

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

ICT AND INITIAL TEACHER TRAINING - RESEARCH REVIEW DRAFT

Introduction

Since 2007 the OECD Project on the New Millennium Learners has been pointing to the increasing gap between the current use of technologies for teaching and learning in schools and the daily experiences that pupils have with technologies outside of school (e.g. OECD, 2006). An example of this comes from a large Scandinavian survey¹, where pupils in 5th and 8th grades in primary school and 11th grade in secondary school report that they use computers a lot more outside school and that there is also a difference between what is learnt in the two settings (Ramboll Management, 2006). At school focus is on using standard office programs such as word processing or calculation sheets, while the pupils claim they learn how to use the Internet outside school. According to the same survey, one in three Nordic teachers think that pupils are less critical of what they find on the Internet than from other sources. This underlines the importance of teaching how to assess and validate information on the Internet – a task parents want schools to do but do not think they actually do (ibid.).

According to many surveys, this is no longer a problem related to the lack of availability of technology in schools. Most OECD countries communicate adequate access to technology resources (OECD, 2006). Governments and other stakeholders in OECD countries have dedicated large budgets to ICT projects in schools. In SITES 2006 it was found that almost all countries in the study have a policy regarding the use of ICT in the educational system (Law, Pelgrum, & Plomp, 2008), but only a few countries have reached a stage where policy is really transferred into the educational system. Therefore, the question is raised why is technology not used to the extent that could be expected?

The lack of teachers' use of ICT in teaching could be explained by a number of reasons. For instance, attitudes towards technology and resistance to change were identified as early explanations (Fabry & Higgs, 1997). Research has revealed that teachers use ICT to a great extent for personal use (e.g. Merchant & Heptworth, 2002), although statistics from Sweden show that teachers use computers less for personal use than the average citizen (Knowledge Foundation, 2006; Nordicom, 2008). According to Russell, Bebell, O'Dwyer and O'Connor (2003) new American teachers, with less than 5 years of teaching experience, were more comfortable with the technology itself and used it for preparation, for instance, but used it less for instructional purposes than their more experienced colleagues. New teachers in Sweden² report regarding information seeking, which is widely used in schools (e.g. Larose, Lenoir, Karsenti, & Grenon, 2002; Pasternak, 2007), that, during their teacher education, focus was on their own information needs and that they were not at all prepared for guiding young students in this

¹ 8000 respondents from Denmark, Finland, Norway and Sweden participated in an online survey in combination with follow-up visits at the 224 schools.

² 6 teachers working less than 4 semesters in lower secondary school participated in in-depth interviews

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

process (Lundh & Sundin, 2006). Student teachers in the UK are also reported to be using computers to a greater extent for their own lesson planning than with their students in the classroom (Twidle, Sorensen, Childs, Godwin, & Dussart, 2006). According to Moeini³ (2008), new teachers have to rely on a “trial-and-error” method regarding ICT in their own teaching, which he thinks can no longer be accepted.

This and similar studies illuminate the importance behind teachers understanding not only how to use computers but also general pedagogical knowledge, as well as an understanding of how technology impacts the learning process. Although more and more teachers and student teachers are becoming personal users of ICT, and the availability of technology is increasing, this knowledge does not simply transfer to teaching practices (e.g. Ottesen, 2006; Player-Coro, 2007).

Some questions arise: How is it possible to prepare new teachers to meet tomorrow’s demands in this respect? Are the problems the same all over the OECD-countries? The objective of this review is to summarize the research knowledge base about ICT in initial teacher training, and, from this, discuss what can be done both in terms of policy making and further research within the field.

Definitions and limitations

This review is limited to the years 2002–2008, and the reason for not going further back in time is that technology is changing rapidly, and some of what was considered as ‘new’ technology at the end of the last century is not always considered as contemporary technology today and is, therefore, not relevant any longer. What can be considered as ‘basic skills’ is not always the same either, since newer technologies continuously enter the scene. The definition of ICT is very wide, but when searches have been done in databases, the words technology, IT or ICT have been used. The articles found, mostly consider personal computers, but when teachers and student teachers are asked about technology use in the classroom, it is not always defined. Some articles from the period studied build on data from around the shift of millenniums, the oldest one from 1997. Not all articles give an account of the year of data collection. Twenty-seven articles out of 56 provided this information, and the average time from latest data collection to published article is 2,3 years.

Not only technology changes, but also student teachers change. People born in the latter 1980s and later grew up surrounded by digital technology and the Internet. Researchers have given them different names depending on the scope of research. N-geners (Tapscott, 1997), Homo Zappiens (Veen, 2003; Veen & Vrakking, 2006), digital natives (Prensky, 2001), or New Millennium Learners (Pedró, 2008) are a few examples. In research data from 1990s, these people were hardly pupils in comprehensive school; today they are entering teacher education. In the articles described here, data was collected between 1997 and 2006. Eleven authors provide information about the student teachers’ ages. Most of them give the range of ages, and in eight studies there are some students older than 30, in seven studies there are students older than 40, and in six of these even 50 and above. The ages and the years of data collection indicate that the majority of student teachers in this review do not belong to a digital generation, even if there is a difference from earlier studies.

Several databases have been used to find relevant literature (e.g. ERIC, Academic Search Elite, Science Direct), but also reference lists in articles, websites, and personal contacts. Searches have mainly been in English, but there are also articles in the Scandinavian languages and in French. The

³ From Baskent University, Turkey

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

main body of research found⁴ covers the United States (33) and the United Kingdom (11). From Canada there are 4 studies, 3 of them large scale studies. Seven articles cover other OECD-countries - Australia, Finland, the Netherlands, Norway, Portugal and Sweden (2). The picture presented in these articles does not differ from the picture given in articles from USA or UK, although it is not complete. It can therefore be assumed that the situations in those countries have similarities, but findings may not be generalized to all OECD countries.

Searches in databases by using the words *technology*, *teacher education*, *information technology*, *ICT* and similar words resulted in less than 70 articles. Technology terms combined with *induction teachers* or *new teachers* did not result in any articles. Thirty articles of those found through databases were considered as corresponding to the criteria mentioned below. In total, about 250 articles have been studied and 61 selected. This review focuses on how teacher education institutions work on preparing teachers to use technology in their future classrooms, and articles presenting empirical research in this area were selected. Studies that focused on using ICT as a tool for student teachers' own learning were excluded from this review as there was no information specifically concerning how to use technology for instruction.

The studies vary in size from the smallest case study with 4 informants to the largest survey with 2, 848 respondents, which also means differences in designs and methods. Twenty-three studies have 30 informants or less, sixteen studies have 31-100 respondents, nineteen studies 101-1000, and three studies more than 1500 respondents. Different designs have different aims, it is therefore not possible to compare the results, but altogether they can give a more complete picture. The quality also differs, and in some studies conclusions are drawn which cannot be considered as having support from the empirical data presented. Conclusions like this are left aside although other part of a study might be referred to. Problems with finding enough well done studies in this area are also reported by Kay (2006) in a review. In this review, though, the studies are not compared explicitly regarding quality.

An area, which can be relevant, is in-service teachers' use of computers for instruction. However, it cannot be presumed that experienced teachers' needs are the same as new teachers' needs (E. A. Davis, Petish, & Smithey, 2006). A few articles compare less experienced teachers with experienced ones, and these articles are of course highly interesting and also included. It is also relevant for this review to document new teachers' views of their initial teacher training in respect of ICT, but other research on teachers' technology integration in instruction is left aside when searching for articles. However, some results are included for the context of the review.

Among the studied articles, there are two reviews (Bergqvist, 2005; Kay, 2006), two meta-analyses (Karsenti, Brodeur, Deaudelin, Larose, & Tardif, 2002; Kirschner & Davis, 2003) and one entire journal issue dedicated to reviewing teacher technology in education (Kirschner & Selinger, 2003). Although the overviews have varying scopes and draw on different bodies of research, all agreed that isolated workshops and courses do not have a lasting impact on practice, and there is support for combined approaches. It is important that student teachers have the possibility to see and experience pedagogical integration of ICT in the classroom during internship, both looking at good examples and being able to learn by doing themselves. The students' personal level of computer competence, but also the value placed on ICT, matters. A number of obstacles prevent successful implementation such as lack of time, lack of access to adequate technology, and faculty members' and mentors' technological skills. What was also found earlier is that the integration of technology in teacher educa-

⁴ Those countries are marked with * in the reference list

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

tion generally consists of separate projects which do not cover all students. These conclusions are also drawn in background literature reviews included in the articles selected.

There is a wide range of concepts used in the articles, sometimes for phenomena that are the same, but the difference also refers to different ways of organising teacher education. Unless it is of importance for the understanding, I have chosen to use *student teacher* for a person studying to become a teacher and without a certificate, *faculty member* for teacher educators on campus, *mentors* for teachers in field placements supervising and guiding student teachers, and *field placements* for the student teachers' practical work in classrooms, both short periods during courses and longer periods before earning their degree, as long as they are not working independently.

There are three areas seen as being important throughout the research literature regarding implementing ICT in teacher education:

1. Student teachers' competence in using computers and their attitudes towards using them – both for personal use and instructional uses.
2. Faculty members' use of technology in their teaching and how theoretical knowledge is discussed.
3. Student teachers' field experiences during teacher education, mentors as role models, and the student teachers' own possibilities to practice.

This overview will be organized around these three areas, and at the end more general points regarding implementation will be highlighted.

Student teachers' own competencies and attitudes

Twidle, Sorensen, Childs, Godwin, and Dussart found that student teachers in the UK feel relatively unprepared to use ICT for pedagogical practices⁵. One of the reasons for this was the students' lack of operational skills (Twidle et al., 2006). The question is no longer if ICT should be implemented in teacher education, but rather if it is necessary with special courses to raise the students' technical competence. In a research overview on science, technology and education (Parker, Carlson, & Naím, 2007) the authors state that teachers need time to develop their knowledge in the area, and hands-on experience is important. Of course teachers have to know how a computer or other technical devices work to be able to use them, but isolated workshops or conferences are not enough to establish a real change concerning the integration of ICT in classrooms. Continuous and sustained training is needed to become comfortable and effective in implementing them (Sardone & Devlin-Scherer, 2008). Kirschner and Davis (2003) also point at the importance for teacher education to meet the requirements for computer competence, so that new teachers do not need to spend time on this once they are practicing teachers.

Vannatta and Fordham (2004) conducted a forward multiple regression to identify the best combination of variables that predicts classroom technology use among K—12 teachers in USA – not student teachers. Self-efficacy, philosophy and openness to change were tested. Results indicate that the com-

⁵ 128 student teachers answered a questionnaire, this was followed up by interviews and observations of 11 of these student teachers.

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

bination of the amount of technology training, number of hours worked beyond contractual work week, and openness to change best predicted classroom technology use. Their conclusion is that it is important to work on student teachers' attitudes, especially towards change. Other researchers have referred to this conclusion and pointed at it as a reason for working on *student teachers'* attitudes towards change. However, it cannot be assumed that this is automatically valid for student teachers.

Attitudes towards ICT in general are found to be an important factor in using technology in the classroom. Discrete ICT courses can therefore be one step towards a higher degree of use. Luan, Bakar and Tang (2006) let 102 student teachers in Malaysia⁶ have such a course. Even if 25% of the participants already were considered as competent users, all participants thought the course changed their attitudes towards ICT in a positive way. They add that it is unlikely for teachers with negative attitudes towards ICT to transfer their technological skills or to encourage the use of technology among young students.

A combination of working on student teachers' attitudes and giving them access to practical training was implemented during a five year period within the programme Preparing Tomorrow Teachers to use Technology (PT3) in Florida, along with different incentives for teacher educators and mentors and also technical support. The model was built upon 10 conditions defined by The International Society for Technology in Education (ISTE), which in turn built on earlier research. The 10 conditions were: shared vision, access, skilled educators, professional development, technical assistance, content standards and curriculum resources, student-centered teaching, assessment, community support, and support policies. Emphasis in this PT3-project was placed on access, professional development, support, incentives, and evaluation; however, the remaining conditions were embedded within the model and assisted achievement of project goals. The student teachers had their own laptops, and this was rated as highly essential by the students, since it made it possible for them to train more regularly. The evaluation of this project supports the effectiveness of this multi-approach model for developing new teachers that are capable of infusing technology into the curriculum. (Judge & O'Bannon, 2007)

A shorter project within a 12-week course, also in USA, did not show the same effects (Willis & Sujo de Montes, 2002). They measured the difference in the student teachers' attitudes, self-efficacy, and understanding of technology integration and to what extent they integrated technology as student teachers. The attitudes did not change, but self-efficacy changed significantly for word processing, e-mail and CD-ROM databases; however, they did not use it very much in the classroom. The survey was self-reported and only 50 students out of 300 answered the online survey which was done in 1999-2000. Although student teachers in general belong to a generation which is used to technology, the students do not necessarily think it is worth integrating technology in teaching. In a survey where 219 student teachers in Florida participated, it was found through pre- and post-test surveys that although the students had reached new stages in technology integration after an introductory course and also used the computers for personal matters, they did not find it worthwhile to integrate it in the curriculum. "Our students can 'talk the talk' about how computers can enhance teaching and learning, but at this point the 'talk' does not necessarily lead to a change in practice" (p. 57 Swain, 2006).

New teachers have a lot to think about and do not always have time to think about incorporating technology, even if they find it important (E. A. Davis et al., 2006), and this is a reason why Davis and her colleagues claim it is important to work with technology throughout teacher education so it be-

⁶ Malaysia is not an OECD-country, but one of the few countries outside USA, UK and Canada, which could present results, and therefore considered as interesting

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

comes a natural part of teaching. Doering, Hughes and Hoffman (2003) offered a course to ten pre-service teachers in USA where one of the aims was for student teachers to begin thinking about teaching *with* technology. The course was integrated with the students' field placements, and focus-interviews were conducted before the course, between the course and the field placement, and finally after the field placement. They could see a change in the way the students talked about teaching with technology. The problem they saw was that only one student out of ten created his own lesson without copying lessons from the course. A reason for this could be that the students in the study often feared they were no technology experts.

Fear of failing or not being able to manage the classroom situation in case of a computer crash was mentioned as a reason for student teachers not to use technology in a study of 11 pairs of student teachers and mentors in UK (Cuckle & Stephen, 2003). However, this was the third part of a larger study where 238 student teachers and 216 mentors had participated earlier. By comparing the three parts they could see that there was a difference in students' level of competence and interest in ICT during the 3-4 years.

In a course focused on creativity, the 16 ICT specialist student teachers had to prepare something creative group-wise for primary school children (Loveless, Burton, & Turvey, 2006). During 2 half-days of the course they visited classes and tried out their planning. This created some degree of initial anxiety and tension in the groups. In the evaluation afterwards they described it as time-consuming and sometimes frustrating, but the positive contributions outweighed the frustrations, although they did not think it was authentic enough with the short visit. One positive outcome was that the student teachers recognised the importance of careful planning and analytical evaluation to support improvisation.

As mentioned at the beginning of this review, many research articles concern the use of ICT in student teachers' own learning, mainly for reflection on classroom work. Taylor (2004) made this the other way. She let her UK student teachers use traditional modes of communication – essays, interviews and questionnaires – when reflecting on the use of ICT in teaching. During one year she followed 44 student teachers, and from her data, she identified three stages in her students' development of the understanding of ICT in teaching. The stages involved processes of personalisation, growth of pedagogical sensitivity and the development of contingent thinking. She concludes that a development process like this takes time, and must be allowed to take time, which was also mentioned earlier.

There are many examples of student teachers being taught online, but fewer examples of preparing student teachers to teach online. However, in the United States this was done within a course to prepare K-12 teachers for future online teaching (N. Davis et al., 2007). The 52 student teachers piloted, and the study was at the same time an evaluation of a specific tool designed for "virtual schooling". The student teachers learned how to use the tool but did not use it with young pupils. Pre- and post-tests were conducted, where the 27 student teachers reported themselves about awareness, confidence in teaching online, competence in teaching online and competence in developing virtual courses. All items scored significantly higher in the post-test.

Most of the articles report on what is happening to student teachers' attitudes and competencies when they have been studying something specific in a course. Tan, del Valle and Pereira (2004) found that far from all student teachers in USA have access to courses which include technology. From a representative sample of 120 institutions where all course descriptions were collected and analyzed, it was found that 38% of the institutions did not offer courses on educational technology at all, and the courses offered were sometimes very short. Approximately 95% of the programs did not offer courses that involved the use and management of technology to support learner-centred strategies. The researchers

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

cherished a hope that technology was so well integrated in the courses that it was not any longer visible in the course descriptions, although they assumed this was not the case.

Pedagogical integration of ICT by faculty members

To be able to integrate ICT in teacher training institutions, the faculty members need to feel confident in using ICT themselves. This is not always the case (Judge & O'Bannon, 2008; Whittier & Lara, 2006). The programme Preparing Tomorrow Teachers to use Technology (PT3) has been run in the USA from 1999 to 2003 to help address the challenge of preparing teachers to use technology. The grants include projects designed to transform teaching and learning through, for example, faculty development, course restructuring, certification policy changes, online teacher preparation, and mentoring triads. Judge and O'Bannon⁷ (2008), Whittier and Lara⁸ (2006) Strudler et al. (2003a) as well as Aust et al. (2005) report from their work respectively. Faculty members report lack of time as a reason for not being updated in the field of technology. Lack of access to equipment and the need for training and support were also reported as problems. In all four studies there were grants and awards for those faculty members who finished the programme and showed they implemented ICT in their courses. This was highly valued by the faculty members. An important part was also extensive technical support as well as collaboration with colleagues.

No grants were offered in Helsinki, Finland, in a similar project (Lavonen, Lattu, Juuti, & Meisalo, 2006); nevertheless, 237 faculty members participated in the evaluation of the project. Another difference seems to be that it was planned in detail with the staff members. The whole ICT strategy was developed from the start among the staff through thorough discussions. However, Lavonen and colleagues report on similar gains and also problems. What is interesting, though, is that the 'lack of pedagogical skills' is higher at the end of the two year project. This does not have to mean that the members of the staff are less competent within the field, but it can of course indicate that they have discovered more ways of using ICT.

In the Netherlands Drent and Meelissen (2008) studied what factors obstructed or stimulated teacher educators to use ICT innovatively. The researchers limited the use of ICT to student-oriented ways of teaching and innovative use, which means that the authors excluded drill and practice programs. Also word processing was excluded since this was considered as having only limited value for the support of the learning process. Less than half of all teacher educators for primary school participated (210). They drew a profile from questionnaire answers with the help of Partial Least Square analyses. Teacher educators who use ICT innovatively in their learning process are interested in their own professional development, keep extensive contacts with colleagues and experts in the area of ICT see and experience the advantages of the innovative use of ICT in education and the pedagogical approach can be described as student-oriented. The last item seems to be logical, since other use was excluded from the study. They call the teacher educators' driving force 'personal entrepreneurship', and this is seen as a catalyst between the endogenous factor on teacher level and the endogenous factor on teacher institute level, since they find that support from the institutes is not enough.

⁷⁷ 42 faculty members were studied by using different methods during the PT3-project period

⁸ 7 faculty members were in-depth studied during 3 years while a developmental program for faculty members was running.

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

Earlier studies and overviews have shown that teacher educators and also mentors do not have enough confidence in using technology, and the equipment is not always what could be expected (e.g. Moursund & Bielenfeldt, 1999), but even if there have been improvements, it seems like it has not been enough (e.g. Mutton, Mills, & McNicholl, 2006; Sardone & Devlin-Scherer, 2008) and that there is still room for improvement (e.g. Judge & O'Bannon, 2008; Lavonen et al., 2006; Whittier & Lara, 2006). The speed of technological development is rapid, and, to keep up, the improvements in teacher training have to be even more rapid.

Internship and mentors

Several researchers have found a crucial point to be how students are able to use computers during their practice periods. The students' field work is differently organized in different countries and different courses. Sometimes it is integrated in courses, and the students study teaching methods in parallel with working in classrooms, and sometimes it is a whole semester or a year before being certified. Preliminary findings (Karsenti et al., 2002)⁹ of a survey of some 10,000 future teachers in Québec, Canada revealed that commitment to and perseverance in pedagogical integration of ICT during practical education of future teachers appear highly dependent on five factors or determinants. Four factors are already mentioned; (1) the future teacher's degree or level of computer literacy, (2) the value placed on ICT by future teachers, (3) a future teacher's expectations of success in integrating ICT, and (4) pedagogical integration of ICT by faculty members. The fifth is pedagogical integration of ICT by the mentors (e.g. also Larose et al., 2002). Also Deaudelin, Dussault and Brodeur (2002) found apprenticeship and support very important for in-service teachers in acquiring knowledge and adopting the innovation process in their classrooms.

Pope, Hare and Howard (2005) organized a course in which the 26 student teachers, besides their regular coursework, had to work in computer labs and also use the technologies in an elementary classroom. The level of confidence in different technologies was measured through a pre- and post-tests. It was found that the student teachers demonstrated a higher use of the technologies in which they had more confidence and with the technologies that their supervising teachers used in the classroom. It is also found that student teachers ask for "role models" at schools (Haydn & Barton, 2007).

There seem to be a gap between what is desired and what the student teachers meet in their field placements. Difficulties for student teachers to see innovative ICT use in classrooms is reported both in reviews as well as in empirical studies (e.g. Clifford, Friesen, & Lock, 2004; Twidle et al., 2006; Whittier & Lara, 2006), and the examples come from different countries. This is due to both mentors' lack of knowledge or interest, and lack of equipment. Lack of equipment is reported by student teachers themselves as a hindrance for using it (Haydn & Barton, 2007; Judge & O'Bannon, 2007; Pierson & Cozart, 2005; Twidle et al., 2006). Strudler, Archambault, Bendixen, Anderson and Weiss (2003b) could see a statistically significant correlation between access to computers and the 153 student teachers' use of them during field placements (student teachers), which they also consider as quite logic. Although it is reported that there is equipment at schools, mainly computers, are not always up-to-date

⁹ Refers to: Research project funded by the Social Sciences and Humanities Research Council of Canada (SSHRC): *Intégration des TIC en formation des maîtres : Développement de la motivation, des compétences et des habiletés à intégrer les TIC en milieux de pratique chez les futurs enseignants (2001-2004; Karsenti, T; Larose, F.; Deaudelin, C.; Viens, J. and Lenoir, Y.)*

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

and because of this inadequate (Clifford et al., 2004). Morgan and Kennewell (2006) let 77 student teachers in the UK discover software in a playful way, and led discussions about to what extent this could be useful in classrooms. During their field placements the student teachers were observed in this regard, but not one single student used it. Except for time pressure and focus on testing, the student teachers all stated lack of their mentor's or their own confidence, limited number of computers and logistics of managing children's access to equipment as reasons. From a larger case study Bullock (2004) describes the difference between two of the students in the respect of their mentors interest in technology. Both students had the same courses, had their field placements in the same school with the same equipment, but the experiences in the classrooms were totally different due to the mentors' different interests in integrating technology in the classroom.

Several researchers point at the problem of finding enough competent mentors for internships (e.g. Judge & O'Bannon, 2007). The regular use of and the proficiency of different domains were studied in a self-report survey to mentors in the USA (Sands & Goodwin, 2005). The aim was to study to what extent student teachers could expect to see and experience different domains of importance during field placements. While the domains of literacy, democratic schooling and classroom management all scored between 80 and 90 percent on regular use, technology scored 20%. Out of those 20% regular users, less than 18% reported a proficient use, which can be compared to over 60% for the three other domains mentioned. A solution to overcoming the lack of competence among mentors is using some kind of technological platform for discussions with more competent persons (e.g. Karchmer-Klein, 2007), or with fellow-students (Karsenti, 2005).

Sime and Priestly (2005) asked student teachers about their reflections on what they actually saw at their school placements. The students in their study, 82 second-year students at a Scottish university, identified a range of factors perceived as conditioning the successful use of ICT in the classroom. The researchers grouped these factors into three categories: (a) physical factors, (b) human factors, and (c) cultural factors. The human factors refer to the mentors' attitudes and competencies, while the cultural factors are on a more general level, and also include the community level.

An interesting finding from Glazewski, Berg and Bush (2002) shows that teacher education students who participated in technology rich field work, and could use it, rated their ability to prepare teaching with technology lower than other students. A possible explanation can be that they realize what they really have to know, which can be compared to the results from Finnish faculty members above (Lavonen et al., 2006).

Mentors

How well the mentors contribute to the student teachers' education in this respect is dependent on their level of confidence in their ability to use ICT both personally and in the classroom (Mutton et al., 2006). The 51 UK mentors in this study often felt that their ICT expertise was not as great as that of the trainees. Mutton, Mills and McNicholl's study also indicates that mentors do not see their role as very important, even if mentors are told to be important also as role models (Twidle et al., 2006). Grove, Strudler and Odell (2004) followed 16 mentors in Nevada, USA during one semester. The researchers list five trends, which they find in their data as important factors for student teachers to develop teaching skills in the area of ICT. The five trends are: (1) one-to-one tutoring, (2) mentors as role models, (3) discussions and reflections, (4) pointing at ways of finding support and (5) offering visions, establishing expectations and challenging the student teachers. These factors assume that mentors are competent in using ICT when teaching themselves. Another problem can be lack of explicit expectations and

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

communication in field-based sites (Judge & O'Bannon, 2007). The mentors might not always know what is expected.

In the national program PT3 in Tennessee, mentors were included and 50 mentors were selected to participate in a professional development program (O'Bannon & Judge, 2004). Their schools respectively agreed upon increased budget allocations for technology, and the mentors participated in five three-hour sessions spread over one semester, stipends of 1.500 dollars were awarded to each teacher as were smaller awards such as technological devices as door prizes during project meetings. Pre-test and post-test were conducted with questions about technical skills as well as technological use and integration in the classroom. Statistically significant post-test scores were found in all tested areas except for use of databases. The program also included training together with student teachers. This was considered as highly essential for the student teachers to integrate technology. In another study (Strudler & Grove, 2003), where the mentors were offered workshops about mentoring and communication, meeting the technological standards, constructivist approach etc., a substantial progress was being made within the field component in terms of increased use of technology among the 345 student teachers. Interview data with 19 student teachers in this latter study showed that student teachers were more likely to teach with technology when they were afforded greater access, flexible scheduling, as well as support and encouragement from the school staff (Ibid.).

Lack of technology competent mentors

To overcome the lack of competent mentors in this respect, Karchmer-Klein (2007) organized a virtual practicum placement in her methods course on literacy in the USA. She engaged two teachers, who were known to be competent in the area and let her 30 student teachers communicate with them and their classes over the Internet during the six weeks the course lasted. She found a lot of advantages in this way of working and so did her students. One of the advantages was that the student teachers could engage in the specific methods without having to think about daily management of the classroom like scheduling, attendance and behaviour issues. However, Karchmer-Klein does not think it should be considered as a replacement, but a compliment to the traditional approach to field placements. Virtual field trips are also described as part of a course in Alberta, Canada, which was one of the learning environments studied by Clifford, Friesen and Lock (2004)

Another attempt to meet the lack of mentors' competence is described by Kovalik (2003). The fact that student teachers were told to know more about technology than mentors lead to a project where they were supposed to collaborate on a 2-week project – in a small scale project of 20 student teachers. The outcome shows that the student teachers were not able to effectively transfer and apply knowledge and skills learned from their courses to the project. One of the problems was that they did not communicate with the mentors enough before the project start. One of the objectives was to exchange knowledge between mentors and student teachers.

A theoretical framework

A few researchers (Grove et al., 2004; Ottesen, 2006)¹⁰ view the apprenticeship explicitly from a socio-cultural perspective, and finds in this a theoretical explanation. "As learners become attuned to environments in increasingly complex ways, they gradually acquire a capacity for diverse responses to

¹⁰ Ottesen conducts an in-depth case study with 4 student teacher-mentor pairs during a 12-week period of practice.

the potentialities for action. But the fact that they ‘can do’ does not imply actual doing” (p. 278 Ottesen, 2006). The student teachers form their identities as teachers during their training, and who they are and how others see them is an important part of building a professional identity. Where others (e.g. Grove et al., 2004) find a technology rich environment important, Ottesen claims this is not enough.

The process of becoming a teacher is deeply embedded in the institutional practices of the school, university and teacher education, and new tools, such as ICTs, may first and foremost be represented within traditional canons and conventions. However, student teachers use ICTs for a number of purposes in their lives, and the socio-cultural framework alerts the researcher to evidence of alternative figured worlds and corresponding budding identities that can be seen to be nested within the dialogues of student teachers and mentors during internship. In teacher education it is imperative that such figured worlds are cultivated, allowing for the development of teachers’ identities as potential architects of ‘new worlds’. (p. 287 Ottesen, 2006).

Dickey’s¹¹ (2008) students participated in a web-based course to learn about integrating technology in the classrooms. During the course, they also had to prepare a lesson plan for their future pupils. The model she uses is called cognitive apprenticeship. The word *cognitive* refers to the field of practice involving both concrete skills and the adoption of cognitive processes. Scaffolding, coaching and reflecting are important concepts. The teacher provides ‘scaffolds’ to support the learners, coaches by offering guidance and feedback and encourage the learner to reflect and so articulate their reasoning. With a few exceptions, the students thought they learned a lot both regarding their own technological competence and how to integrate ICT in their future classrooms.

What student teachers do during their practice periods

When student teachers use ICT during their internship, Brawner and Allen (2006) found that Word-processing and the Internet for research was most frequent in use when student teachers were teaching younger students. About 70% of the 1601 student teachers reported this in their survey in North Carolina. Other type of use were presentation software, e-mail, spreadsheets and databases, and these applications were reported by less than 30% of the student teachers. There was also a difference among the grades, while word-processing and the Internet had a peak in grade 3–5, spreadsheets were used the most in grade 6–8. This confirms Aust, Newberry, O’Brien and Thomas’ (2005) finding where word processing scored the highest when 244 student teachers and 21 instructors answered questions about their confidence in computer skills.

In many studies, the lack of equipment at schools is addressed, and this includes restricted access to equipment. Sime and Priestly (2005) identified two different views from the student teachers in their Scottish study. Some reacted by criticising the lack of support from local authorities, while others started to think of ways through which schools could change practices to adapt to the level of existent resources. This is not developed further.

During their first year of teaching, Pierson (2005) followed four teachers, which she knew from teacher education. Those new teachers struggled with finding access to resources and equipment, and even if there were resources, there could be problems. She could see that they have a lot of things to think about – managing the classroom situation for example. From their quite small case study, Wright and Wilson (2006) suggest mentors in this respect during the first year of teaching.

¹¹ Dickey made an interpretive case study of 42 students in a web-based learning environment

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

As mentioned above, some research groups have trained student teachers in different techniques to use in the classroom during practice periods. Hoban (2005) let 30 Australian student teachers create 'slowmations', which means putting together a range of still photos to a slow film, in order to explain scientific concepts to primary pupils. The aim was double; the student teachers' own understanding of the concept and a way of presenting it to the young pupils. Sardone and Devlin (2008) used multi-user virtual environments, MUVE, games for use in educational settings, with their 18 student teachers in the USA. In both studies, the students were positive about using the techniques in the classrooms. The difference between the studies is that Sardone and Devlin's student teachers did not use the application with their own pupils in practice, although the techniques were thoroughly discussed as teaching methods in both studies, and found useful by the student teachers.

It is not always mentioned in the articles what kind of use is measured. In a recent study from The Czech Republic, where 404 randomly selected in-service teachers answered questionnaires on how they used technology in their classrooms, the researchers differ between a methodological level and a relations level. The relations level is about managing the classroom situation and can, for example, be what they call 'stuffing' – watching a film, letting the pupils play games to keep quiet etc.; as many as 38% of the teachers in the study reported this kind of use. Forty-five percent of teachers reported use for their own preparation or presentations, and 41% used technology as a testing tool (Šeřová & Zounek, 2008).

Different subjects

Computers are used differently in different subjects. This was obvious when 24 UK history student teachers' use of ICT was compared to 47 science student teachers' ditto (Barton & Haydn, 2006). The history student teachers focused on laptops for teachers, data projectors in classrooms and Internet access, while the science student teachers were more concerned about subject-specific hardware and software that would enable them to undertake data-logging activities with pupils. The researchers advocate differentiated training, which takes into account the differing ways ICT is used in different subjects. In French speaking Canada it was found that, in the subjects where computers were used the most, among 250 mentor primary teachers were French (90.1%) followed by mathematics (65.7%), natural sciences (63.0%), and humanities (53.0%) (Larose et al., 2002), which correspond to the findings from Brawner and Allen (2006) that primary student teachers mostly use word-processors. Among primary teachers in Belgian Flanders the use was less some years later, but the proportions were similar except for mother-tongue, which was at the same level as mathematics (Valcke, Rots, Verbeke, & van Braak, 2007). It must be remembered that they were not mentors, and that statistics show that the average citizen in Canada uses computers and the Internet 1.5-2 times more than the average Belgian citizen (ITU, 2006).

Haydn and Barton (2007) interviewed those 27 history and science teachers in their first year of teaching. This was a follow-up in a study on trainees use of ICT recently mentioned. Many of them point at lack of access to equipment, but it was also mentioned that they did not want to 'risk' a lesson by bringing the pupils to the computer room because of the risk of a computer crash they could not handle. Both groups of teachers agreed that much of their training was irrelevant or even counter-productive and they wanted more subject specific training. They also appreciated having at least one colleague who could act as a role model.

From a survey in Northern Ireland it was found that between 30% and 40% of 259 primary student teachers used computers when teaching mathematics (McAlister, Dunn, & Quinn, 2005). The researchers conclude that student teachers' experience of using computers in mathematics teaching were very

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

varied and rather limited. Niess (2005) claims that developing a technology-enhanced pedagogical content knowledge in mathematics – and also science – is dependent on the student teachers' views on the integration of technology in combination with the nature of the discipline. Da Ponte, Oliveira and Varrandas (2002) gave a course in ICT in a pre-service program for 160 middle and secondary school mathematics teachers in Portugal. The aim was to help the pre-service teachers develop a positive attitude regarding ICT, and to use it confidently. The students constructed webpages that could be used for teaching pupils, but using them was not part of the study. The course only provided discussions on teaching. The pre-service teachers took important steps in assuming professional values and attitudes, such as the need to discover and investigate by themselves and assuming the important role of discussions and collaboration in carrying out professional tasks. However, although the student teachers thought they benefited from this course, the students did not regard the discussions on teaching as enough - they wanted to have more of these.

Pre-service and in-service teachers in Canada participated in an applied linguistics course, where they were asked to present the content on the World Wide Web (Shi, Reeder, Slater, & Kristjansson, 2004). The participants expressed general appreciation of the experience, but they also thought that technology problems took time from content learning, although they had access to technological support. The authors interpret the tension between the technology and the content as connected to the participants' beliefs about traditional content learning. They conclude that teachers need to be given more evidence that ICT can make teaching and learning more effective, and that research has to demonstrate that the time and energy spent on learning technology along with content is worthwhile. This finding goes hand in hand with Swain's (2006) where the student teachers of varying levels and subjects did not always find it worthwhile to integrate technology in the curriculum.

Whether or not ICT should be taught as a separate subject is sometimes discussed in the articles. ICT student teachers take a special position in this respect, since they are taught ICT in separate courses. In the different studies in this review it differs a lot whether or not technology experts have been involved as researchers or support persons, but when there have been separate ICT courses or experts integrated in other courses for support, the participants have expressed their appreciation and the importance of this kind of support. Morgan and Kennerwell¹² (2006) find it important to make a distinction between subject teaching and separate technology teaching, and they express this in these words:

“Many teachers do not have a clear view of what constitutes developing children's ICT capability. Often this is confused with using ICT to enhance teaching and learning in other subjects. This is probably due to the fact that the focus is too often on what children are doing rather than what they are learning” (p. 318, *ibid.*).

As stated earlier there is also a distinction between letting pupils use a computer and using a computer as a teacher for presentations or preparation.

Hammond's (2004) 52 ICT student teachers in the UK considered themselves as unique and important. What they taught could be used by their pupils at school in different subjects as well as in their leisure time. It is a constantly and rapidly changing subject which requires teachers to be continuously interested in learning new things. How different aspects of computers can be taught was the focus of

¹² Morgan and Kennerwell let 77 primary student teachers taking a one-year course to achieve Qualified Teacher Status in Wales answer to a survey.

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

Woollard's (2005) study of computer teachers – also in the UK, where he identifies what is particularly difficult to teach and how pedagogic metaphors can be used to facilitate teaching and learning. This kind of pedagogy is used both for student teachers' own learning and as strategies when they teach.

There are some examples already mentioned, where student teachers, for example, learn about a special technique or software and are obliged to use it during their internship (e.g. Hoban, 2005; Sardone & Devlin-Scherer, 2008). Evaluations show that the student teachers favour these 'experiments', but it is too early to know if those experiments lead to a more extended use of ICT in the long run.

There are differences reported depending on the subject taught; however, this cannot be assumed to be contradictory since different researchers have been studying different aspects. It is also difficult to see if the differences are due to country or culture, since the studies are few.

Constructivism vs. Traditionalism

There are discussions in several articles about constructivism vs. traditionalism. Constructivism is sometimes also called student-oriented teaching or something similar; in short it means that the pupils are more active in constructing their own knowledge. The traditional way of teaching is described as the way of teaching where the teacher is in front of the class giving lectures, and, roughly, this means that the pupils are supposed to 'repeat' what the teacher tells them. Although some authors claim that a constructivist view is necessary for the integration of technology in the classroom, there is no empirical evidence presented in the articles selected. Drent and Meelissen (2008) are the only ones who can show a connection between a student-oriented view and technology integration in their data, but they excluded the use of technology that they considered not to be student-oriented from the start, which also means that there was another kind of use.

Larson (2008) reports from Denmark, that it is possible to see a move back towards a more traditional way of teaching, in spite of increased technology use. The use of electronic whiteboards is one example of how it has become easier, PowerPoint-presentations are another. Vogt (in Law et al., 2008) found when analyzing data from SITES 2006 from mathematics and science teachers, that there is no change in the distribution of responsibilities between teachers and pupils, although frequent use of ICT in the classroom seems to contribute to a change in educational practice in this direction. These two studies are conducted among in-service teachers.

What is good practice?

Like in other processes, parts included are not always possible to separate from each other. What is discussed above is mainly on a micro-level – how to change student teachers' attitudes, what they have to learn, etc., but in most of the articles policy issues are discussed as an important part of implementing ICT in teacher education, although it is not specifically studied. However, a few of the studies mentioned above are large studies with several layers of implementation where it is shown that all levels in the implementation process are of importance (Clifford et al., 2004; Judge & O'Bannon, 2008; Karsenti, 2005; Lavonen et al., 2006; Strudler & Wentzel, 2005).

In 2003 Kirschner and Davis (2003) gathered five researchers from different parts of the world. Their task was first to find 'best practices' in the field of teacher education and ICT. The researchers found 26 excellent initiatives in the area, and a synthesis was made to use as model for best practice. The geographical regions represented were Australasia (3), Canada (1), Scandinavia (6), Europe except Scandinavia and the UK (4), Israel (1), United Kingdom (6), and the USA (5). General results are de-

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

scribed, and they found six priorities which they list as benchmarks for good practice. The teachers should become (a) competent personal users of ICT, (b) competent to make use of ICT as a mind tool, (c) and competent to make use of ICT as a tool for teaching. They should also be able to (d) master a range of educational paradigms that make use of ICT, (e) master a range of assessment paradigms which make use of ICT, and (f) understand the policy dimension of the use of ICT for teaching and learning. (Ibid. p.145).

In Belgian Flanders a policy-level evaluation was set-up where 100 schools were selected in a stratified sample (Valcke et al., 2007). The aim was to study to what extent the ICT training is linked to policies of schools, and also the validity of the content in this training seen from a school perspective. The result shows that policies are not very well developed, and what the schools ask from teacher education is mostly basic computer training, followed by use of the Internet and use of Office software. The proportion of respondents that mentioned objectives in relation to the educational use of ICT was rather low. This was also the case when the new teacher education was evaluated at a teachers college in Sweden (Müller, 2004). Questions were asked to faculty members about the use of ICT in different courses. The answers give the same picture as the Belgian one, and the remarks about how the new teachers will be able to teach with technology are very few and also un-reflected: "What they use themselves, they can teach their future pupils to use"¹³ (p. 19). Earlier in this text it has been questioned if the requirements for the mentors are not explicit and clearly communicated enough (Judge & O'Bannon, 2007). Maybe the reason is that the requirements are much lower than researchers expect them to be, and that there is confusion when researchers enter the scene and pose questions about requirements that were never thought of.

Williams (2005) discusses current policy in UK and what is needed for the future. He finds that today's centrally-controlled policy is increasingly inappropriate, since it is not flexible enough for the changing demands. He advocates broad and flexible policies developed in consensus by members of the teacher training institutions. The interpretation and management of these policies should be an urgent responsibility of local actors. Examples of how this can be carried out are mentioned above in the American PT3 studies and the Finnish study (Judge & O'Bannon, 2008; Lavonen et al., 2006).

Player-Coro, Sweden (2007) looked at why teachers use ICT, but most researchers focus on why they do *not* use it. The results do not differ, but Player-Coro finds it more constructive to build knowledge on something that exists instead of looking at what is lacking. Morgan and Kennewell (2006), though, are among the ones who focus on what is missing. They highlight National Curriculum (UK), compulsory and optional testing, which do not measure ICT competencies, and that teachers therefore do not give priority to them. Teachers' confidence in using computers, as well as classroom equipment, are factors that are important. They also stress the lack of role models.

Shuldman (2004) concludes from his overview on research mainly from the 90s, that the impact on students' learning will be small unless teachers evolve towards a clear and comprehensive understanding of technology and its role in instruction, which is what is expected from any instructional tool. Many factors contribute to this development. Apart from knowledge and training, rewards or incentives are needed, not to forget leadership (Shuldman, 2004; Vannatta & Fordham, 2004; Wetzel & Strudler, 2005).

¹³ The authors own translation of "Det de själva använder kan de lära sina framtida elever att använda".

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

There are factors on different levels having an impact on the use of ICT in classrooms from the configuration of education systems to personal experiences and attitudes. In general, teacher culture does not comprise contemporary research to a desirable extent. This is also found in teacher education on a general level. An example from Sweden tell us that higher education based on research can mean different things, and there is, for example, a difference between teacher education and education for nurses in that respect (Säljö & Södling, 2006). Research-based teacher education in Sweden means that student teachers are trained to carry out their own research in the classroom, but are not trained in reading about others' results like the Swedish nurse students. There is also a lack of incentive to rely on research-based evidence for teaching in common (Ekholm, 2005). Ekholm's suggestions in this respect include improved leadership of the schools.

Discussion

The picture from the articles in this review is on the one hand not contradictory, but it is on the other hand far from complete. A few large studies confirm what is also seen in small scale studies or vice versa, that student teachers in the countries covered by this research do not integrate technology in teaching to a large extent. Reasons for this, according to research, are...

- * Lack of role models – on campus as well as in field placements.

- * Lack of confidence in the own competence – basic computer skills as well as competence in pedagogical use.

- * Lack of equipment at field placements - concerns both lack of updated and/or adequate equipment as well as restricted access in different ways.

The lack of role models is dependent on competent and confident mentors as well as faculty members. Along with lack of confidence, competence and equipment there is also lack of incentives for those two groups, which puts down technology integration on the priority list. Besides salary raise and career possibilities, which can be a leadership issue, is the fact that pupils' technology competence is not tested to the same extent as other competencies. The latter is rather a policy issue. How the different actors are related and act together is shown in Figure 1.

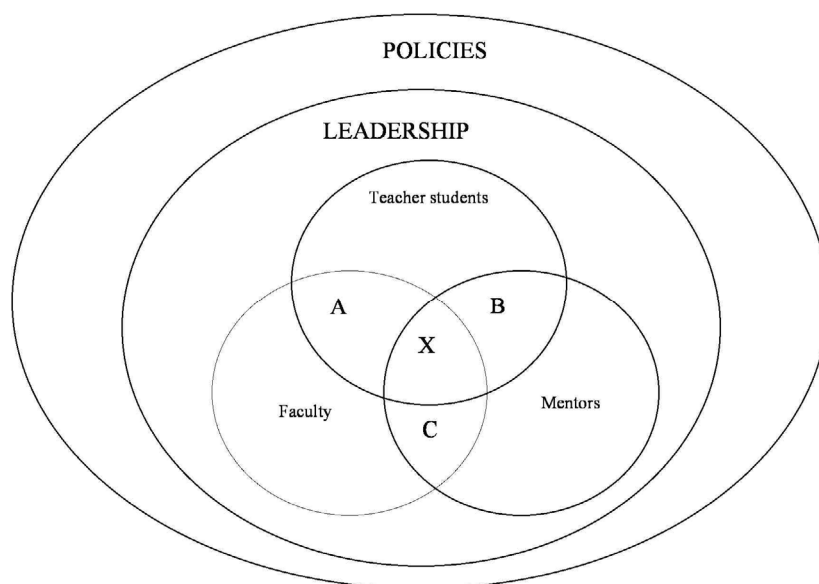


Figure 1 – Different actors at different levels as they are presented in the articles reviewed.

There are macro- meso- and micro-levels, which here are represented by Policies, Leadership and the three main groups of actors mentioned; Student teachers, Faculty and Mentors. On a policy level there has to be clear expectations on what has to be done and how the outcomes should be evaluated. Policies also have to be flexible enough to reflect the rapid changes within the field. The leadership level has to provide career possibilities, other relevant incentives, and also access to suitable equipment. The three groups of actors in the middle need to have personal technological competence, confidence in what they are doing, pedagogical competence in using technology, and positive attitudes towards technology integration in education. The areas A, B, C and X represents where the actors meet, and A stands for the theoretical discussions on integrating ICT, but also how faculty members use technology themselves in teacher education classes. B stands for mentors as role models, guides and supervisors. The field C is only mentioned in one of the articles (Judge & O'Bannon, 2007) and can be expectations on mentors, which Judge and O'Bannon suspected not to be enough explicit. None of the articles selected for this review mention what in the figure is called X, which is a supposed collaboration where all three actors are involved. Pratt (2008) studies the use of e-conferencing between students, faculty and mentors to facilitate the communication between the three, a lot of obstacles were experienced, but there is also a potential. His study does not concern integrating ICT in the classroom, but he claims what Judge and O'Bannon touch, that guidance for schools has to be clarified.

The overall picture is that implementation is necessary at all levels for a successful outcome, but research also gives examples of how problems can be overcome at a micro-level. For instance, a couple of studies show how it is possible to use technology as a solution for not finding enough competent mentors (Karchmer-Klein, 2007; Karsenti, 2005). Enthusiasts do seem to have room for manoeuvre, but the lack of incentives makes it difficult to involve everybody. This is probably also a reason why most studies are done on the micro-level.

There is a lack of follow-up studies to the big, successful projects, to see if the student teachers who were part of these projects are more frequent or 'better' users of ICT in their classrooms in the long run. It could be an interesting challenge to find out whether or not this is the case.

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

There is one problematic issue, which can be seen as a contradiction, but not necessarily. That is on the one hand the results from Kirschner and Davis' (2003) study where researchers define 'good practice', which also is implicit in most studies. On the other hand are the results from Belgium and Sweden (Müller, 2004; Valcke et al., 2007), where teachers and teacher educators do not have those high expectations. Who is to decide upon good practice? Is it enough if we use word-processors at school? Personally I would answer no, referring to the initial discussion that we have to prepare tomorrow's teachers. This might also be a sign showing that teachers in general have other priorities.

What does it mean to integrate technology in education? Some of the articles in this review show that technology use has increased after inventions, but it is not always obvious what kind of use. Statistics show that a lot of courses – both for student teachers and young pupils – concerns basic computer training only. Several authors claim that a constructivist or student-oriented perspective on learning is necessary for the use of technology. No empirical data in this review shows this. Policy documents are often not very clear in this respect, which leaves it to the teacher or teacher educator to decide the level of use.

So, what are the reasons for integrating technology in education? What is mentioned in many articles is that it should support learning, and a first step is of course basic computer training, but definitely not enough. It is known that certain groups in society have less access to technology than others, more privileged groups. Integrating technology is therefore also one step in bridging this gap. Student-oriented perspectives on learning are often mentioned, and learning-theories in this field claim that it is important to connect to the learners own world. No studies in this review cover the use of simultaneous online communication or mobile devices, common occurrences in many young people's lives in the OECD-countries today. According to this review it seems like teacher training is still struggling on a very basic level: to use technology in education at *any* level instead of not at all.

If the demands and expectations are not explicit, but only ask for technology use, there is a risk of ending up in a situation Kovalik (2006) describes, where the student teachers were supposed to bring the technological knowledge and the mentors the subject knowledge. It did not turn out well, because none of the groups knew enough about the field where technology and education meet, where the two are integrated.

Does it look the same all over the OECD-countries? From this review it is not possible to tell, since only ten countries are represented. All studies are not comparable, but there are a few large studies and a few multi-methods studies conducted over time, which gives a picture that teacher education in the countries represented have similar problems in this specific area. Some of the researchers, though, seem to be enthusiastic developers of ICT in teacher education, but it is as a problem it is mostly presented. Like in earlier reviews, researchers state that too little is done, and that the reasons seem to be the same. Kirschner and Selinger (2003) express this with the words: "If the Internet is an information superhighway, then teachers just might be the road-kill on the asphalt of the information superhighway (p. 5)." This might also be the reason why all projects are so successful and so appreciated by student teachers, faculty and mentors; anything is better than nothing. This also points at that faculty members and mentors are interested in improving education in this respect. The big question is why so little is done in practice, why researchers still report lack of knowledge and equipment. Student teachers might be more and more skilful when it comes to using technology, but this is no guarantee for being able to use it to its full extent, and definitely not knowing what it means to teach about it or with it (Clifford et al., 2004; Sardone & Devlin-Scherer, 2008)

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

Conclusion

There is a knowledge-base which is not used. The large studies in this review show that a change is possible, but implementation has to be done at all levels at the same time, from student teachers' hardware skills to leadership and policy-making. According to the presented research, the following is needed:

- Policy-level: Clear expectations and evaluations, enough flexibility for the changing field.
- Leadership-level: Career possibilities and relevant incentives, suitable equipment, clear expectations on cooperating schools and mentors.
- Course-level: Ensure basic technological skills (might be required before entering teacher training in some countries), integrate technology as a natural part in subject courses and internship, knowledge about pupils' technological worlds.

Time and money are needed since there is a lot of work to be done before all faculty members and mentors change their views from teaching *about* ICT to teaching *with* ICT (words from Kirschner & Davis, 2003).

Research questions

In the comparative study, the main objective is to study how technology is used in teacher training institutions to prepare student teachers to integrate technology in teaching to meet tomorrow's demands. As shown in the research review there are still a lot of questions. The issues that should be addressed in the comparative study are as follows:

- *To what extent and in what ways is technology used in teacher training institutions in OECD countries?* To map the integration of technology in teacher training institutions, it has to be clearly defined what kind of technology is being used (e.g. whiteboards, mobile devices, personal computers and different kinds of software), and the different ways of using it (e.g. own planning, presentations, teaching basic computer skills, communication, to enhance learning).
- *In what ways are student teachers prepared to integrate technology in teaching?* Are there separate technology courses or is technology integrated in subject specific courses? Is it taken for granted that the student teachers will find out themselves how to integrate technology as long as they know how to use it themselves? What role do internships play?
- *If student teachers are not satisfactorily prepared, what are the main obstacles?* Several obstacles are pointed at in the research review, are they the same in all countries?
- *What are the national frameworks and requirements regarding the use of technology in initial teacher training?* In a wider context of increasing institutional autonomy, teacher training institutions may have to comply with government regulations, or at least expectations, regarding the competencies that teacher may have to develop in accordance with what national school curricula require them in terms of teaching objectives and methods. Also, the political importance attached to the development of XXI Century skills may also have a reflection on teacher training requirements.

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

- *How different are the institutional frameworks and requirements?* Objectives, definitions and precise descriptions of skills and competencies must be taken into account, as well as concrete means of implementation, methods of assessment and certification, and the balance of responsibilities between government and teacher training institutions.
- *How is policy evaluated?* Are policies evaluated regularly? Are there incentives related to policy? Are there relevant means available to implement policies? The role of leadership is part of this.
- *Does practice correspond to policy?* If not, are there clear obstacles? If yes, what are the supporting strategies?

To answer these questions, the study will be carried out on different levels from policy documents to classroom situations to get the main stakeholders' views, including teacher trainers, student teachers and actual school teachers/mentors.

REFERENCES

- * Aust, Ronald, Newberry, Brian, O'Brien, Joseph, & Thomas, Jennifer. (2005). Learning Generation: Fostering Innovation with Tomorrow's Teachers and Technology. *Journal of Technology and Teacher Education*, 13(2), 167–195.
- * Barton, Roy, & Haydn, Terry. (2006). Trainee teachers' views on what helps them to use information and communication technology effectively in their subject teaching. *Journal of Computer Assisted Learning*, 22, 257–272.
- Bergqvist, Thomas. (2005). IT och lärande – i skola och lärarutbildning. *Tidskrift för lärarutbildning och forskning*, 12(1), 11–22.
- * Brawner, Catherine E., & Allen, Rodney H. (2006). Future teacher's classroom applications of technology. *Computers in the Schools*, 23(1/2), 33–44.
- * Bullock, David. (2004). Moving from theory to practice: An examination of the factors that preservice teachers encounter as the attempt to gain experience teaching with technology during field placement experiences. *Journal of Technology and Teacher Education*, 12(2), 211–237.
- * Clifford, Patricia, Friesen, Sharon, & Lock, Jennifer. (2004). *Coming to teaching in the 21st century: A research study conducted by the Galileo Educational Network*. Retrieved 5 May, 2008, from <http://www.galileo.org/research/publications/ctt.pdf>
- * Cuckle, Pat & Clarke, Stephen (2003). Secondary school teacher mentors' and student teachers' views on the value of information and communications technology in teaching. *Technology, Pedagogy and Education* 12(3), 377–391.

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

- * da Ponte, João Pedro, Oliveira, Hélia, & Varandas, José Manuel (2002). Development of pre-service mathematics teachers' professional knowledge and identity in working with information and communication technology. *Journal of Mathematics Teacher Education*, 5, 93–115.
- Davis, Elisabeth A., Petish, Debra, & Smithy, Julie. (2006). Challenges new science teachers face. *Review of Educational Research*, 76(4), 607–651.
- * Davis, Niki, Roblyer, M.D. (Peggy), Charania, A., Ferdig, Rick, Harms, Chad, Compton, Lily Ko Li & Cho, Mi Ok (2007). Illustrating the “virtual” in virtual schooling: Challenges and strategies for creating real tools to prepare virtual teachers. *Internet and Higher Education* 10, 2739.
- Deaudelin, Colette, Dussault, Marc, & Brodeur, Monique. (2002). Impact d'une stratégie d'intégration des TIC sur le sentiment d'autoefficacité d'enseignants du primaire et leur processus d'adoption d'une innovation. *Revue des sciences de l'éducation*, 28(2), 391–410.
- * Dickey, Michele D. (2008). Integrating cognitive apprenticeship methods in a web-based educational technology course for P-12 teacher education. *Computers & Education*, pp. 506518.
- * Doering, Aaron, Hughes, Joan, & Hoffman, Doug. (2003). Preservice teachers: Are we thinking with technology? *Journal of Research on Technology in Education*, 35(3), 342–361.
- * Drent, Marjolein & Meelissen, Martina (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Computers & Education* 51, 187199.
- Ekholm, Mats. (2005). *Att fånga kunskandet om lärande och undervisning*. Stockholm: Utbildningsdepartementet.
- Fabry, Dee. L., & Higgs, John. R. (1997). Barriers to the effective use of technology in education: Current status. *Educational Computing Research*, 17(4), 385-395.
- * Glazewski, Krista, Berg, Kimberley, & Brush, Thomas A. (2002). Integrating technology into preservice teacher education: Comparing a field-based model with a traditional approach. Proceeding of SITE 2002 (pp. 1968–1972). Nashville, TN: Association for the Advancement of Computing in Education.
- * Grove, Karen, Strudler, Neal, & Odell, Sandra. (2004). Mentoring toward technology use: Cooperating teacher practice in supporting student teachers. *Journal of Research on technology in Education*, 37(1), 85–109.
- * Hammond, Michael. (2004). The peculiarities of teaching information and communication technology as a subject: A study of trainee and new ICT teachers in secondary schools. *Technology, Pedagogy and Education*, 13(1), 29–42.
- * Haydn, Terry Anthony & Barton, Roy (2007). Common needs and different agendas: how trainee teachers make progress in their ability to use ICT in subject teaching: Some lessons from the UK. *Computer & Education* 49, pp. 10181036.
- * Hoban, Garry F. (2005). From claymation to slowmation: A teaching procedure to develop students' science understandings. *Teaching Science*, 51(2), 26–30.
- ITU (2006). *Internet indicators: Hosts, users and number of PCs*. Retrieved March 12, 2006, from http://www.itu.int/ITU-D/ict/statistics/at_glance/Internet04.pdf
- * Judge, Sharon, & O'Bannon, Blanche. (2007). Integrating technology into field-based experiences: A model that fosters change. *Computers in Human Behavior*, 23, 286–302.

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

- * Judge, Sharon, & O'Bannon, Blanche. (2008). Faculty integration of technology in teacher preparation: outcomes of a development model. *Technology, Pedagogy and Education* 17(1), 17–28.
- * Karchmer-Klein, Rachel. (2007). Reexamining the practicum placement: How to leverage technology to prepare preservice teachers for the demand of the 21st century. *Journal of Computing in teacher Education*, 23(4), 121–129.
- Karsenti, Thierry. (2005). Développer le professionnalisme collectif des futur enseignants par les TIC: Bilan de deux expériences au Québec (1). *Recherche et Formation*(49), 73–90.
- * Karsenti, Thierry, Brodeur, Monique, Deaudelin, Colette, Larose, François, & Tardif, Maurice. (2002). *Integrating ICT's in teacher training: A challenging balance*. Paper presented at the 2002 Pan-Canadian Education research Agenda Symposium "Information Technology and Learning", 30 April - 2 May 2002.
- Kay, Robin H. (2006). Evaluating strategies used to incorporate technology into preservice education: A review of the literature. *Journal of Research on Technology in Education*, 38(4), 383–408.
- * Kirschner, Paul, & Davis, Niki (2003). Pedagogic benchmarks for information and communications technology in teacher education. *Technology, Pedagogy and Education*, 12(1), 125–147.
- Kirschner, Paul, & Selinger, Michelle. (2003). The state of affairs of teacher education with respect to information and communications technology. *Technology, Pedagogy and Education*, 12(1), 5–17.
- Knowledge Foundation (2006). *IT i skolan: Attityder, tillgång och användning*. Stockholm: Knowledge Foundation.
- * Kovalik, Cindy (2003). Reflections on a technology integration project. *Journal of Technology and teacher Education* 11(1), pp. 7390.
- * Larose, François, Lenoir, Yves, Karsenti, Thierry, & Grenon, Vincent (2002). Les facteurs sous-jacents au transfert des compétences informatiques construites par les futurs maîtres du primaire sur le plan de l'intervention éducative. *Revue des sciences de l'éducation*, 28(2), 265–287.
- Larson, Anne. (2008). *Pedagogical practices and ICT use around the world: Findings from the IEA international comparative study SITES2006*. Paper presented at the ECER 2008, 10-12 September.
- Law, Nancy, Pelgrum, Willem, & Plomp, Tjerd (Eds.). (2008). *Pedagogy and ICT use in schools around the world: Findings from the IEA SITES 2006 study*. Hong Kong: Comparative Education Research Centre, Springer.
- * Lavonen, Jari, Lattu, Matti, Juuti, Kalle, & Meisalo, Veijo. (2006). Strategy-based development of teacher educators' ICT competence through a co-operative staff development project. *European Journal of Teacher Education* 29(2), 241–265.
- * Loveless, Avril, Burton, Jeremy & Turvey, Keith (2006) Developing conceptual framework for creativity, ICT and teacher education. *Thinking Skills and Creativity* 1, pp.3–13.
- Luan, Wong Su, Bakar, Kamariah Abu, & Tang, Sai Hong. (2006). Using a student-centred learning approach to teach a discrete information technology course: The effects on Malaysian pre-service teachers' attitudes toward information technology. *Technology, Pedagogy and Education* 15(2), 223–238.

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

- * Lundh, Anna, & Sundin, Olof. (2006). Lärare och informationskompetens: Från utbildningspraktik till yrkespraktik. *Dansk Biblioteksforskning*, 2(3), 5–14.
- * McAlister, Mary, Dunn, Jill, & Quinn, Louise. (2005). Student teachers' attitudes to and use of computers to teach mathematics in the primary classroom. *Technology, Pedagogy and Education*, 14(1), 77–105.
- Merchant, Lucy, & Heptworth, Mark. (2002). Information literacy of teachers and pupils in secondary schools. *Journal of Librarianship and Information Science*, 34(2), 81–89.
- Moeini, Hosein. (2008). Identifying needs: A missing part in teacher training programs. *seminar.net*, 4(1), online.
- * Morgan, Alexandra E., & Kennewell, Steve E. (2006). Initial teacher education students' views on play as a medium for learning - a divergence of personal philosophy and practice. *Technology, Pedagogy and Education* 15(3), 307–320.
- Moursund, David, & Bielenfeldt, Talbot. (1999). *Will new teachers be prepared to teach in a digital age: A national survey on information technology in teacher education*. Eugene, OR: International Society for Technology in Education.
- * Mutton, Trevor, Mills, Gary, & Mcnicholl, Jane. (2006). Mentor skills in a new context: Working with trainee teachers to develop the use of information and communications technology in their subject teaching. *Technology, Pedagogy and Education*, 15(3), 337–352.
- * Müller, Bosse. (2004). IKT i den nya lärarutbildningen: *Studenternas användning av IKT vid lärarutbildningen, Malmö högskola (No. 8/2004)*. Malmö: Malmö Högskola.
- * Niess, Maggie L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education* 21, pp. 509-523.
- Nordicom (2008). *Sveriges internetbarometer 2007 (No 2/2008)*. Gothenburg: University of Gothenburg, Nordicom-Sweden.
- * O'Bannon, Blanche, & Judge, Sharon. (2004). Implementing partnerships across the curriculum with technology. *Journal of Research on Technology in Education*, 37(2), 197–213.
- OECD. (2006). *Are students ready for a technology-rich world?: What PISA studies tell us (No. 54931)*. Paris: Programme for International Student Assessment.
- * Ottesen, Eli. (2006). Learning to teach with technology: Authoring practised identities. *Technology, Pedagogy and Education*, 15(3), 275–290.
- Parker, Caroline E., Carlson, Bethany, & Naím, Alyssa. (2007). *Building a framework for researching teacher change in ITEST projects*. Newton, MA: ITEST Learning Resource Center. E. D. Center.
- * Pasternak, Donna L. (2007). Is technology used as practice?: A survey analysis of preservice English teachers' perceptions and classroom practices. *Contemporary Issues in Technology and Teacher Education*, 7(3), 140–157.
- Pedró, Francesc. (2008). The new millennium learners: Challenging our views on digital technologies and learning. *Digital kompetanse [Nordic Journal of Digital Literacy]*, 2(4), 244–264.
- * Pierson, Melissa E. (2005). Novice teachers case studies: Technology reality during induction years. http://www.iste.org/Content/NavigationMenu/Research/NECC_Research_Paper_Archives/NECC_C_2005/Pierson-Melissa-NECC05.pdf NECC Philadelphia, Pennsylvania June 27-30 2005.

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

- * Pierson, Melissa E. & Cozart, Alysia (2005). Case studies of future teachers: Learning to teach with technology. *Journal of Computing in Teacher Education* 21(2), pp. 5963.
- Player-Coro, Catarina. (2007). *Why teachers use ICT in education*. Paper presented at the JURE, 27–28 August.
- * Pope, Margaret, Hare, Dwight & Howard, Esther (2005). Enhancing technology use in student teaching: A case study. *Journal of Technology and Teacher Education* 13(4), pp. 573-618
- Pratt, Nick (2008). Multi-point e-conferencing with initial teacher training students in England: Pitfalls and potential. *Teaching and Teacher Education* 24, pp. 14761486.
- Prensky, Marc. (2001). Digital Natives, Digital Immigrants Part 1. *On the Horizon*, 9(5), 1-6.
- Ramboll Management. (2006). *E-learning Nordic 2006: Impact of ICT on education*. Copenhagen: Finnish national Board of Education, Swedish National Agency for School Improvement, Norwegian Ministry of Education and Research, Danish Ministry of Education.
- * Russell, Michael, Bebell, Damian, O'Dwyer, Laura, & O'Connor, Kathleen. (2003). Examining teacher technology use: Implications for preservice and inservice teacher preparation. *Journal of Teacher Education*, 54(4), 297–310.
- * Sands, Deanna Iccaman & Goodwin, Laura D. (2005). Shared responsibility for teacher preparation: An exploratory study of the match between skills of clinical teachers and those required of their teacher candidates. *Teaching and Teacher Education* 21, 817828.
- * Sardone, Nancy B., & Devlin-Scherer, Roberta. (2008). Teacher candidates' views of a multi-user virtual environment. *Technology, Pedagogy and Education*, 17(1), 41–51.
- Šeová, Klara & Zounek, Jiri (2008). *Teachers among modern technologies*. Paper presented at ECER 2008, 10-12 September, Gothenburg.
- * Shi, Ling, Reeder, Ken, Slater, Tammy, & Kristjansson, Carolyn. (2004). Tensions in learning content and technology: The experience of education students in a web-based research project. *Technology, Pedagogy and Education*, 13(1), 43–60.
- Shuldman, Mitchell. (2004). Superintendent conceptions of institutional conditions that impact teacher technology integration. *Journal of Research on Technology in Education*, 36(4), 319–343.
- * Sime, Daniela, & Priestly, Mark. (2005). Student teachers' first reflections on information and communications technology and classroom learning: implications for initial teacher education. *Journal of Computer assisted learning*, 21, 130–142.
- * Strudler, Neal, Archambault, Leanna, Bendixen, Lisa, Anderson, Don, & Weiss, Rita. (2003). Project THREAD: Technology Helping Restructure Educational Access and Delivery. *Educational Technology Research and Development*, 51(1), 39–54.
- * Strudler, Neal, & Grove, Karen. (2003). Integrating technology into teacher candidates' field experiences: A two-pronged approach. *Journal of Computing in Teacher Education*, 19(2), 33–38.
- * Strudler, Neal, & Wentzel, Keith. (2005). The diffusion of electronic portfolios in teacher education: Issues of initiation and implementation. *Journal of Research on Technology in Education*, 37(4), 411–433.
- * Swain, Colleen (2006). Preservice Teachers Self-Assessment Using Technology: Determining What is Worthwhile and Looking for Changes in Daily Teaching and Learning Practices. *Journal of Technology and Teacher Education* 14(1), pp.29-59

DRAFT NOT FOR QUOTATION CITATION OR DISTRIBUTION

This background paper was prepared for discussions at the OECD/CERI Expert meeting held on 29-30 Oct, 2008.

- Säljö, Roger, & Södling, Maria. (2006). *Utbildning på vetenskaplig grund: Röster från fältet (No. 2006:46 R)*. Stockholm: Högskoleverket [Swedish National Agency for Higher Education].
- * Tan, Ashley, del Valle, Rodrigo & Pereira, Maura (2004). *Required educational technology course in NCATE accredited preservice teacher programs*. Presented at IST Conference in Bloomington, IN.
- Tapscott, Don. (1997). *Growing up Digital: The Rise of the Net Generation*. New York: McGraw-Hill.
- * Taylor, Liz. (2004). How student teachers develop their understanding of teaching using ICT. *Journal of Education for Teaching*, 30(1), 43–56.
- * Twidle, John, Sorensen, Peter, Childs, Ann, Godwin, Janet, & Dussart, Molly. (2006). Issues, challenges and needs of student science teachers in using the Internet as a tool for teaching. *Technology, Pedagogy and Education*, 15(2), 207–221.
- Valcke, Martin, Rots, Isabel, Verbeke, Marjolein, & van Braak, Johan. (2007). ICT teacher training: Evaluation of the curriculum and training approach in Flanders. *Teaching and Teacher Education*, 23, 795–808.
- Vannatta, Rachel A., & Fordham, Nancy. (2004). Teacher dispositions as predictors of classroom technology use. *Journal of Research on Technology in Education*, 36(3), 253–271.
- Veen, Wim. (2003). *A new force for change: Homo Zappiens*. Retrieved 1 okt, 2006, from <http://www.learningcitizen.net/articles/AnewforceforchangeHo.shtml>
- Veen, Wim, & Vrakking, Ben. (2006). *Homo Zappiens: Growing up in a digital age*. London: Network Continuum Education.
- * Wetzel, Keith, & Strudler, Neal. (2005). The diffusion of electronic portfolios in teacher education: Next steps and recommendations from accomplished users. *Journal of Research on Technology in Education*, 38(2), 231–243.
- * Whittier, David, & Lara, Sonia. (2006). Preparing Tomorrows Teachers to use Technology (PT3) at Boston University through faculty development: Assessment of three years of the project. *Technology, Pedagogy and Education* 15(3), 321–335.
- Williams, Peter. (2005). Lessons from the future: ICT scenarios and the education of teachers. *Journal of Education for Teaching*, 31(4), 319–339.
- * Willis, Elisabeth M. and Sujo de Montes, Laura (2002). Does requiring a technology course in pre-service teacher education affect student teacher's technology use in the classroom? *Journal of Computing in teacher Education* 18(3), p. 7680
- Woollard, John. (2005). The implications of the pedagogic metaphor for teacher education in computing. *Technology, Pedagogy and Education*, 14(2), 189–204.
- * Wright, Vivian H. & Wilson, Elizabeth K. (2006). From preservice to inservice teaching: A study of technology integration. *Journal of Computing in Teacher Education* 22(2), pp. 4955.