity for advanced studies in instruction technology. Reaching these goals is still an extensive undertaking, and it is not realistic to think that it can be done merely by adding new elements to the present curricula and by employing more teacher trainers specialized in instruction technology. To reach the goal, it is necessary to refocus the present curriculum and, accordingly, rearrange the structure of permanent positions.

Studies in the use of ICT must also not remain a separate island in teacher education. Instead, they must be integrated into the other theoretical and practical studies in teacher education as much as possible.

The impact of teachers' basic education is felt very slowly. A central strategic tool becomes teacher's in-service training and independent study.

Learning how to utilize IT independently always contains two phases: one has to learn to use the technical tools reasonably fluently and, on the other hand, one has to learn to envisage how one's own tasks can be carried out better and more easily using these new tools. If sufficient fluency in use is not reached in the user's opinion, he or she will carry out the tasks in some other ways if given the opportunity, and teachers usually do have these opportuntities.

Learning the IT basics takes time, but there is never enough of it. For this reason, in addition to intensive courses, there is a need for tutoring and advising that can be flexibly coordinated with the rest of the work on-site.

The training emphasis depends very much on what kind of technical support is available in schools. If students can be tutored, for example, in some detailed exercise by the media librarian or by school IT support staff, teachers can pay less attention to IT. However, if they have no help of this kind, their own facility with computers is the prerequisite for all such activities. In Great Britain, over 30 million Ecus were reserved in this year's national budget for training in the pedagogical use of IT. In Finland, the corresponding annual na-

tional investment has come to about 1.5 million Ecus, which, taking the number of teachers into account, is less than one half the British amount. We could also certainly use a bigger sum than we have now. A careful survey of training needs should be done now so that better-focused training can be planned for teachers with different levels of mastery—training in which there would be a sufficient emphasis on the immediate application of the training.

The municipalities have organized further training for teachers, but the resulting pedagogical advantages have been pretty modest. The subject teacher organizations and other training organizations have also been organizing further training. Nowadays the continuing education institutes in the universities take care of a significant amount of the teachers' further training in IT. They have a clear idea of what the state of research is that deals with learning, and this expertise has been recognized in the fact that they have mostly been given the responsibility for organizing, among other things, five-credit teachers' pedagogical further training in accordance with the national strategy.

About 1,600 teachers per year were trained in this training program during the years 1996-1998. As about 43,000 teachers are working in general education schools, about 11% of the teaching staff participated in this training during these years. This is not sufficient for a clear change in the teaching culture: at least a similar investment is needed in shorter-term training and an additional investment in extensive further training. Furthermore, teacher training is needed in the basic skills of IT, which must be provided mainly by the municipalities.

The impacts of the completed training can only be seen over time. However, even now we can conclude that training alone is not the solution to the complex problem of how to improve a teacher's pedagogical skills in using ICT. For one thing, training alone does not always raise the teachers' skills to the desired levels. However, training may change beliefs forcefully, and in the long run this may be even more important. Several participants in the national training program commented on its personal significance from a point of view that did not have anything to do with the development of skills:
"*The training has strengthened my touch for ICT, in other words it gave me the courage to try to participate in something new and even strange.*"

"My own distrust of everything that has to do with technology has diminished. I am more prepared to think a little less narrowly."

"I got the courage to touch the computer and to try to find ways of using it myself."

In training, it is necessary to forge a better link between studying IT skills and the pedagogical development of one's own school community.

Lasting developments in school ICT use*

Ethical questions

One often speaks of a "technological imperative," according to which everything that can be used must be used, and everything that can be technically carried out will be carried out sooner or later. If true, this also means that we cannot plan ICT ethically and we are unable to analyze critically the value questions that come with its future development. The way we think strengthens our passive attitudes and our adjustment to IT. This gives rise to the thought that people are helpless in their relationship to technical development. For example, according to an American study, 63% of those interviewed thought that technological development was getting out of hand.

Part of seeing technological development as uncontrollable is also the thought of its being value-free in the same way as "weapons don't kill, people kill." The supporters of this view admit in general quite willingly that ethics and values are certainly important, but discussing them is appropriate only when there is already some technology, and the question of how it should be used comes up only later.

*This passage is partly based on Reijo Työrinoja's article (Sitra, No. 192, 1998)

It is often thought that technology is tied to values, but that it is good, at least initially. Technology is based on modern science and has borrowed the inherent value of science and information from it. The firm foundation of Western scientific culture has been the vision of the intrinsically blessed character of science and information, which can become problematic only when information is used and applied. The idea of the completely benevolent nature of technology leads to the notion that it must be allowed to grow "naturally" without any controls, according to its own self-directed conformities to law.

ICT should be analyzed not as an autonomous force, but first and foremost as a part of our culture, its values and goals. One should also ask critically how it reflects our social values and the goals and aspirations that they reflect.

The information society and the technology on which it is based make it possible to acquire a remarkably better level of information than before. Then, however, it can become problematic that the amount of conflicting information increases, thus hindering rational decision making and subsequent action. Unorganized information and its rapid changes can cause similar problems. The increase of information does not by itself improve peoples' quality of life if the information is not at the same time trustworthy and relevant. The ability to distinguish between the essential and the trivial is decisively important.

By computer and network ethic we mean all ethically significant activity that has to do with using computers and programs and activity in the network environment. This ethic can be expressed as rules and regulations to which IT users should commit themselves. Some of these rules can be described as a set of professional virtues like, for example, the ethical rules for IT professionals put together by the Finnish Information Processing Association.

In many countries an effort has been made to set forth the goals and etiquette for student use of ICT in detail in school ICT strategies. Finland should pay more attention to this matter than it has in the past. For example, the state of New South Wales in Australia has published rules with support materials on how schools can plan their Internet strategies and what matters should be discussed in connection with the student use of the Internet. Attention should be paid in the design to the following points, among others:

- the safety and privacy of students, staff and other Internet users
- establishment of an Internet code of behaviour for use by students which clearly identifies the consequences of breaches
- strategies for dealing with the transmission or receipt of inappropriate Internet material
- equity of access to the Internet
- the relationship with established principles of, and existing school policies and strategies regarding, student welfare, good discipline and effective learning, child protection, anti-racism and anti-discrimination
- strategies for the effective and secure management of the school's Internet computer system and associated virus and user access software
- the legal requirements regarding copyright for students and staff, including the copyright on computer software
- an implementation plan allowing for the regular review of the policy.

(New South Wales Department of School Education Curriculum Directorate, 1997, p.4)

Many Finnish schools also have at their disposal various permits, commitments, rules and etiquettes which attempt to bind the students to an ethically sustainable way of life in the information society. Educationally important is also the courage many schools have shown in giving their students a lot of responsibility for the maintenance of ICT equipment.

Challenges in the instruction of computer ethics

Instruction in IT must be, of course, linked to general instructional values that have been defined by Finnish society. Mastery of IT use is an essential factor in guaranteeing democracy, as well. In the Nordic form of democracy one starting point has been that all citizens have free access to as much information as they wish to gain. That is why we have a library system which is free and open to everyone.

The use of computers in instruction increases student autonomy. It liberates one from certain outside obligations in traditional instruction and it places great emphasis on independent search for informa-

tion and independent skills to evaluate it. Our ability to search independently for proper information also increases our understanding of ourselves as rational actors and deepens our comprehension of the world in which we live. Free access to information networks is doubtless a democratic value *per se* in the information society.

Information networks are, however, not only a tool to search for and exchange information, but also a form of entertainment and social interaction as well. In this respect, they differ from the traditional relationships between a human being and a machine. Information networks also provide access to materials which do not in any way support equality of instruction and democratic values, materials which advocate racism and fascism, among other things. However, the imposition of external restrictions would mean that the benefits gained through autonomy are at least partly lost.

It is also clearly difficult to implement restrictions. The opportunity of global communication offered by the Internet comes with only a few commonly accepted standards. For example, certain kinds of material may be prohibited by law in one country, but acceptable in another. One can ask whether society is obliged to protect its members in some way, especially children and youngsters, by denying them access to harmful material. This especially applies to the so-called "news groups," of which there are currently several tens of thousands. Those who offer Internet services are in a key position here. It is up to them to determine, for example, for how many news groups are accessible through their servers and what information services these groups offer.

It is very difficult, however, to implement censorship or official control over these services. On the other hand, many see in the fact that they are not controlled a hitherto totally unknown "kingdom of freedom" which is almost totally beyond official control.

By learning IT, students must get an idea of its cultural and social impacts and of its influence on the information society. They must also concern themselves with the pertinent ethical questions. The goal of this instruction should be making students independent, but at the same time responsible users of ICT, users who know about the ethical requirements of the communication that ICT makes possible.

How the ethics of the information society can be taught in practice has yet to be arranged. It could be made part of other instruction

in ethics, or part of IT instruction or media education. Suitable learning materials should be developed and made available.

In this evaluation project, it was not possible to find out what pedagogical solutions have been implemented or are being developed in schools in order to internalize the ethical principles and the practical methods in the information society. This will have to be done in future reports.

The challenges of ICT to equality

In Finland the difference between the sexes is quite clear in the whole population when it comes to using computers at home. In the young age groups the clearest difference between boys and girls is, however, in playing games, not so much in using computers for useful purposes. The international investigations refer to accumulating evidence to suggest that the same difference between sexes which exists in the use of home computers is repeated in the opportunities and activities to use IT in schools.

Male students have better opportunities to use computers at home than do the female students. There are probably also differences between students of different socioeconomic backgrounds, such that higher-income homes offer better opportunities to use modern IT. The situation in Finland corresponds both in gender and in social class difference to the picture given by international reports. The Finnish material did not, however, give enough information to draw conclusions about differences between social classes. Even though the IT used in homes is generally closely linked to income level, on the other hand, reports show that Finnish families with school-age children have tried to purchase computers for the home regardless of their income level.

In university disciplines where most of the students are female, the students have clearly fewer opportunities to use IT than in those which are traditionally male-dominated. The Ministry of Education has in recent years distributed special funding according to the information strategy to improve the IT infrastructure in universities. It seems that the humanities and education have not succeeded significantly in improving their ICT facilities with this funding. Instead, money for ICT purchases has been given to those who already had

resources for this purpose. In other words, efforts have not been made to use the distribution of money to even out the differences of opportunities to use computers by students in different disciplines. The fact that the equipment at the students' disposal is insufficient in many universities and in many disciplines may be partly due to the fact that only the money received through the special funding of the information strategy of the Ministry of Education has been used to purchase ICT, and at the same time funding received for operating expenses through the normal budget may have been used for other purposes.

The recent changes in the ways that state subsidies for training and the partially competitive national support for investments in ICT have increased the differences between municipalities and schools in its availability. The educational and income level of the family influences the purchasing of IT for the home. According to a Statistics Finland report, a clear link between family income level and the purchase of home computers was observed in the use of ICT in homes during the years 1996 and 1997 (cf. Table 1, page 27).

Even though the results show a pretty strong connection between income level and computer purchases, the connection is not as clear in families with children as has been stated above. It is possible in our country, too, that children in upper-income families have better access to IT, whereas school equipment depends strongly on local decision making and on the wealth of the municipality funding the school.

One can say pointedly that the elite in the Finnish information society consists mainly of the young, well-educated men living in the metropolitan area of the capital. Women and unemployed less educated persons living in less developed areas of Finland, as well as the elderly, are being marginalized. These are the same groups that are also otherwise threatened by alienation in the present society.

This tendency toward inequality is clearly alleviated by the fact that schools and libraries offer opportunities to use ICT to all their customers without charge. The use threshold is being lowered as people learn ICT skills in schools and workplaces. Even the less wealthy with children purchase a lot of IT equipment. The traditional viewpoint in the mastery of learning emphasizes the significance of the home's cultural capital. One can assume that when it comes to the skills needed in the information society equal availability does not guarantee equal

development. Instead the essential question is which types of technology do families want to use. On the other hand the rapid development of IT and the whole net culture has created a new situation in this respect. The parents' high level of education or the fact that they work in demanding expert professions does not guarantee that they necessarily have the qualifications to guide their children in the use of IT. IT as a hobby seems to involve such a high degree of spontaneous mastery that no adults are needed to mediate it, as must be done with traditional culture-specific knowledge. Children can often guide each other and their parents in the use of computers. This means that even though the mastery of IT may give rise to new inequality of opportunities to act and cope in the future, passing it on culturally and socially from one generation to another is not necessarily the same thing as transmitting traditional academic skills.

It is to be supposed that improving the availability of IT and its increased use in education will even out potential differences in IT skills caused by difference in home background. Schools have so far not been capable of tackling the fact that girls are significantly less interested in IT than boys. It may even be so that the increase in its use only strengthens the difference between the sexes and makes some disciplines which use a lot of IT unattractive to girls. The mere increase of equipment and its use may not solve the problem of gender difference, but solving it presupposes changing beliefs concerning technology and developing methods that motivate girls, too.

It will be decisive for future development to enable citizens to partake of the services of the information society as extensively as possible. In the last few years attention has been focused on the IT resources needed by the schools and here rapid development is taking place. Little attention has been paid to that part of the nation which is not being trained and which has no opportunity to develop IT skills in working life. The doors of the schools should also be opened more often for the evening use of other groups of citizens. In order to improve the information society skills of all citizen groups, the civic institutes should be made to include many more courses in their programs in order to motivate and encourage people to use computers despite their fear of IT. In the same way, the number of public computers in the libraries should be increased, and other open-access computer stations with free tutors should be arranged. For example,

IT workshops for young people should be further developed so as to offer all citizens IT services and guidance with the help of the young. In addition, such workshops could supply support personnel at reasonable expense to help schools that suffer from a lack of resources.

Economic considerations*

In Finland the comprehensive schools, the upper secondary schools, and the vocational schools are funded by the municipalities. The municipalities are of very different sizes and have differing resources. State support in the funding of municipal activities changes according to the economic situation of the municipalities. State funds are not earmarked. In addition—and by-passing this normal practice—the state has given money to schools for the purchase of computers and networks according to the national information strategy. All schools or municipalities, however, have not applied for this support. This refusal puts families with children in these areas in a somewhat unfavorable position if they are keen on getting ICT access and training for their children. In institutions of general education the number of computers has been rising steadily since the beginning of the 1980s, when the computerization of the schools was begun.

The national program launched in 1996 has brought a significant and additional incentive to purchase computers. To get extra national funding the municipality itself has to invest matching funds. At the same time the number of computers attached to a network has risen a lot faster than before the program, when the building of the networks was random and depended on the municipal development programs and on how active the schools were. However, the municipalities often see the situation differently due to overall cuts in state funding.

Some small municipalities seem especially dependent on extra help from the state, whereas big townships carry out their own projects without the national programs having any special significance. All in

In this section we rely on calculations provided by Jari Koivisto.

all, in order to have a sufficient guiding influence, the amount of awarded funds should be increased.

Equipment and network expenditures

If institutions of general education aim for the ratio of six students per computer and estimate the life of a computer to be four years, one ends up estimating that annual purchase expenditures for equipment for institutions of general education should be 50 Ecus per student. The annual purchase numbers should remain at least at this level so that the equipment will not become out-dated. The numbers are the same as the estimate of the Rand Corporation for the United States in 1994-1995 (Glennan & Melmed, 1996; Keltner & Ross, 1996). However, according to estimates, institutions of general education spent only about 16 Ecus per student in Finland in 1998 on equipment purchases.

In the vocational schools, computer use is often linked to certain professional applications which one has to learn thoroughly.

In the same way, computers are used to control different devices and to draft designs and workplans. Thus it is not unreasonable that these schools should have one computer for every two students. This calculation method would entail computer expenditures equal to 137 Ecus per student. The need for IT varies from study program to study program. For example, students of graphic design, communication, foundry technology, information technology or automation technology need one computer per student. On the other hand, cosmetology students, for example, do not need as many computers.

School libraries are nowadays very modest, and often they are not kept at all. Therefore, their conversion into live media centers requires starter money in addition to their normal annual funding.

The networking of the schools has necessitated a shift to a technology in which the speed of information transfer is 100 Mb/s. In some places even faster technologies have already been used, and an ATM network is not a rarity any more. In vocational schools the network situation is good, and funds can be used to improve the networks.

In the municipalities which are thinly populated and where the distances between villages are great, the schools that are far from the

municipal centers have been linked to the municipal network with ISDN connections. Modern ISDN routers bring the students practically the same level of services as if the schools had been connected by a permanent line. The speed of the old municipal networks is usually 10 Mb/s. These will become obsolete in a couple of years. Neither these aging networks nor the ISDN connections can guarantee the functionality of the next generation of network applications.

Educational databanks that follow the model of English resource centers (cf. Educational Design Initiatives, 1991) are being developed in many regions. One of their typical services is transmitting video clips through the information network. Experiments have been conducted with this ATM connection in Tampere, among other places.

Old, slow networks do not necessarily need to be replaced by new networks in a great hurry in all cases, as technologies have been developed (e.g. ADSL) with which the speed of telephone connections can be increased remarkably. Thus it seems that in the near future networking will come to a point at which constructing new networks will slow down and renewing old networks will not yet have begun. One could predict that by the year 2002 at the latest, it will be necessary to replace or update networks, and that it will be necessary to take new pedagogical visions into account in this context. Efforts will have to be made to construct networks that are easy and inexpensive to renew, because constructing new networks again and again is, for many reasons, not feasible.

Expenses for general purpose software and peripherals

Purchasing general purpose software (word processors, spreadsheets, net browsers, e-mail software, etc.) for schools one by one is quite expensive. Suggestions have been made about extensive licensing arrangements that could even be national. Such arrangements could guarantee that reasonable basic ICT tools are available to all students.

The software purchases of the vocational schools are often linked to certain devices and to training in their use. In the same way, the peripherals are to a great extent specific to the area of study, so that purchasing software and peripherals is inseparable of the study ma-

terials package purchased. In many study areas their portion of the expenses is much greater than that of the general purpose software; therefore their share of the total costs was not possible to estimate. Subsequently, we have been able to estimate that purchasing generic software alone would cost about 40 Ecus per student per year.

Expenses of learning materials and technology maintenance

A reasonable sum for the purchase of digital learning material could be the price of one mid-range CD-ROM product per 10 students. When the networks improve, the printed products are partly tranferred to the network and the volume of material disseminated through the net will most likely rise quickly. In a couple of years, the expenditure on net materials per student may even rise to nearly 120 Ecus per year.

After purchase, the school's IT hardware and software must be maintained in such a way that it can remain functional and usable in a pedagogically purposeful way. Today's capacity can be maintained if there is one trained full-time microcomputer support person per 500 students. This means the annual salaries of approximately 1,400 persons. In vocational schools, more support persons are needed relative to the number of students. As about 200,000 students are studying in vocational schools, about 1,000 support persons are needed. In addition to the salary expenses, at least 12 Ecus per student must be reserved for equipment maintenance and spare parts.

Development projects

Most development projects take place without separate funding. In addition, there are projects that can manage on an ongoing basis with relatively small special funding. Furthermore, there exist, and there is also a continuous need for, some extensive, thorough, long-lasting, regional, national and international development projects, whose funding comes from several different sources. As there will be an ongoing need for them, we have to guarantee their continued support. In addition to municipal and state monies, the projects get outside

funding from businesses, communities and the EU. The support should remain at least at the present level in the future because it is these projects that are essential in order to change the schools' study culture and to develop the teachers' pedagogical vision. There is still a lot of room for better cooperation between businesses and schools.

Further training expenses

Maintaining the teachers' professional skills demands the teachers' continuous participation in training. Teaching technology develops so rapidly that years can not pass between teacher training sessions. An annual three-day study period that focuses on instruction technology and pertinent pedagogy would most likely be sufficient to keep the teachers' basic skills up-to-date. It would cost about 25 Ecus per teacher per year, plus expenses for travel and substitutes.

We judge that one fifth of our teachers have a satisfactory knowledge of ICT and satisfactory skills to use ICT in effective instruction. Eighty percent of the teachers need further training in ICT. Reducing this figure to as close to zero as possible would require a similar amount of money annually until 2004.

A summary of total expenses

We have estimated the expenditures needed to maintain up-to-date IT equipment that meets the needs set for learning outcomes in the current instructional use of ICT in comprehensive schools, upper secondary schools and vocational schools. We have also estimated reasonable expenses and their distribution to different goals in the year 2002. According to our estimate total expenditures for this year are at a level which should almost be trebled and made stable by the year 2002 at the latest.

A total annual investment of this sort would create a realistic basis for the achievement of the pedagogical goals. It is not possible to estimate the distribution of expenses between the state and the municipalities in this context. Sufficient funding can, however, be guaranteed only if the proportion of state funding is increased. The present level of investment is sufficient only in relationship to networking expenditures. All other sub-areas require additional investment. Main-

tenance expenses are rising very rapidly. Corresponding estimates have not been made for the universities.

Why is the influence of the new media on teaching and learning still so small?

As was pointed out above, digital learning materials have been around for a long time. Finnish schools have been computerized already for 15 years. All that time, teachers have been trained to use IT in instruction. However, only about 20% of them utilize it extensively in their instruction.

There are certainly many reasons for the limited use of information technology. Lehtiö (1998) gives the following account: first of all, it is significant that technology may become a factor shaping culture, curricula, or pedagogy if it is always present. In the schools one cannot yet be confident that it will always be possible to use computers. Still less has one been able to trust that useful learning materials will be available. As a result of 15 years of work, the school use of computers has become a real pet of continuing and further education. Teachers have laudably been made to participate in many different kinds of courses, but not to adopt IT to a great extent in their teaching.

The stages in which ICT is being applied in studying and teaching are typical of those found elsewhere in the adoption and use of technology. Moore (1996) has described the spread of the use of technology as follows. First come the innovators, then the early adopters, the early majority, the slow majority and finally those who are opposed.

In Moore's figure there are gaps to show the difficulties that come about when technology is marketed to a new group using the same principles as with the previous group. The innovators work with the new technology because they are interested in technology per se and in its possibilities. If they accomplish interesting results, along come the early adopters, who have some vision of how to use technology

and what benefits it may offer. Very often numerous consultants and trainers belong to this group that earns money by selling visions. The most troublesome place of discontinuity in the spread of technology —Moore's chasm—is between the early adopters and the early majority. Talking about new things is not the profession of the early majority, but they do something else and they don't want to take risks with uncertain or non-functional technology. However, the real mass markets start with them. Many new inventions never cross this chasm. Slow adopters start using technology reluctantly and as the last group those against may not necessarily start at all.

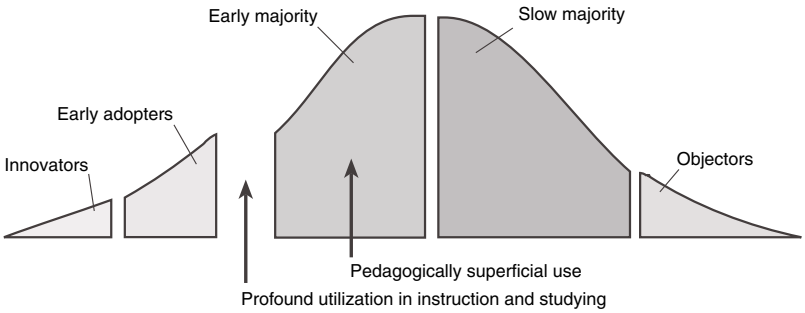

Figure 7. The introduction of ICT in Finnish education on the basis of Moore's diagram on the adoption of innovations.

Obviously the in-depth use of ICT in instruction is just now emerging from Moore's chasm in Finland and reaching the early majority stage.

The obstacles, according to Lehtiö (1998) are still great between the opportunities and the practical use of information networks and digital media. For one thing, with the information networks becoming more numerous, the amount of available material is horrendous. And where there is a lot of information, finding it becomes a problem. In everyday life at school, the problem is still on a more general level: Do teachers have access to computers to help them prepare their instruction, surf the nets and select material? One has to also keep in mind that only 10-15% of the teachers know IT well enough to be able to copy pictures off web pages, save them properly, move them

to various folders in the network and again when needed, take them into use.

Another difficulty is that nearly all the material is in English and not in the students' mother tongue. Even though it supports the students' language studies, its extent or purpose is in no way self-evident. The teachers who apply IT also know that the students' IT skills vary greatly.

When it comes to the students' independent work, one prerequisite is that a sufficient amount of computers in the net are at their disposal, computers that can be reserved for this purpose for just the lesson when the teachers need them.

Traditional forms of schoolwork have developed without IT, and often the introduction of technology brings only a small advantage to the work of the teacher or the student. On the other hand, adapting methods of using IT to traditional teaching techniques is pretty easy, but it does not yet give sufficient justification for investing in it. The special pedagogical significance of IT lies in the fact that it makes possible many learning environments which are interesting from the learning point of view but whose arrangement without IT is difficult.

Recent learning research has developed a new way of understanding higher-level learning as the result of the learners' active individual and collaborative efforts. According to the results of the reports made in connection with this project, the teachers are starting to be rather conscious of these new ideas and opportunities for enhancing learning. However, the problem is that the discussion of concepts of learning has offered only a few concrete suggestions of how these thoughts could be implemented in practice. It seems that the field of Finnish education is only now looking for ways in which the changed concepts of learning could be taken into account in instruction and in studying. It is to be assumed that with this process IT is also going to be used innovatively in the same way as it is now being used in individual experiments.

The possibilities for IT are coming up in a pedagogical environment where learning is no longer a separate activity that is enclosed within school walls, but takes place in active interaction with life outside the school. This means participation in national and international exchanges of ideas, connections with expert and work cultures in various fields, and in collaboration with other students. IT becomes

pedagogically important when the students themselves try to find out about complex phenomena through their own inquiry and experimentation. When used correctly, information networks have shown themselves to be excellent tools for information acquisition and the social construction of knowledge, argumentation and discussion. Without ICT it would be much more troublesome to publish teachers' and students' own learning materials, research reports and other information. In the case studies we have collected here, one can find real examples of high-level pedagogical activity. The great challenge in the years to come will be to help other schools develop their own innovations. IT itself does not produce this kind of progress, but it is a useful tool in the development of the pedagogical practices that can better respond to the new learning demands of the information society.

9 RECOMMENDATIONS

This extensive report confirms earlier international and domestic observations that the introduction of ICT to support instruction and studying may produce significant results. Getting to know the most important technical equipment in society and working life is itself an important challenge, one which, in any case, has to be met in training. The use of ICT in instruction and learning, however, opens much more extensive prospects.

STRATEGIES NEED UPDATING AT ALL LEVELS

The National Strategy for Education and Research in the Information Society must be updated. The report shows that both the Ministry of Education's information strategy for education and for research has proven to be important in guiding education policy after the recession. To some extent it may have even helped to overcome the recession itself.

However, meeting the goals of this program will require a sustained effort in order to succeed, and this process must be established as part of normal teaching activities. In March of 1999 Parliamentary elections took place in Finland. It is desirable that the next government update the national information strategy for its entire term. This continuation program should take—and indeed does take—into account the needs and strategic solutions brought up by this report. Initiated by the then Minister of Education, Olli-Pekka Heinonen, the preparation of the new strategy was started in the winter of 1999 and has just been published. Also, an English translation will be available on the web at the ministry's URL: http://www.minedu.fi, as well as in print.

Municipal strategies should be updated. In addition to the national education administration, the municipalities overwhelmingly play the

most important role in funding and maintaining primary, secondary and vocational institutions. Therefore they must do what is necessary to assure that all those involved will carry out the national strategy. The commitment of the municipalities will be furthered if the national policy directives give strong signals of what is regarded as important and will contribute significantly to the creation of conditions that are favorable to this end. According to the National Board of Education, not quite all of the municipalities have joined the implementation program of the previous strategy. This situation is unacceptable from the standpoint of equality of opportunity. At least those who have not yet finished their compulsory education must have the opportunity to learn the basic skills needed in the information society. This should be taken into account in the new national strategy.

Furthermore, in the near future the municipalities will have to improve their ICT resources to the levels set for their school and civic education activities. They will also have to *establish* these activities, i.e., they will have to transform them from projects to permanent practices. There are already at least some satisfactory examples of such municipal strategies, and their dissemination should be continued and strengthened.

In addition to providing an adequate technical infrastructure, municipal ICT strategies for school and civic education must also cover the pedagogical approaches to content. The strategies also have to be formulated so as to be applicable at the school level. Good examples can certainly be found in great numbers on every educational level.

The implementation of the goals defined in the strategies presupposes careful planning and profound knowledge of the situation in the field. It is decisively important to make the majority of teachers embrace the new technology and integrate it into their practical work. Satisfactory incentives have to be provided. This evaluation project uncovered a great number of innovative practices, which have been presented. Among other things, an effort has to be made to publicize them extensively. In addition, more surveys must be taken to assess the need for further teacher training and development of instruction.

University strategies must be sharpened. Even though strategic thinking has been taken farthest in polytechnics and universities, it does not seem to cover ICT instructional use in every single university. Development of the pedagogical use of ICT in the universities is random at present. The pedagogical and information technological support for projects carried out by individual departments is often limited, and the ideas emerging from the various projects are not disseminated effectively for use by others. Cooperation within and between universities in developing the use of ICT in instruction should be increased, and ear-marked funding should be allocated to these kinds of projects.

The universities have important strategic significance in all training involving the development of ICT use. University investment in this development takes place through both research and teacher training. Current teacher training does not provide enough skills for the effective application of ICT in their work. A lot must be improved, especially in the pedagogical studies of subject teacher training. Furthermore, there are remarkable differences between teacher training units in how well they prepare future teachers to meet the demands of the information society.

Other challenges and demands of working life must be taken into account in higher education better than now. ICT can be utilized in a significant way to deepen the interaction between education and working life.

One cannot manage without technology or support

The results of the evaluation confirm that the level of the IT infrastructure is not yet sufficient when thought of as a pedagogically well-based use of technology. The equipment purchases and the denser and more extensive networks swallow up so much tax money that the targeted quantitative level is difficult to reach and maintain.

Future investment needs will hardly diminish significantly. Although investment needs may appear to lower after the networks are

completed, rising running costs will keep the total need at a level which so far has not yet been reached, even temporarily, in many municipalities. The situation is best in all levels of vocational education. It is thus realistic to start from the fact that development is also needed for pedagogical activities in which even a small amount of equipment can be used to gain the best possible advantage for learning.

Networks and computers will not be efficiently utilized if appropriate learning materials cannot be purchased. Making teachers responsible for maintenance, in addition to their regular tasks, is now becoming more and more difficult as technology increases and becomes more complex. Maintenance must be transferred to experts in IT so that teachers can do what they are supposed to do, namely provide pedagogical support. There is still a pressing need to increase total expenditures on the instructional use of ICT. Therefore, cheaper equipment must be sought and its applicability must be experimented with. The pedagogical architecture of technical solutions must be developed more systematically. The results might lower costs if the equipment, materials and support could be used optimally. Even national cooperation in purchasing and updating programs might bring about significant savings, for example, with national licensing. The Ministry of Education and the National Board of Education could have coordinating roles. In this evaluation project a pedagogically appropriate investment and funding program was devised for institutes of general and vocational education up to the year 2002.

Transforming libraries into mediatheques

Libraries are off to a surprisingly good start in orienting themselves to the demands of the information society, and they have used new ICT to that end. The Internet has significantly transformed the very concept of a library. The availability of massive amounts of information on the Internet is increasing the need for information professionals, despite the fact that those who need information can nowadays independently access the sources of information more directly

than before. Expertise is needed, however, among other things for improving the quality of searches and for constructing and maintaining databases and WWW-based information services meant for end users.

More free client PCs are clearly needed in public libraries, not only for finding individual facts, but also as workstations for storing and producing output. According to the present thinking the school libraries should be the heart of the school. Unfortunately, the heart needs forceful resuscitation almost everywhere: well-functioning school libraries can only be found at the university and polytechnic levels. However, even there, few of them can be called *mediatheques*. The possibilities of a public library to serve schools are also far too limited, even in those cases where the library is so close that you can drop in.

Schools should find solutions which permit some equipment to be placed so that students can work independently and in small groups and where additional source materials are readily at hand. The library is very well-suited for this purpose. The role of the school librarians will then change profoundly from that of a traditional caretaker of catalogues and an on-call person for checking out materials to become that of tutors and information professionals. The most significant increases in expenditures will result from increased personnel costs.

Curricula must be improved

Education is more than teaching and learning with an emphasis on technology. Instead, when analyzing the impacts of technology on teaching and learning one must ask how we can broaden our viewpoint to embrace a more extensive interpretation of the information society in which the emphasis is on the qualitative changes in work, getting information, social participation and everyday life. Although the availability of sufficient appropriate technology is important when analyzing its impacts, it is even more essential to know what purposes technology is being used for and what the teaching and learning dispensed with its help are like.

The curriculum is nowadays understood to be a more dynamic concept. The schools' own curricula have become ever more important in addition to the national curriculum guidelines. In some areas even personal curricula are being devised. Not nearly everywhere does the curriculum take a clear stand on the instructional use of ICT as a target or a tool of instruction.

When the national curriculum guidelines are reviewed next time, a lot more attention has to be paid to the opportunities of the new technology and the demands of the information society. The guiding impact of the curriculum is strengthened through evaluation, and evaluation should be complemented by new technology, both as a tool and object of evaluation. Experimentation should be started, among other things, on how the new technology could also be used in student assessment, in addition to its current use for tabulating and recording results. In the same way, the evaluation of ICT skills should be developed.

At the university level as well, curricular shortcomings make it difficult to use ICT effectively. In many sectors, this aspect would require clear improvement in which the needs of students and working life, along with the academic demands made of students, should be better taken into account.

The report showed that the instructional use of IT has not been generated by the curriculum but instead by the teachers' personal approach. This was satisfactory during the pioneer phase, but the long-term consolidation of ICT use and the students' needs for it requires greater curricular commitment in this respect.

Teacher training must be increased and made more precise

When the students and the teachers start having equipment within their reach, the teachers' mastery will become more and more decisive for the outcomes. Teachers at all levels need much more technical know-how and pedagogical expertise. However, the learning needs of teachers are now diversifying so forcefully that more precise infor-

mation about them is needed so as to improve the effectiveness of teacher training.

The impact of the training can be strengthened by supporting the transition from theory to practice by making training a permanent part of the pedagogical development work in the school.

Development must be made permanent – the dissemination and scaling up of the results

In order to develop, the instructional use of ICT presupposes long-term networking activities with a fixed purpose. Schools can not develop in isolation from others who are faced with the same challenges. A more profound reform presupposes rather significant research and development investments. Therefore, research on ICT instructional use must be included in a national strategy and in basic funding. Finland has to be able to maintain a research and development program comparable to those found in other parts of the Western world.

To continue the present report work, a national research and development program of instruction technology should be designed under whose auspices even rather large projects could be funded. National funding is also needed for participation in international projects, which is necessary in order to keep in touch with the international state of the art.

Along with the big virtual school and university projects, one has to continue making small-scale autonomous improvements in all schools. The new communication technology makes possible the necessary networking, in which ideas and results are conveyed and new innovative practices are spread. Public funding for this kind of small-scale development could be mainly devoted to maintaining the high quality of network contents.

In the previous strategy to distribute funding for equipment and networking, a good idea has been to link the funding to development

plans. Funding is not granted without a pedagogical utilization plan. This criterion must be applied in the future, too, and the rationale for funding as well as the follow-up activities should be tightened.

The positive outcomes and experiences of these experiments have shown themselves to be extremely difficult to disseminate beyond the well-funded experimental conditions, so this problem should receive special attention in the future.

At its best digital learning material is an environment that is easily revisable and users are able to select from a large amount of material according to their own needs. In this way digital material is able to meet the user's need to investigate and understand phenomena. The publishing, producing and distribution of new products require new solutions.

It is equally important to understand that the Internet is also going to be a shop for new learning materials. Digital forms which can be transferred and revised through the nets are so advantageous for learning materials that the attending legal, technical and economic barriers must be minimized in every way possible. Furthermore, the various fields must be able to use the best international learning materials, and assistance in localizing them must be supported, if necessary.

It is of primary importance to get the national information resources to be used flexibly in education. It is also essential that information produced with public funding be as freely, easily and as inexpensively available as possible, especially for study purposes. This is related to a much larger national effort of digitalizing the national (text, image and audio) heritage.

New digital learning material is bringing about changes in the publishing of learning materials. Markets for new materials must be created. Public authorities can help stimulate initial demand by increasing the present amount of funding now reserved for the school purchase of learning material. Another way to support the supply is to fund the publishers' product development by advance orders. Thirdly, public organizations (the National Board of Education, the Finnish Broadcasting Company, national museums, etc.) can themselves produce nationally important but commercially perhaps unaffordable materials with public funding. All of these means have been used, and they must be used in the future, too.

Of the WWW-based learning material services, the management of the so-called educational object economy was described above. Its Finnish application is well-suited for development by the National Board of Education. Commercial publishers should also be made to come along. Establishing the educational object economy distributes the development pressure over an extensive area and offers an environment for step-wise and cumulative development work in which the threshold to join is reasonably low. This approach makes it possible to link the debate over materials directly to the materials and their development.

The effective utilization and distribution of the learning environments produced by the extensive development projects are often neglected. In the project funding one has to make more certain that the new learning environments to be developed will also be marketed effectively and that one will provide for their extensive utilization so as to ensure justification for the public money invested.

The most difficult obstacle to overcome in the use of digital learning materials and information networks is teacher motivation. Success presupposes real advantages. Therefore, one should reward schools on two levels for publishing content material on the network. For one thing, when the results of school activities are being evaluated, funding should be a reflection of the school's contribution to increase the reserves of national, generally available digital information. Secondly, it should be possible for both teachers and students to enter their materials in annual competitions in which the winners get significant personal awards. The conditions for publication should be arranged in such a way as to favor cumulative development work. In other words, one has to promote the publication of materials that constitute an advancement over, or new combinations of, previous materials.

The teachers' subject organizations should be supported in the creation of electronic communities to support the development of teaching methods. The subject organizations gather together teachers to improve instruction in their own field. If they start using the principles of electronic communities, they constitute a significant resource in the critical development of ICT usage. One task of these communities is to evaluate and further refine the information currently available in the information networks. They can also utilize

the economic opportunities of the information networks and integrate commercial and non-commercial partners.

Towards equality in the Finnish information society

The basis for self-directed learning and the purposeful use of technical tools is being created as early as in learning experiences during early childhood. Pre-school and the first stages of elementary school have a great influence in this respect. Through experiences that resemble play without any pressure to achieve, the utilization of technology becomes a habit of working and learning. Based on this, the evaluation project conforms to the rationale in the pre-school curriculum made by the National Board of Education (1996): "It would also be good if the children could familiarize themselves with the use of the computer as early as pre-school." With research and development activities, one has to guarantee that pre-school and initial learning have high quality programs and activity models that support the learning conditions and that take both genders equally into account.

The opportunities to utilize IT are very unevenly divided among Finnish citizens. Young, well-educated men in the Helsinki metropolitan area have the best opportunities, while those living in outlying areas, women, people who are less wealthy, and the elderly have less access to IT. People should be able to use ICT more and more as a tool against alienation and, for example, to alleviate the problems that come with being unemployed. Being able to use ICT in working places, schools and libraries adds in a significant way to the use opportunities at home. Furthermore, in the future it will be with their help that people can resist the polarization of the information society. The young, as well as others, must be able to use the schools' IT resources outside of school hours. The schools must be made into more open learning centers than is now the case.

The IT services of the libraries must be increased and kept free for the users, or at least so inexpensive that use will not be inhibited by the fee.

In many places students serve as assistants in the maintenance of the schools' IT. Such practices are really worth developing further and should be taken advantage of more extensively. The youngsters' growing expertise in IT could also be utilized to meet the needs of the community outside the school. More could also be done to help their IT workshops meet the needs of schools and libraries. The educational offerings of civic institutes must increase the opportunities of various citizen groups to receive training in using the Internet.

Virtual school and university projects must be developed in such a way that studying in open universities, distance upper secondary schools and study groups in free popular education can be functionally realized in network form.

Public data bases and materials that are based on research and on the actions of authorities must be arranged so that citizens can access them as easily as possible. For instance, some services of university libraries should be available for everybody, not only for people within the universities.

On all education levels, even in extramural learning, the contents which are being sought for and used with technical equipment will have a decisive role in determining the development of the Finnish information society. The threats are the trivialization of learning and weakening of the special characteristics of small cultures that are taking place through the multinational production and distribution of contents in the global net.

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