Towards a Learning Society in Finland: information and communications technology in teacher education

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ABSTRACT This article describes the recent development of Finland as a learning and information society. Education, training and research have been seen as core factors to accelerate development towards a society where all citizens have a high level of competence in using information and communications technology (ICT) in their lives. A short review is given of the present situation in schools and teacher education and of how governmental strategies have guided the development and use of ICT for a learning society in Finland. The strategies of teacher education departments in universities are then analysed with the main focus on how teachers learn to use ICT as a tool which opens up high-quality learning opportunities for pupils and challenges teachers' growth as professionals. Cases have been selected to describe good examples of teachers' pre-service and in-service education. These draw a picture of how ICT is applied in different fields of teacher education. At the end of the article some trends from the late 1990s to early 2002 will be summarised. These trends are: using ICT more as a mindtool, moving towards more collaboration, interactivity and active learning, more integration of ICT in curricula and a better technical and pedagogical infrastructure.

Introduction

Finland launched a special information society strategy in the mid-1990s (Ministry of Education, 1995; Ministry of Finance, 1996), in which the use of information and communications technology (ICT) in teaching and learning figured prominently as a key to accelerating the progress in the chosen direction (Sinko & Lehtinen, 1999). Education and research were considered to be fundamental factors to develop Finland as an information society. The national development has been outlined in the document *Education, Training and Research in the Information Society: a national*

strategy (Ministry of Education, 1995). The principles of the strategic actions can be summarised as:

- From instant training towards continuous learning, all levels of an educational system must develop their learning environments towards networking and flexibility, to provide individual learning opportunities using relevant ICT applications as their normal working methods.

- Information society skills for all – all primary and secondary schools must provide both genders with ICT skills. Adults should have opportunities to gain the basic skills of ICT and to deepen them continuously.

- Professional skills in ICT – Finland must be in the front line of vocational competence to develop services and products in information management. This requires high-quality basic and further education.

- Teachers have a central role. They must have high-quality content knowledge and pedagogical skills to supervise learners in independent inquiry. Teachers must be able to use different media in teaching and to develop relevant learning materials for these environments. Pre-service and in-service teacher education must be developed along the lines of these requirements.

- Knowledge products and services must be developed. High-quality national knowledge storage and resources must be available in education, training and research. Finnish multimedia entrepreneurship will be supported.

- Research into the information society. Higher education and research must be on the international cutting edge of research. This requires a high-quality computing infrastructure, e.g. workstations' capacities and high-speed connections. Learning through media and the interaction of human beings with machines are fundamental areas of pedagogical research.

- Information networks of education and research. The national ICT infrastructure is combined with global open networks, such as the Internet. Schools and learning institutions are also integrated parts of local communities and their networks. The whole educational system and libraries will be provided with the necessary infrastructure for access to information networks. The expertise for effective use of these facilities is secured.

- Supportive conditions – legal aspects, copyright issues, standardisation, publicity and intimate protection, security of information networks, and commercial conditions are clarified.

Since 1995, the crucial aims have been to combine ICT skills with a good common civilisation, a large variety of skills to manage and solve problems and professional abilities to work in a continuously changing and networking working life (Ministry of Education, 1995, pp. 13-16).

The Ministry of Education (1999) has updated the ICT strategy in *Information Strategy for Education and Research 2000-2004*. This is a continuation of earlier governmental efforts to steer national growth towards an information society through learning and education. The main concept is a 'learning citisenship society'. The updated strategy consists of ten national projects to ensure development in 2000-04. The projects are:

1 Information society skills for all.
2 OPE.fi ('TEACHER.fi', a free translation).
3 Education and training of professionals in knowledge production and digital communication.
4 Virtual University.
5 Virtual Polytechnics.
6 Virtual School Project.
7 Research into learning environments.
8 Digital learning materials.
9 Infrastructures of an information society.
10 Cultural content production.

All of the projects have many sub-themes and at the national level, they promote large-scale collaborative activities. The Virtual University is a consortium of all of the universities in Finland and provides learning opportunities over university boundaries to all university students. The Virtual Polytechnics is also a joint project of all of the vocational higher education institutions. Production of high-quality digital material in the national language is also an important mission of many projects, focusing on developing learning materials for a virtual environment and storing cultural materials digitally. The infrastructure of an information society aims to create effective technological environments for communication, learning and knowledge production in both educational institutions and non-institutional settings such as homes and during leisure time. The intermediate report of the projects has been published in 2002 (Ministry of Education, 2002a).

Research into ICT in teaching and learning is an important part of the national strategy. There have been several national research programmes focusing on the themes of the information and learning society. Since the mid-1990s, Tekes (1996), the national technology funding agency, has funded programmes which promote new research into electronics and telecommunication and programs which have educational technology and 'user-friendly' interface components (e.g. *Usix*). Two new programmes 'Life as Learning' and 'Proactive Computing' started in 2002, funded by the Academy of Finland. Also in 2002 a new national multidisciplinary doctoral

school was established with the purpose of promoting research into technology-based learning environments. The Ministry of Education has also supported a network and annual meetings of researchers who focus on developing ICT in teaching and learning (Academy of Finland, 2002; Tekes, 2002).

Many of the strategic projects and programmes have a strong connection with pre-service and in-service teacher education and teachers' work in schools. The most important of these is the project 'OPE.fi' (TEACHER.fi, a free translation), from the point of view of the teaching profession. It sets aims for teachers' development in different educational institutions. The other projects, such as 'Infrastructure' and 'Developing Digital Learning Material for Schools and Higher Education', also support and create conditions for the effective use of ICT in schools.

The OPE.fi project sets the aim that, during the period 2000-04, all teachers will have at least basic ICT skills and to ensure that half of all personnel in educational institutions will have high-level skills. The OPE.fi project has three different levels, which facilitates strategic progress towards teachers' ICT competence. The project outlines both pre-service and in-service teacher education (Ministry of Education, 1999).

Level	Skills/Competencies
I	Every teacher can use computers and other ICT facilities, and has knowledge of the principles to use them in teaching and learning. These skills are related to word processing, email, the World Wide Web and educational technology in teaching and learning
II	At least half of the teachers, in addition to basic skills, have more advanced ICT competences, such as: – implementing email, the Web and ICT-based platforms for groupwork; – managing toolkits for developing teaching and knowledge of the main principles of producing and using digital material in their own teaching area and good competences for pedagogical applications of ICT; – following up the development of technological tools and programmes
III	Ten per cent of the teachers should have special competences in ICT, such as: – content-specific or profession-specific applications, e.g. picture management, multimedia, distance education applications, simulations; – high standards in levels of pedagogical applications and skills, to support colleagues as ICT users, to work as ICT trainers and developers of schools and learning communities and as partners of expert networks; – special skills in computer programming; – producing digital material; – ICT management and administration in schools; – anticipating ICT innovations in teaching and conducting research into them

Table I. Competency levels of the OPE.fi project.

The important aim is that the ICT strategies help the whole institution to grow as a community. ICT is not a separate component in a teacher's work. It must be integrated as a natural element in teaching and developing

instruction in schools. ICT should also be a connecting factor, creating a culture of collaboration and sharing in schools and teacher education (see also the penultimate paragraph in the article by Kirschner & Davis in this issue).

Teachers' pre-service and in-service education also has a special position in the updated national plan. Teacher competence is a core issue in developing the information society. It is not only a question of ICT skills, but a much deeper and larger cultural issue in schools. The boundaries between school, home and working life are diminishing. This requires new methods in teaching in which collaboration and sharing, providing students with learning skills, and learning and working in net-based environments are essential qualities. Changing learning environments opens paths for lifelong learning, and the acceleration of knowledge production in particular requires combining pedagogical expertise with collaborative methods in teaching.

According to updated strategies (Ministry of Education, 1999), all pre-service and in-service teacher education should allow for:

- learning and studying in different environments;
- continuous development and evaluation of working communities;
- sharing and adding expertise in communities;
- inquiring, managing and assessing knowledge;
- knowledge of different cultures and communication skills;
- using multimedia and different methods in studying;
- in-depth content knowledge;
- an innovative approach;
- opportunities for different new media tools and environments.

The OPE.fi project also requires all educational institutions to evaluate their current curricula, and by 2002, design their strategic plans on how to use ICT in teaching and learning. In this article, the current situation in ICT in teachers' pre-service and in-service education will be analysed through the strategies of teacher education departments and by describing teachers' ICT working conditions in schools.

ICT in Schools

Finland Towards an Information Society Programme (Ministry of Education, 1995) states as its aim that schools should have a maximum of 10 students per PC by 2000 (Table II).

Schools/educational institutions	Students per PC
Comprehensive schools – primary level	10
Comprehensive schools – lower secondary level	8
Upper secondary schools	6
Vocational schools and polytechnics	3-5
Universities	10

Table II. Students per workstation: aims for schools by 2000.

In 2000-01 (Table III), the actual situation was surveyed by the working group set up by the Ministry of Education (2001). The results revealed that the institutions have not achieved these objectives and that there are great differences between schools. The weakest conditions are in the large urban comprehensive schools (ages 7-15 years) (more than 400 students), with 13 students per PC and the large upper secondary schools (ages 16-18 years) (more that 1000 students), with 33 students per PC. Practically all the schools have an Internet connection, but at the primary level (ages 7-11 years) 45% of the schools only had a dial-up connection. The problem is that in some institutions the computers are too old. The committee's recommendations were that new workstations should be acquired and that a quarter of the old workstations should be replaced annually. They also proposed that technical support personnel must be available, with at least one full-time person per 50 workstations. The committee also recommended that teachers should receive pedagogical support in addition to technical help to enhance the use of ICT in teaching (Ministry of Education, 2001). Pedagogical support can be arranged in such a flexible way that teachers can have help at grassroots level and learn how new technical environments can be used and developed as a pedagogical tool.

Schools/educational institutions	Students per PC	% old* PCs	% with high-speed connections	% with dial-up connections
Comprehensive schools	11	63	54	45
Upper secondary schools	13	54	97	3

* PCs purchased before 1998

Table III. ICT infrastructure in schools in 2000.

The earlier survey in 1998 (Sinko & Lehtinen, 1999; Huovinen, 1998) pointed out that in 1997, there were 8-16 students per PC in comprehensive schools and 8.6-18.4 students per PC in upper secondary schools, depending on the size of the school. The conditions have improved a little since then, but at the same time the PCs have became too old. The earlier survey

showed that there was a relationship between the frequency of teacher use of ICT in teaching and the number of PCs available. The survey also indicated that the number of computers did not automatically increase teachers' ICT use in their instruction. In addition to technical infrastructure, they also needed pedagogical support.

All educational institutions have to submit their ICT strategies to their local authorities by the end of 2002. This process is under way. Tentative results of the analysis of their strategies are indicating that there are serious efforts being made towards achieving the aims of the OPE.fi project. Teachers' ICT skills have increased on the whole, and the use of ICT has become more frequent. However, schools differ depending on their local resources and authorities. Some cities and municipalities have had an ICT strategy for many years, which has had a clearly positive impact on schools.

Developing ICT in schools is a long process, which not only needs an effective technical infrastructure, but requires psychological and cultural changes in teaching and learning. It changes teaching and evaluation methods, as well as teachers' and pupils' roles. It seems that schools are in the middle of this changing process. Teachers are not resisting implementing ICT, but neither are they totally convinced of its advantages. Their doubts have focused on some key elements: they are expecting better learning materials and digital content in the national languages, they have problems integrating ICT in the curriculum, they feel that they do not have enough time for ICT and that the schools lack both effective technical facilities and support to maintain these environments. However, it does not seem unrealistic to achieve the objectives of the OPE.fi project by 2004. As an example of how teachers' ICT competence can be increased with school-based efforts, the following case will be presented (Walls-Carpelan, 2002).

The Sipoo Institute Project

Sipoo Institute can be called a virtual institute, or a project which started at the beginning of 2000 and will continue at least until 2005. (For more information please see http://sipooinstituutti.net/asp/hankkeet/index.htm 2002.) Sipoo is a small rural town with 20,000 inhabitants, situated approximately 25 kilometres east of Helsinki, and utilising ICT in education in an innovative way. Sipoo Institute aims to develop, together with teachers, on-line learning in a wide-ranging and balanced way, in order to find out how the network could be best used in classrooms.

Sipoo Institute emphasises the role of the whole school community in the development of educational ICT throughout the primary, secondary and tertiary education levels in Sipoo. Of about 110 teachers in Sipoo, at least 30 are involved in ICT projects, and all of the teaching staff have been provided with a large selection of ICT training and school-based support. The bottom-up principle has been extremely important and – perhaps – a success factor for the whole project. Teachers and principals have together,

equally, made many important decisions and set up the goals regarding the ICT use, not the other way round, with the local authorities telling them what to do and setting the goals.

The main idea of Sipoo Institute has been to develop tools and methods to be used in as many subjects as possible. Working methods used have been to:

- collect and process information in order to develop cognitive skills needed in web-based learning;
- learn how to inform others on the Web using home pages, webzines and video news;
- use collaborative learning and working in web-based environments;
- use learning diaries and portfolios, and tutor and assess learning processes in web-based environments;
- provide technical support systems as an aid for web-based learning.

Video conferencing has been an ongoing part of various projects in Sipoo; schools in the 'Comenius' project, for example, have been using video conferencing with their foreign partner schools in order to gain authenticy in classrooms (e.g. language teaching projects). A special emphasis has been laid on web page publishing and planning and designing digital learning material on the Internet and in learning environments. Mobile learning – to some extent – has also been introduced to teachers: SMS (short message service), integrated with a web-based learning environment, offers students quick information services from their schools, teachers or courses to their cellular phones.

Multimaker (multimedia work tool application) has been used and implemented in web page materials, for example, in a reading comprehension course in English. The teacher planned the course to be delivered in a web-based environment and the technical support person uploaded the digital material and designed the course platform. A file manager application (which functions on the *Linux* server) was applied here. In addition to English, the aims were also to learn to use ICT to create photo images with a digital camera and use them in the learning environment (course platform); to use asynchronous and synchronous discussion forums and, especially in asynchronous communication, to import and manage files and edit them if need be, etc. Another application called *Ryhmix* (groupware) is also used to a large extent, especially in science subjects. The *Ryhmix* groupware system provides an individual teacher's and student's report on all the comments and reflections of both the teacher and the student throughout the course. It provides them both with a new way to assess the whole learning process. In many courses, 'a new coursebook' is the result of the web-based coursework done by the individual teachers; thus, the material is up-to-date, tailored for specific

groups and constantly changing together with the feedback and interaction of the students of the subject or the course.

Sipoo Institute also connects other educational institutions on a larger regional basis. Sipoo Institute and the Training Consortium of Vocational Education KEUDA (http://www.keuda.fi) have joint courses, and schools in neighbouring municipalities are partners in developmental projects. Other major partners are the National Board of Education (which also partially finances the project), Campus Internetix (http://www.internetix.fi/), which provided the first completely net-based virtual upper secondary school for adults, and the University of Helsinki, Department of Education. The intensive collaboration and networking with Campus Internetix has contributed to a versatile virtual learning environment, together with Sipoo's self-tailored web environments.

ICT in Teacher Education

Common Trends and Projects

This article focuses on university-based teacher education, which covers all teachers from kindergarten to upper secondary school. Teacher qualification in Finland is based upon a 5-year higher-degree programme. Finland has eight universities with 11 teacher education departments. Vocational teacher education is offered in five polytechnics.

All teacher education departments in the universities submitted their strategic plans for using ICT in teaching and learning to the Ministry of Education by the end of 2001 (Ministry of Education, 2002b). The strategies were designed for local university purposes, and though their structures and lengths varied greatly, they had some common features. Each teacher education department followed the strategic steps of OPE.fi. As a very rough generalisation, at least 50% of the teacher educators had reached the OPE.fi project level, but in some universities competence level was as high as 80%. Teacher educators at all institutions showed great willingness to learn to use ICT in teaching and learning. Each teacher education department had implemented a development policy and organised more pedagogical support to teacher educators to include ICT applications in their daily work (Ministry of Education, 2002b).

The infrastructure is also improving. In 1998 there were on average 14 students per PC (varying between 5-50 students per PC). A recent government study (Ministry of Education, 2001) found that in 2000 there were 13 students per PC (varying between 3-29 students per PC). The main objective in all teacher education institutions is that all new teachers have at least basic skills in ICT, reaching the OPE.fi I level, and they learn to assess how to use it in teaching and learning. In addition, each university also offers special courses in ICT applications giving student teachers a chance to achieve the OPE.fi II or III levels. There are joint national networks in which

all teacher education institutions are partners to advance ICT in teaching and learning. Examples are:

- The Finnish Virtual University (FVU) is an alliance of all the universities in Finland. It will create channels to deliver courses and other study options in different universities. The portal of the FVU combines and creates materials from the partner universities available to students, who may select individual courses or larger combinations. They may also connect conventional campus-based studies and FVU studies with each other. The FVU does not serve as a direct provider of instruction. However, it has certain meta-level tutoring services: a learning skills tutoring service, which supports students in planning their studies and in growing as learners (e.g. Niemi, 2002). The Ministry of Education has supported local universities in running projects which produce courses for the FVU or to combine web-based studies with their programmes at the local level. Some of the projects are courses in different academic fields, some are collaborative modules of minors or majors in different disciplines.
- The Virtual Project 'KasVi' (EduVi) is a national collaborative project of all the teacher education departments of universities in Finland. It provides pedagogical studies in a web-based environment to teachers who have no official teaching qualifications but who have worked in schools and aim to become qualified teachers. The study programme is partly virtual, partly locally based. All host universities are responsible for some courses in their own specific areas of expertise. This project offers experiences in how teaching practice and teachers' growth processes can be supervised and supported virtually. It also aims at developing a teacher education curriculum for technology-based learning environments, and to create new models to apply open and distance education in teachers' pre-service and in-service education. The project also consists of research on these experiences.
- 'National Networks for University Teachers' also includes teacher educators. 'TIE VIE' is a project which promotes ICT in higher education instruction. 'IT-PEDA' is a network which creates a communication forum for ICT experts in different universities, ICT-oriented people in ministries, other universities, and student unions and associations. The networks allow virtual collaboration and support national conferences where new ideas and projects can be introduced.
- 'Network of Normal Schools' ('E-Norssi') is a network of all university internship schools, where student teachers can obtain experience in classroom teaching. E-Norssi aims to promote ICT in teaching practice and provide high-quality ICT learning environments for student teachers.

ICT Orientation as a Major or Minor in Teacher Education Programmes

Some universities provide a 5-year programme (300 ECTS) with a strong ICT or technology component.[1] Since 1997, the University of Lapland has had an ICT-oriented teacher education programme for primary school teachers consisting of media pedagogy as a major (±120 ECTS) or as a large minor (±60 ECTS), focusing on media and communication as societal phenomena. It teaches new teachers to make assessments about media use from cultural, aesthetic and ethical viewpoints. The main parts of the programme are: new learning environments, critical media pedagogy, and practical media education. The objectives of the programme are to provide new teachers with high-quality, practical ICT skills, a good theoretical knowledge basis, and support in applying theories related to new environments. Their higher-degree theses are closely connected to communication and information technology (Department of Teacher Education, 2002).

The Faculty of Educational Sciences and Teacher Education (2002) at the University of Oulu has had a technology-oriented teacher education programme since the autumn of 1996. (For further details please see http://www.oulu.fi.) It is based on a standard Finnish teacher education programme with special emphasis on training teachers in skills that enable them to make use of things that technology makes possible. It aims, on the one hand, to educate children to understand the world of technology, including its advantages and disadvantages. On the other hand it is meant to stimulate teachers' readiness to use knowledge and the skills of maths and science in technological education, and vice versa, to use technology in developing maths and science teaching. The structure of the 5-year education programme comprises a major and minor, each with a strong focus on technology. A major (120 ECTS) of this programme is orientated towards curriculum design in technology education, didactics of technology, and technology and culture of maths and science. The programme also has a strong research component.

Other universities such as the University of Helsinki and University of Tampere provide ICT or media education as minor studies (30 ECTS) and as larger minors (60 ETCS) for the teacher's higher degree. These studies provide extensive skills to use and develop ICT in teaching and learning and to do research work in these areas. They give skills which are typical at the OPE.fi project's second and third levels.

Special Content Knowledge for Teachers

Some universities have created virtual courses or modules which are based on specific academic disciplines or content knowledge. 'eScience' is a training programme developed in the joint project between the Department

of Teacher Education at the University of Helsinki, the City of Helsinki and the Federation of Finnish Electrical and Electronics Industries (Walls-Carpelan, 2002; for further information see http://www.malux.edu.helsinki.fi/koulutus/escience/index.htm).

It is a programme for primary school student teachers. eScience provides part (10 ECTS) of the 60 ECTS credits allocated in total for studies in school subjects in the 5-year teacher education programme (300 ECTS). The courses include pedagogical content knowledge of maths, science and technology and their design was based on design research described by Edelson (2002) within the 'Arithmetic, Science and Technology e-Learning' (ASTeL) project. The first student teachers started the programme in February 2002.

The goals of eScience are 1. to design and plan a virtual (web-based) learning environment for primary school teacher education, where versatile teaching methods of science and technology education can be introduced; 2. to introduce physics and chemistry subject knowledge to primary school student teachers learning in distance education settings; and 3. to develop a learning environment for primary school pupils. The design puts special emphasis on opportunities for web-based publishing. The web-based material aims at:

- encouraging pupils to study and learn science subjects;
- encouraging teachers to teach more innovatively;
- contributing to pupils' enthusiasm in these subjects;
- being easily accessible and easy to use in the classroom and at home both from pupils' and teachers' point of view;
- offering the pupils new, rich learning experiences;
- offering teachers new teaching and learning experiences.

The various ICT areas of this programme all contribute to developing participating student teachers' ICT skills and make it essential for them to become competent personal users of ICT. These areas include a learning portal, different learning environments of which the ASTeL learning environment is the most important (foundation and 'backbone' of eScience), simulations and games, and wide-ranging use of multimedia (sounds, moving images and animations). This whole is provided to student teachers in a *WebCT* learning environment (net-based distance education), combined with occasional short (1- to 2-day) intensive workshop seminars (information, instruction and practical use of the ICT tools and skills required by the student teacher). The distance education training for the student teachers deals with issues such as how studies in chemistry, physics and technology could enlarge and increase pupils' views of life and contribute to a wider understanding of the technological structures/technologies that lie behind our modern societies. These discussions, reflections and inputs will take

place on *WebCT*'s asynchronous (bulletin board postings) and synchronous (chat) areas, email lists and in face-to-face meetings and seminars.

In-service Courses for Teachers

Many teacher education departments have in-service courses where ICT is used as a tool for developing teaching and learning. An example of this is 'The Finnish Virtual School for Science Education' (FVSSE) of the University of Helsinki (Lavonen et al, 2001; Walls-Carpelan, 2002).[2] The FVSSE was founded in the autumn of 2000 with seven local authorities all over the country, as well as four researchers from the Department of Teacher Education at the University of Helsinki, coordinating the whole programme. The goal of the FVSSE is to improve learning and teaching in science through the effective use of ICT. Specifically, the FVSSE aims to develop *new approaches* for science education where ICT can be used in a versatile manner within several teaching methods, help science teachers *adopt and develop pedagogical models* for utilising ICT in science education, and *foster collaboration* between schools and universities, and other institutions, to provide professional development opportunities for teachers. Two cities (Vantaa and Oulu) and three rural towns (Eurajoki, Kauhajoki and Kiuruvesi), with their participating teachers, are involved in this project, now in its 3rd year.

An important working method is the 'Virtual Library', which supports the student teachers, as well as all Finnish science teachers, with an outstanding link to a collection of resources for using ICT in pre-service and in-sevice science teacher education. The library contains electronic databases and search engines, handbooks (general and research methods), on-line journals, learning environments and course management systems, and articles of interest. Internet databases of newspapers also offer excellent sources for science education, e.g. concerning local environmental issues.

The pedagogical basis of the FVSSE underpins the 'Rich Environment for Active Science Learning' (REASL). *Active science learning* means that students are involved in their own learning, such that teachers can transfer the responsibility of learning to them (Bentley & Watts, 1989). *Rich* means that ICT offers a wide variety of different methods for students to become active learners (Grabinger, 1996). It facilitates students' active roles in the creation of meanings for new concepts based on information available, their prior knowledge and their individual and social experiences. In REASL, the teacher is the consultant who guides and supports the students' learning, chooses appropriate teaching/learning methods and guides students to integrate ICT into their learning.

A rich learning environment also reaches out to nature (e.g. during field trips) and to the man-made environment. Data are collected 'on site' and distributed and presented (e.g. graphically) to fellow teachers and students. In this way it is linked to the opportunity to network in learning

situations, to the mobility of learners, and to partial independence of time and place.

First-year activities in the FVSSE are based on the self-evaluation data on teachers' ICT skills and availability of equipment in the science classroom. Based on these data, we concentrated on developing a pedagogy of using ICT in science education in those areas where teachers felt competent in using ICT (Lavonen et al, 2001). New pedagogical and ICT knowledge, as well as skills learned in connection with real and virtual meetings, are applied in a school context by small groups of teachers and the experiences are then reported in real and virtual (e.g. computer conference) meetings. A large part of the FVSSE is thus self-directed, distance-guided work in groups of two or three teachers at their school sites, within different projects. Working is supported through a discussion forum, personal email discussions and web pages. Teachers are encouraged to discuss in small groups in order to assess their knowledge and experience, to share their experiences, to reflect on current teaching, to plan teaching sequences and to organise small teaching experiments in their classrooms. Both the teaching sequences and the experiences teachers gained with their students were published on the home page of the FVSSE.

Activities and projects within the FVSSE are on two different levels, namely experiences of teachers within real and virtual meetings, and experiences of those teachers and pupils in the classrooms. Two-day contact meetings twice a term, and computer conferences between the meetings, are the main working models for the FVSSE. A separately selected subgroup of teachers plan each contact meeting and computer conference before and after the meetings. On the basis of tentative results we see that gradual, positive changes have occurred in school practice.

Discussion and Conclusions

In 1998, a large evaluation project whose purpose was to examine the impact of ICT on education was initiated by the Finnish Parliament. The review process covered the entire education system, from childhood to adult education, taking into account principles of lifelong learning (Viteli et al, 1998; Niemi, 2000).

The evaluation revealed that teachers in schools, teacher educators and student teachers in universities mainly used computers for word processing, email and surfing the Web. Their ability was fairly low with regard to using other applications of telecommunications, such as video or Internet conferences, or to using or producing electronic learning materials. ICT was not yet a real mindtool (see Wopereis & Kirschner in this issue) or forum for networking. Vocational teachers had the best ICT skills and kindergarten teachers had the lowest readiness to use ICT. Teachers and student teachers did not undervalue ICT. They strongly indicated that they would need more opportunities to practise using ICT, with the first step being the

procurement of easy and flexible access to computers. In addition, teachers, teacher educators and student teachers requested more courses and support, and asked for more training and tutoring to help create meaningful pedagogical environments with computers or other ICT applications. They hoped that this help could also be given as on-line support, not as a traditional course. In addition, there was a lack of software in the Finnish language of a suitable standard. The evaluation revealed that there was a clear relationship between the available technical infrastructure and user readiness, which meant that ICT skills could not be learned without an effective infrastructure. In addition, there is the need for technology to grow along with experiences in open learning environments. The frequency of using ICT and considering it as an important aid was highly correlated; those who used it saw it as a meaningful tool, and vice versa. A very serious problem seemed to be that neither students, teacher educators nor student teachers had the time to learn new skills and there was no space for this in the course schedules.

At that time, relatively few ICT projects were being run in schools or in teacher education. Those that were running remained projects within small active groups, very often isolated from other schools or the teacher education community. The culture of these projects was different from what is usual in these institutions. They worked with a flexible timetable; they allowed for individual choices; and they had contacts with other institutions and partners. The projects were very rewarding for participants, but they had difficulties in becoming integrated with traditional school life or teacher education practice. There was a danger that the projects and innovative practices would only enrich their participants, without enabling other students or teachers to benefit from the experiences gained in the projects.

If we compare the situation in 2002, clear changes have occurred. ICT is now more part of the daily life in schools and pre-service and in-service teacher education. The infrastructure is better, but also the demands on it are greater. All schools and teacher education institutions have Internet connections and systematic staff development has started. More innovative projects are running and in the best of cases they are a natural part of school life.

Schools and teacher education are in the middle of a cultural process. It is only partly connected with ICT. It is, in a larger sense, connected with changes in the teaching profession and school life in a learning society. Schools have to prepare students for the future (Luukkainen, 2000). ICT is not a separate area; its meaning and importance are seen based on how it adds to the quality of knowledge and learning. The situation can be described through the following trends:

Towards More of a Mindtool

ICT is seen more and more as a tool to create something new, individually or together. It provides resources (e.g. through the Internet, databases and libraries) and it helps to find, structure, and restructure knowledge. Its value depends on how it supports learning and different learners. Innovative projects create new concepts and practices, and these again raise new needs. Little by little, these change the curriculum and school culture. Processes are slow. But at a general level, there are many signs that ICT may facilitate the restructuring processes and work as a mindtool in schools and teacher education.

Towards More of a Community

Schools and teacher education use ICT more as a platform for networking and sharing ideas. New strategies and practices emphasise collaboration among teachers and between teachers, students, parents, and local partners. ICT is not only an information delivery channel, but also an interactive platform. The aims of the TEACHER.fi project are that all teachers gain basic skills, but in local communities different expertise is needed. Teachers do not need to master everything in ICT, but they do need to learn to work together and share their expertise. This process is still taking its first steps and is dependent on teachers' professional culture. However, it seems that ICT may advance collaborative projects and create local, national and global networks in which teachers and students are partners.

Towards More Integration in Curricula

All national-level ICT strategies have emphasised since the mid-90s that ICT must be integrated into the curriculum. It cannot be a separate area in education. The process has been slow because of a lack of teacher competence in ICT and a lack of infrastructure. Now it seems that basic skills are more common and schools and teacher education institutions have more computers and fast Internet connections. The new ICT strategies of teacher education departments and schools show that ICT is being integrated more into school subjects and the daily life of schools and universities than previously. But we have to see that strategies only give a direction and plans for the future. What happens in real life needs follow-up and evaluation.

Towards More Active Learning

Earlier, ICT was more or less a technical tool and learning to use it was important in itself. Now it is more of a pedagogical tool. Its value is judged

on the basis of how much it adds to the quality of learning, makes students active learners, and promotes a participatory, collaborative culture and problem solving. In this respect, teachers have critical minds. They put a lot of pressure on infrastructure and demand high-quality software.

ICT is seen in Finland as a tool to accelerate development in a learning society. It requires a continuous interactive process between sociocultural and technology infrastructure factors (e.g. Markkula, 2002). This process is stimulated by governmental input, but it cannot move in the appropriate direction without determined efforts at institutional and personal levels. The Government has taken an active role to advance ICT in Finnish society. The strategic plans are ambitious and aim for citizens to be ICT-literate and have access to knowledge and information through new technology. In addition, the aim is that Finland should be in the front line of ICT development in various fields of its applications. These aims require simultaneous processes in several sectors of society.

As a sociocultural phenomenon, ICT changes leadership and roles in organisations (Szewczak & Snodgrass, 2002), as well as teachers' and students' roles in schools. It also creates opportunities for collaborative knowledge production and problem solving, dissolving previous limits of time, distance and ownership of knowledge. It also creates new social dysfunctions, such as problems of privacy, escape, lack of commitment and false role models. Pre-service and in-service teacher education must face these issues.

The technology infrastructure component means that people have high-capacity computers and fast network connections are available. Technological development must serve users' needs and there must be standards which make networking easier. Legal issues, such as copyrights, must be clarified and agreed upon. Interaction between a sociocultural and technology infrastructure component is necessary in all fields where ICT is applied, e.g. in social and health care, business and commerce, people's leisure time and certainly in the educational system. This requires a continuous development of pre-service and in-service teacher education, as well as ambitious efforts to advance ICT infrastructure in schools and teacher education. The Ministry of Education has updated the national ICT strategy in this direction to stress that teachers' competence and infrastructure are key issues in a learning society.

Notes

[1] ECTS (European Credit Transfer System) is a new European credit unit. 1 ECTS is about 27 hours of students' work.

[2] The Finnish Virtual School for Science Education – http://www.malux.edu.helsinki.fi/malu/tutkimus/index.en.htm

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