

OECD Education Working Papers No. 38

ICT in Initial Teacher Training: Research Review

Ann-Britt Enochsson,

Caroline Rizza

https://dx.doi.org/10.1787/220502872611

OECD

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

20-Nov-2009

English - Or. English

DIRECTORATE FOR EDUCATION

EDU/WKP(2009)17
Unclassified

Cancels & replaces the same document of 19 November 2009

ICT IN INITIAL TEACHER TRAINING: RESEARCH REVIEW

EDU Working Paper No. 38

Francesc PEDRO: +33 1 45 24 80 83, francesc.pedro@oecd.org

JT03274621

Document complet disponible sur OLIS dans son format d'origine
Complete document available on OLIS in its original format

English - Or. English

OECD DIRECTORATE FOR EDUCATION

OECD EDUCATION WORKING PAPERS SERIES

This series is designed to make available to a wider readership selected studies drawing on the work of the OECD Directorate for Education. Authorship is usually collective, but principal writers are named. The papers are generally available only in their original language (English or French) with a short summary available in the other.

Comment on the series is welcome, and should be sent to either edu.contact@oecd.org or the Directorate for Education, 2, rue André Pascal, 75775 Paris CEDEX 16, France.

The opinions expressed in these papers are the sole responsibility of the author(s) and do not necessarily reflect those of the OECD or of the governments of its member countries.

Applications for permission to reproduce or translate all, or part of, this material should be sent to OECD Publishing, rights@oecd.org or by fax 33 1 45 24 99 30.

---

www.oecd.org/edu/workingpapers

Applications for permission to reproduce or translate
all or part of this material should be made to:

Head of Publications Service
OECD
2, rue André-Pascal
75775 Paris, CEDEX 16
France

Copyright OECD 2008

TABLE OF CONTENTS

OECD DIRECTORATE FOR EDUCATION OECD EDUCATION WORKING PAPERS SERIES 2
TABLE OF CONTENTS 3
ICT IN INITIAL TEACHER TRAINING RESEARCH REVIEW 4
Abstract 4
Résumé 4
1. Introduction 6
2. Definitions and limitations 7
3. Student teachers' own competencies and attitudes 9
4. Pedagogical integration of ICT by teacher trainers 13
5. Internship and mentor teachers 14
Why is internship important? 15
Mentor teachers 16
Lack of technology competent mentor teachers 16
What student teachers do during their practice periods 17
Different subjects 18
6. Constructivism vs. Traditionalism 20
7. What is good practice and how can it be reached? 21
8. Discussion 24
Competence (C): 25
Access (A): 25
Motivation (M): 25
9. Conclusion 28
10. Research questions 29
REFERENCES 31
EXISTING OECD EDUCATION WORKING PAPERS 39
THE OECD EDUCATION WORKING PAPERS SERIES ON LINE 41

ICT IN INITIAL TEACHER TRAINING
RESEARCH REVIEW

Ann-Britt Enochsson, Associate Professor, Karlstad University, Sweden
Caroline Rizza, Associate Professor, Télécom ParisTech, Paris, France

Abstract

This research review reports on articles presenting empirical research in the area of how teacher-training institutions work on preparing future teachers for the integration of information and communication technologies (ICT) in their future classrooms. It was conducted mainly in English and French and covers research in 11 OECD-countries during the years 2002–2009.

The research is unanimous, even if it is not comprehensive, and it shows that ICT is not used regularly or systematically in the countries reviewed. There are good examples, carried out by enthusiastic teacher trainers, but only a minority of the student teachers benefit from this. Very few articles report innovative use of recent technology. Most of the research reports on the use of computers and traditional computer software.

Overall, student teachers do not integrate technology into their teaching. A number of reasons for this are identified. The overall picture is that implementation is necessary at all levels (macro, meso, micro) for a successful outcome, but research also gives examples of how problems can be overcome at a micro-level, which is the level of the actors' pedagogical practice. Enthusiasts do seem to have room for maneuver, but the lack of incentives makes it difficult to involve everyone.

According to the presented research, the following is needed:

- Policy level: Define clear expectations, carry out evaluations and give room for enough flexibility for the changing field.

- Management level: Offer career possibilities, relevant incentives and suitable equipment, define clear expectations on cooperating schools and mentor teachers in addition to what is already mentioned for a policy level.

- Local actors level (teacher trainers, mentor teachers and student teachers): Ensure basic technological skills, integrate technology as a natural part in subject courses as well as internship, and learn about pupils' technological worlds.

Résumé

Cette revue de littérature concerne les études empiriques relatives à la manière dont les institutions de formation préparent les étudiants-enseignants à intégrer les technologies de l'information et de la

communication (TIC) dans leurs pratiques pédagogiques. Elle a été conduite en anglais et en français. Elle couvre la période 2002-2009 et onze pays de l'OCDE y sont représentés.

Les recherches sont unanimes. Elles montrent que les TIC ne sont pas utilisées régulièrement ou systématiquement dans les pays passés en revue. Bien qu'elles présentent de bonnes pratiques de la part des formateurs, seulement une minorité des étudiants-enseignants en bénéficie. Peu d'articles font référence à une pratique innovante des technologies « nouvelles » (au sens de récentes). La majeure partie des recherches se réfère à l'utilisation de l'ordinateur ou de logiciels traditionnels.

Le tableau qui est dépeint montre que les étudiants-enseignants n'intègrent pas les technologies dans leurs pratiques pédagogiques. Un certain nombre de raisons sont identifiées et présentées. D'une manière générale, un déploiement à tous les niveaux (macro, méso, micro) est nécessaire pour un réel succès. Cependant, les recherches mettent également en évidence des manières de surmonter les difficultés au niveau micro (celui des pratiques pédagogiques des acteurs). Ainsi, si les pionniers semblent avoir une marge de manœuvre, le manque d'incitations constitue un frein à l'intégration des technologies dans les pratiques pédagogiques.

Finalement, cette revue de littérature met en évidence la nécessité de mener conjointement les actions suivantes selon trois niveaux :

- Au niveau politique : expliciter les attentes et les évaluations, faire preuve et donner une plus grande flexibilité pour faire face à un domaine changeant ;

- Au niveau des gestionnaires (de l'institution) : offrir de meilleures possibilités de carrière et mettre en place des incitations à l'intégration des TIC plus pertinentes ; mettre à la disposition des acteurs un équipement approprié, expliciter les attentes vis-à-vis des établissements associés et des tuteurs de stage (« mentors ») en complément de ce qui est énoncé ou demandé au niveau politique ;

- Au niveau des acteurs (formateurs, mentors, étudiants-enseignants) : faire preuve des compétences technique basiques, intégrer les TIC de manière usuelle dans la matière enseignée ou lors des stages, connaître le monde technologique des élèves.

1. 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 survey[1], 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 would like for schools to do but do not think they actually do it(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), and student teachers in Sweden as well as USA use ICT less than other students (CMA, 2009; Salaway, Caruso, & (Nelson, 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 Sweden[2] report regarding information seeking, which is widely used in schools (according to Larose, Lenoir, Karsenti, & Grenon, 2002; Pasternak, 2007), that, during their teacher education, the focus was on their own information needs and that they were not at all prepared for guiding young students in this 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). This was also what Australian first year teachers reported as late as 2009 (McGregor Tan Research, 2009)[3]. The new teachers from Australia also claimed that their training for classroom work had been patchy and inconsistent. According to Moeini[4] (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 related to ICT, as well as an understanding of how

[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

[3] Three focus group discussions were conducted in Adelaide and Melbourne in Nov 2008

[4] From Baskent University, Turkey

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-Koro, 2007).

This review focuses on how student teachers in the OECD-countries are prepared to use ICT in a pedagogical way in their future teaching. The objective of the review is to summarize the research knowledge base in the field, and, from this, discuss what can be done both in terms of policy-making and further research.

2. Definitions and limitations

The review is limited to the years 2002–2009, 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, no longer relevant. 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 *teacher education/training* in connection with *technology*, *IT* and *ICT* have been used, and there have also been searches for *video*, *mobile phones* etc. For the French references the corresponding French words *formation initiale, enseignant* and *TIC* was used. References in other languages were found by way of other means. 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 1998. Not all articles give an account of the year of data collection. Thirty-seven articles out of 66 provided this information, and the average span of time from latest data collection to a published article is 2,4 years.

Not only technology changes, but student teachers also change. People who were born in the latter 1980s grew up surrounded by digital technology and the Internet. Researchers have given these people different names depending on the scope of research. N-geners (Tapscott, 1997, 2008) 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 1998 and 2008. 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 studies they were 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 and French, but there are also articles in the Scandinavian languages and Spanish. The main body of research found[5] covers the United States (33), the United Kingdom (12), and Canada (9 - 6 of them large scale studies). Twelve articles cover other OECD-countries – Australia (2), Belgium, Finland, the Netherlands, Norway, Portugal, Sweden (2) and Switzerland (3). The picture presented in these articles does not differ from the picture given in articles from USA, UK or Canada, 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.

[5] The articles listed here are marked with * in the reference list

Searches in databases resulted in less than 70 articles. Technology terms combined with *induction teachers* or *new teachers* did not result in any articles this way. Thirty articles of those found through databases were considered as corresponding to the criteria mentioned below. In total, more than 300 articles have been studied and 66 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 when there was no information specifically concerning how to use technology for instruction; however, it should be stressed that this area is not less important. It is also part of the requirements for student teachers' skills in several countries, as we can see in another report within this project.[6] There are especially two reasons for the importance: the first is that the student teachers can experience models of teaching from a student perspective, and the second is that it is also a way of getting familiar with the tools used (e.g. Baron & Bruillard, 2003; Daele & Lusalusa, 2003a, 2003b).

The studies vary in size from the smallest case study with 4 informants to the largest survey with 6998 respondents, which also means differences in designs and methods. Twenty studies have 30 informants or less, thirteen studies have 31-100 respondents, twenty studies 101-1000, and five 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 parts 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 present review, though, the studies are not compared explicitly regarding quality.

An area which is possibly 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 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 three entire journal issues dedicated to reviewing teacher technology in education (Charlier & Coen, 2008; Kirschner & Selinger, 2003; Viens, Peraya, & Karsenti, 2002). 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 teacher trainers' and mentors' technological skills. What was also found earlier is that the integration of technology in teacher education 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.

This review includes a chronological analysis of the development in the area during the period of the articles. Peraya, Lombard and Bétrancourt (2008) carried out a similar analysis from Geneva, Switzerland and they saw three periods with different foci: first, the period of training centred on technology (1996–1998), which was followed by a period when coherence of technology and student teachers' own

[6] Review on national policies

production became important (1999-2002), and the last period showed how to go from the product to the scenario, and technology was implemented in the classroom (later than 2002). Since the articles in the research review cover the years 2002 to 2009, the review is covering the scenario period when theories are, according to the Swiss findings, put into practice in the classrooms. There are many examples of how to integrate technology in classroom teaching, but it is not possible to see any significant development, neither in research nor in practice, based on the reviewed articles.

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, we have chosen to use *student teacher* for a person studying to become a teacher and without a certificate, *teacher trainer* for teacher educators on campus, *mentor teachers* 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 four areas regarding implementing ICT in teacher education around which the research literature can easily be structured.

a. Student teachers' pedagogical competences in using computers and their attitudes towards using them – both for personal use and instructional uses.

b. Teacher trainers' use of technology in their teaching and how theoretical knowledge is discussed.

c. Student teachers' field experiences during teacher education, mentor teachers as role models, and the student teachers' own possibilities to practice.

d. Policies impact on the use of ICT in initial teacher training.

In the fourth area the research literature does not present much empirical evidence. Nevertheless it is very important, and some researchers discuss how implementation can be done throughout the system building on other research in similar contexts. The three first themes concern the micro level, but from research on organisations it is known that also the meso and macro levels are important when it comes to overall implementation. The planned study will also look at those levels, and this is the reason why the results presented are complemented with research from adjacent areas in the overview.

3. 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 practices[7]. One of the reasons for this was the students' lack of operational skills (Twidle et al., 2006). The question is no longer whether or not ICT should be implemented in teacher education, but rather whether 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. 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. Bétrancourt (2007) claims that there is no correlation between student teachers' technological competencies and their pedagogical use of ICT[8]. She

[7] 128 student teachers answered a questionnaire; this was followed up by interviews and observations of 11 of these student teachers.

[8] According to a study in the UK

underlines that recently trained teachers do not use more ICT than the more experienced ones and that the idea according to which the youngest teachers, who are naturally accustomed to using these technologies, are more comfortable with introducing them in their pedagogical practices, is false. She highlights the following paradox: on the one hand teachers' technical competences have increased over the last ten years, and today they master the basic data-processing competences, but on the other hand the pedagogical use of ICT in classrooms remains constant. The increased use in schools concerns the use of technologies in the phases of preparation of courses.

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 Malaysia[9] 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.

However, there is also a risk in taking away ICT courses. By considering ICT as a transversal subject, nobody feels responsible for it, and this was found to have a negative impact on teacher students' use of ICT in their teaching (Karsenti, 2005b; Karsenti, Raby, & Villeneuve, 2008). Continuous and sustained training is needed to become comfortable and effective in implementing ICT (Sardone & Devlin-Scherer, 2008), but 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 combination of the amount of technology training, number of hours worked beyond contractual workweek, 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 have pointed it out as a reason for working on *student teachers'* attitudes towards change. However, it cannot be assumed that this is automatically valid for student teachers.

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[10], along with different incentives for teacher educators and mentor teachers 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).

[9] 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

[10] 49 student teachers were involved in this study during the years 2001-2002.

A smaller project with 13 prospective teachers in Florida also used the method of combining working on attitudes and practical training (Dawson & Fitchman Dana, 2007). The method used is called 'teacher inquiry', where the teacher trainers used a well-structured plan for working with the development of the student teachers attitudes. The authors show how the student teachers' attitudes changed from technology-centred to curriculum-centred orientation of technology use.

Another way for student teachers to work on their technology skills in separate courses is to let them use technology for their own learning. Several researchers show that technology is a very good tool for reflecting (e.g. Baron & Bruillard, 2003) and collaborating (e.g. Daele & Lusalusa, 2003a; Daele & Lusalusa, 2003b). This way of working can also be used together with their pupils, but the transfer does not come automatically. At the university of Montreal, Karsenti (2006) adopted a different approach. In order to support the ICT integration in the educational context, a team of the University of Montreal created a specific tool: an e-portfolio dedicated to education called "e-portfolio.org". E-portfolio.org was developed in collaboration with 549 teachers, student teachers and pupils in primary and secondary school, in order to create a tool that would fit the needs of these actors. This development project aimed at bringing an answer to the following problem: new teachers seldom use ICT because they lack proper time and because the tools dedicated to education are complex. More precisely, the aim of the development of the e-portfolio tool is double: on the one hand, to bring teachers to use ICT in a regular way while supporting e-portfolio use by the pupils and on the other hand to bring student teachers to use ICT during their initial training. Moreover, the testing observed the impact of the e-portfolio on initial teacher training: 379 student teachers of primary and secondary schools used it during their field placements (Ibid.).

A shorter project within a 12-week course, also in USA, did not show the same effects (Willis, 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 into 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 becomes 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. According to the conclusion, a reason for this could be that the students in the study often feared they were not 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 mentor teachers in UK (Cuckle & Stephen, 2003). However, this was the third part of a larger study

where 238 student teachers and 216 mentor teachers 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 student teachers specialising in ICT had to prepare something creative group-wise for primary school children (Loveless, Burton, & Turvey, 2006). During the 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 such a 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) turned this around 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 on 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 not all student teachers in the United States 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 were hoping that technology would be so well integrated in the courses that it would no longer be visible in the course descriptions, although they assumed this was not the case.

Although the numbers in the above paragraph seem somewhat depressing, Peraya, Lombard and Bétrancourt (2008) show in their 10-year-overview from the University of Geneva that there *has* been a change in approach of ICT in initial teacher training which is mentioned above. In the mid-nineties there was a training centred on technology. Around the shift of millenniums the technological training became part of the student teachers' production of web pages, for example. Later there was a focus on collaboration and reflection, and to some extent this is implemented in the classrooms. They can see an evolution of the training and they highlight the necessity of "setting in context" the activities and use of ICT that student teachers have to realise or implement. They also show how to help student teachers reflect upon their own practices. In this context, the integration of the e-portfolio in initial teacher training is a relevant illustration: by using an e-portfolio, student teachers formalize their learning, they reflect upon

their practices, they familiarize themselves with a very-easy-to-use tool. This activity takes place "in context" and is supported by the training device. (Ibid.)

4. Pedagogical integration of ICT by teacher trainers

To be able to integrate ICT in teacher training institutions, the teacher trainers need to feel confident in using ICT themselves. This is not always the case (Baumberger, Perrin, Betrix, & Martin, 2008; Judge & O'Bannon, 2008; Whittier & Lara, 2006). The programme Preparing Tomorrows' Teachers to use Technology (PT3) was run in the USA from 1999 to 2003 to help address the challenge of preparing teachers to use technology. The grants included 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'Bannon[11] (2008), Whittier and Lara[12] (2006) Strudler, Archambault, Bendixen, Anderson and Weiss[13] (2003) as well as Aust, Newberry, O'Brien and Thomas'[14] (2005) report from their work respectively. Teacher trainers 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 teacher trainers who finished the programme and showed they had implemented ICT in their courses. The grants were highly valued by the teacher trainers. 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 teacher trainers 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 trainers 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 trainers for primary school participated (210). They drew a profile from questionnaire answers with the help of Partial Least Square analyses. Teacher trainers 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 trainers' driving force "personal entrepreneurship", and this is seen as a catalyst between the endogenous factor on the teacher level and the endogenous factor on the teacher institute level, since they find that support from the institutes is not enough.

[11] 42 teacher trainers were studied by using different methods during the PT3-project period

[12] 7 teacher trainers were in-depth studied during 3 years while a developmental program for teacher trainers was running.

[13] 153 student teachers answered a questionnaire after being involved in a project concerning many different levels and means of implementation of ICT in initial teacher training.

[14] 244 student teachers and 21 instructors answered questions about their confidence in computer skills

Similar conclusions are drawn from Switzerland (Baumberger et al., 2008; Perrin, Betrix, Baumberger, & Martin, 2008). The only difference is that lack of technological equipment and software is not a barrier to the integration of ICT in their teaching. It is the lack of competences in implementing these tools which constitutes a real difficulty. Whether teacher trainers have competences in computer science or not does not make a difference in their pedagogical representations regarding the use of ICT, but it has an impact on the probability that they will integrate ICT in their practices.

Earlier studies and overviews have shown that teacher educators and also mentor teachers do not have enough confidence in using technology, and the equipment is not always what could be expected (e.g. Moursund & Bielenfeldt, 1999). Even if there have been improvements, it seems like it has not been enough (e.g. Mutton, Mills, & McNicholl, 2006; Sardone & Devlin-Scherer, 2008). In the above cited Swiss study the researchers state that available equipment and software was not a hindrance for using ICT in teaching (Baumberger et al., 2008), but results from other researchers show 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.

5. Internship and mentor teachers

Several researchers have found one crucial point to be how students are able to use computers during their practice periods. The students' fieldwork 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 they can be certified. Findings of a survey of 6,998 future teachers in Québec, Canada revealed that commitment to and perseverance in pedagogical integration of ICT during practical education of future teachers mainly depend on five factors or determinants (Karsenti, 2005b). 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 teacher trainers. The fifth is pedagogical integration of ICT by the mentor teachers (e.g. also Larose et al., 2002). Deaudelin, Dussault and Brodeur (2002) found apprenticeship and support very important also 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 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. Larose, Lenoir, Karsenti and Grenon (2002) claim the student teachers' use of ICT in their future teaching strongly depend on representations and practices of teachers they meet during their field placements and training. It is also found that student teachers ask for "role models" at schools (Haydn & Barton, 2007).

There seems to be a gap between what is desired and what the student teachers find in their field placements. Difficulties for student teachers in seeing innovative ICT use in classrooms is reported both in reviews as well as in empirical studies (e.g. Clifford, Friesen, & Lock, 2004; Larose et al., 2002; 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). However, it has to be stressed, that the Francophone articles do not mention lack of equipment as a hindrance for using ICT in teaching. Also Bullock's (2004) finding is contradictory to many studies in this respect. From a larger case study he describes the difference between two of the students in the respect of their mentor teachers' 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.

Strudler et al. (2003) 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, the computers, primarily, are not always up-to-date and because of this are 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.

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 teacher trainers above (Lavonen et al., 2006).

Why is internship important?

A few researchers (Grove, Strudler, & Odell, 2004; Ottesen, 2006)[15] view the apprenticeship explicitly from a socio-cultural perspective, and find in this a theoretical explanation. "As learners become attuned to environments in increasingly complex ways, they gradually acquire a capacity for diverse responses to 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 mentor teachers 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's[16] (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

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

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

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.

From a systemic point of view, it must be stressed that not only student teachers develop and change. Teacher education also changes because of the feedback student teachers give (Peraya et al., 2008)[17].

Mentor teachers

How well the mentor teachers 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 mentor teachers 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 mentor teachers do not see their role as very important, even if mentor teachers are told to be important also as role models (Twidle et al., 2006). Grove, Strudler and Odell (2004) followed 16 mentor teachers 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) mentor teachers 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 mentor teachers are competent in using ICT when teaching themselves. Another problem can be lack of explicit expectations and communication in field-based sites (Judge & O'Bannon, 2007). The mentor teachers might not always know what is expected.

In the national program PT3 in Tennessee, mentor teachers were included and 50 mentor teachers 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 mentor teachers 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 mentor teachers 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 mentor teachers

Several researchers point at the problem of finding enough competent mentor teachers for internships (e.g. Judge & O'Bannon, 2007; Karsenti, 2005b). The regular use of and the proficiency of different domains were studied in a self-report survey to mentor teachers 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

[17] Peraya, Lombard and Bétrancourt studied field placements in Switzerland.

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 mentor teachers is using some kind of technological platform for discussions with more competent persons (e.g. Karchmer-Klein, 2007), or with fellow-students (Karsenti, 2005a).

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 mentor teachers 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 mentor teachers enough before the project start. One of the objectives was to exchange knowledge between mentor teachers and student teachers.

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 types 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 et al. (2005) finding where word processing scored the highest when 244 student teachers and 21 instructors answered questions about their confidence in computer skills. That there is a difference between grades could also be seen in Karsenti's (2005b) study of 6998 student teachers in Quebec. Secondary school student teachers declare they almost never use ICT while 50% of the primary student teachers say they use it during their internship.

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, but can explain differences in other studies.

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.

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 in 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 didactic dimension and a dimension of power. The didactic dimension 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 (Šeďová & Zounek, 2007, 2008). Another finding from the Czech study was that 83% of the teachers downloaded material from the Internet and the same percentage of teachers used commercial software. It means that they preferred to use prepared materials and software and they use/create less own materials. The authors consider this as a question of creativity and look at it from a view of autonomy versus determination (ibid.).

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 mentor teachers, 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). Different use in different subjects may explain part of the difference between primary and secondary teacher students.

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 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 Varandas (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 web pages 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 whether or not technology experts have been involved as researchers or support persons varies, 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 Kennewell[18] (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 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.

[18] Morgan and Kennewell let 77 primary student teachers taking a one-year course to achieve Qualified Teacher Status in Wales answer to a survey.

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.

6. 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 return towards a more traditional way of teaching, in spite of increased technology use. The use of interactive 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.

An interesting remark is made by Bétrancourt (2007) who uses an example from the UK project "Harnessing technology" deployed in 2005[19]. She shows that the discourse of the politics concerning the implementation of ICT in schools is double: although the accent is put on national objectives concerning use of ICT in order to support an active pedagogy (cf. socio-constructivism), the majority of the tools support traditional transfer pedagogy and the use of ICT is limited to presentations (documents) or evaluations (quizzes). This kind of policy displays a negative image of ICT based on the use of ICT in a professional context of training. These uses are not integrated into the professional identity of the teachers. From a pedagogical point of view, the teacher is relegated to a subordinate level and faced only with technical problems, which is not what a teacher is educated for. This can be part of an explanation for teachers not using ICT in teaching to an extent desired by the authorities.

Bétrancourt (2007) also points at how different ways of organizing computers physically supports or makes it more difficult to apply a student-oriented way of teaching. She presents three models of organization: (1) a specific classroom fully equipped with computers makes it possible to work in a whole class with computers but it requires a reservation in advance and displacement of pupils. Thus, this model poses the problem of the continuity of the teaching activities with computers. (2) Classrooms with a few

[19] Department for Education and Skills (2005). *Harnessing Technology: Transforming Learning and Children's Services*. London: DFES. Available online: http://publications.dcsf.gov.uk/eOrderingDownload/1296-2005PDF-EN-01.pdf

shared computers at the back of the room solve the problem with displacement but not the problem of continuity and spontaneity. The teacher must plan activities for a restricted number of pupils during the lessons. (3) Mobile laptops solve the problem with displacement and continuity of the pedagogical activities but not the problem of the spontaneity. Instead she suggests classroom equipment with thin clients or handheld devices. She thinks this will constitute a possible solution for the next 10 years.

7. What is good practice and how can it be reached?

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, 2005a; 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 a 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 described, 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 teacher trainers 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"[20] (p. 19). Deale and Lusalusa (2003b) also advocate this view by referring to "teach-as-taught", but there is no empirical evidence that this method works. What they can see is that when student teachers collaborate on the net, the teacher trainers change their role and become tutors, which does not automatically lead to a change in the role of the future teachers. Earlier in this text it has been questioned if the requirements for the mentor teachers 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.

Charlier, Daele, & Deschryver (2003) from the French Community in Belgium present an approach, which takes into account both the individual experiences of teachers and institutional contexts, and they call it "the action-research-training". Part of this approach is a diagnostic approach and part is a

[20] The authors' own translation of "Det de själva använder kan de lära sina framtida elever att använda".

participative construction of the training device. The diagnostic approach relates to the institutional constraints, the resources and the projects of each teaching institution. The participative construction of the training device is based on the revision of the objectives and the methods by the implicated actors, such as the directors or school managers, the teacher trainers and the student teachers. They are both required in order to preserve the coherence of the training with the existing practices. The authors show that integration of ICT in the teaching practices is more than a question of teaching. This integration requires to take into account all the dimensions of the educative system and to reconsider the function of the trainer. In this context, the learning processes are those already identified in the learning of teaching, but they reinforce the role of the teacher network as well as the necessity to take into account individual and institutional situations.

In 1997, the Ministry of education of Quebec started an action plan called *Les technologies de l'information et de la communication en éducation* (Information and communication technologies in education)[21] in order to contribute to a better preparation of student teachers to integrate ICT in their teaching. There is also a text considered as the official reference concerning teacher training in Quebec (Ministère d'Education, 2001). This text presents the twelve professional competences student teachers are supposed to acquire at the end of their initial training. Among these twelve professional competencies, one is specifically about pedagogical use of ICT by teachers: *"Integrate ICT in order to prepare, to control teaching-learning activities, and administrate teaching and professional development"*[22]. The competence consists of six components of which the last one is to help pupils to take possession of ICT, use them for their learning etc. By their content, these texts mark the transition from computer science teaching *per se* to a transversal integration of ICT in university. And this transition can appear as a progress in the field of the introduction of ICT in initial teacher training. However, the evaluation of this plan showed that universities only considered technological training as a speciality and failed to see it as a pedagogical tool (Karsenti et al., 2008).

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-Koro, 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-Koro 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 does not measure ICT competencies and that teachers therefore do not give priority to. Teachers' confidence in using computers as well as classroom equipment is an important factor. They also stress the lack of role models.

Lebrun (2004) applies a systemic approach to analyse the teacher training institution through three levels: the student teachers and the training of students in the classroom; the teacher trainers with their ICT practices, knowledge and competences; and the institution. His article does not present empirical evidence, but has a thorough theoretical approach. He considers that training of teacher trainers (meso-level) constitutes the central link between student teacher training (micro-level) and innovation development in

21 *Les technologies de l'information et de la communication en éducation*, Plan d'intervention enseignement universitaire, Ministère de l'Éducation, 29 janvier 1997 http://www.mels.gouv.qc.ca/nti_plan/nti_univ.htm

22 Authors' own translation: Compétence No 8 : Intégrer les technologies de l'information et des communications aux fins de préparation et de pilotage d'activités d'enseignement-apprentissage, de gestion de l'enseignement et de développement professionnel, pp. 107-112.

the institution (macro-level). In this context, he shows that analysing how the educational system runs allows us to understand the innovative process. Teacher training is important to promote innovative pedagogical use of ICT in school. It is also necessary to train teacher trainers so that they influence student teachers during the training and support their future innovative use of ICT in the classroom. Moreover, trainers have an influence on the institution (macro-level) by using and integrating ICT in their practices. Finally, teacher training institutions also have to support these practices from providing the equipment to answering to trainers' needs of ICT training.

Describing more precisely the teacher training (meso) level, Lebrun (2004) highlights a specific innovative sub-process: first, the trainer uses computers to do usual tasks such as writing courses notes, publishing documents on the Internet, managing grades with a spreadsheet, etc. Then, with experience and competences, he/she is supposed to be able to promote new pedagogical uses and new pedagogy. Lebrun shows that these different steps have to be supported by the institution, which has to inform, motivate, give the resources and means of action (funds, training, etc.), encourage share of practices, support projects, etc. His answer to the question "how can pedagogical innovation and innovative pedagogical practices be promoted?" is "by implicating all the levels and actors of the training institution", from the student teachers to the teacher trainers and institution management.

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).

Since it is also important for student teachers to meet mentor teachers who can use ICT in their teaching, there is included an example from school and the impact school managers have on the integration of ICT in teaching. IsaBelle, Lapointe, & Chiasson (2002) conducted a survey in one of the New-Brunswick districts, Canada. All the French-speaking school management and assistant school management were solicited, and among the 36 institutions, 28 have answered. The authors refer to a national survey[23] conducted in 1975 concerning factors of success in the establishment of innovation in American schools. Its results indicate that the success of an innovation is not only related to the nature of the innovation and the allocated funds. But it depends above all on the organizations' characteristics and on the type of management practiced in the school commissions and schools. This survey highlights that the success in the establishment of innovation depends strongly on the school managers' capacity to create the right conditions to support teachers.

IsaBelle, Lapointe, & Chiasson (2002) establish relationships between pedagogical innovation (defined as a successful ICT integration in schools), school manager ICT knowledge and the support they have to give to teachers. The results show that the more school management and assistant school management use ICT in pedagogical activities: (1) the more they affirm that ICT contribute to increase their effectiveness in their duties and that ICT are useful for teachers in the classroom; (2) the more they would like to follow ICT pedagogical training; (3) the more they believe that it is important to create an expert commission to support ICT pedagogical integration in the school; (4) the more they feel able to support teachers' uses of ICT in the classroom; and (5) the more they believe that in a few years ICT will be important in the educative system. The school managers that use ICT in a pedagogical way, who also think that it's easy to use ICT to renew the pedagogical way to teach, and at the same time feel at ease in supporting teachers' uses of ICT in the classroom, believe that in a few years ICT will be important in the educative system. The representation of school managers' own capacity to support teachers' uses of ICT in

[23] Owens, R.G. (1998). Organization behavior in education. (6th ed.). Boston, MA: Allyn and Bacon.

the classroom increases with their representation of their capacity to help teachers to use computer programs (word-processing, presentation software, spreadsheets and databases, etc.)

On the basis of their results, IsaBelle, Lapointe, & Chiasson (2002) highlight the necessity to train school managers to use ICT in a pedagogical way in order to support pedagogical ICT integration in schools. To ensure the success of ICT teacher training, they advise to understand school manager needs concerning ICT pedagogical practices. They underline the importance of the school manager's leadership concerning the development and the coherence of ICT practices, knowledge and competences required from teachers.

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 tells 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.

8. 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 and recently graduated teachers in the countries covered by this research do not integrate technology in teaching to a large extent. In another study within the project *New Millennium Learners* (OECD, in press), a model from Viherä and Nurmela (2001) has been used to show different factors necessary for implementing ICT in schools. The model focuses on access (to digital equipment), competence (in using software, and applying it for teaching purposes) and motivation (gauged through the attitude that using ICT result in significant benefits). This can be seen in figure 1.

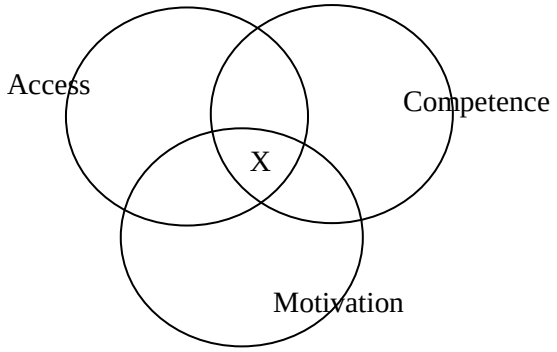


Figure 1 – The Access, Competence and Motivation model (Viherä & Nurmela, 2001). X represents the ideal use of ICT in teaching.

The reasons for student teachers and new teachers not using ICT, according to the research review, can fit into this model:

Competence (C):

- Lack of competence in basic computer skills and/or in pedagogical use, part of this is the complexity of the ICT-tools dedicated to education.
- Lack of confidence in basic computer skills as well as pedagogical use.
- New teachers have a lot to think about when managing their work on different levels. If they are not trained in the use of ICT, it will be put down on the priority list in favour of more urgent tasks.

Access (A):

- In many countries lack of equipment at field placements is reported. This concerns both lack of updated and/or adequate equipment as well as restricted access in different ways.

Motivation (M):

- Lack of incentives. Integration of ICT is not requested.
- The absence of representations of the potential of ICT in teaching and learning.
- The tools available at schools do not fit into a professional identity that aims at a student-centred way of teaching.

In addition to this some reasons can be seen as suggestions for solutions and can be placed on a level where the actors themselves do not have enough impact. Lack of time is one of those reasons. This also implies a lack of financial resources, since it is not possible to have dedicated time for training and exploring. The lack of role models is also a reason on a meta-level and is dependent on competent and confident mentor teachers as well as teacher trainers. Along with lack of confidence, competence and equipment there is also a lack of incentives for these two groups, which lowers technology integration on the priority list. Other than 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. The lack of role models leads to lack of representations of the potential of ICT in teaching and learning for the student teachers, which in turn puts the use of ICT down on the priority list and not enough time is set aside to increase the competence, and there is a vicious circle.

The Access, Competence and Motivation model (ACM model) can be useful on an actors' level, but the use of ICT in teaching is more complicated since the actors do not have impact on all factors involved. Most of the research presented is conducted on a micro-level, only a few studies take other levels into account. Looking at these few studies, we can nevertheless draw a model with several layers (figure 2). The macro- meso- and micro-levels, are here represented by the national level, the institutional level and the three main groups of actors mentioned; Student teachers, Teacher trainers and Mentor teachers. A few areas are not represented in the research review, but we can still assume they are of some importance. In the figure those areas are drawn with weaker lines; we can, however, assume from adjacent areas that those two fields of interaction play a part.

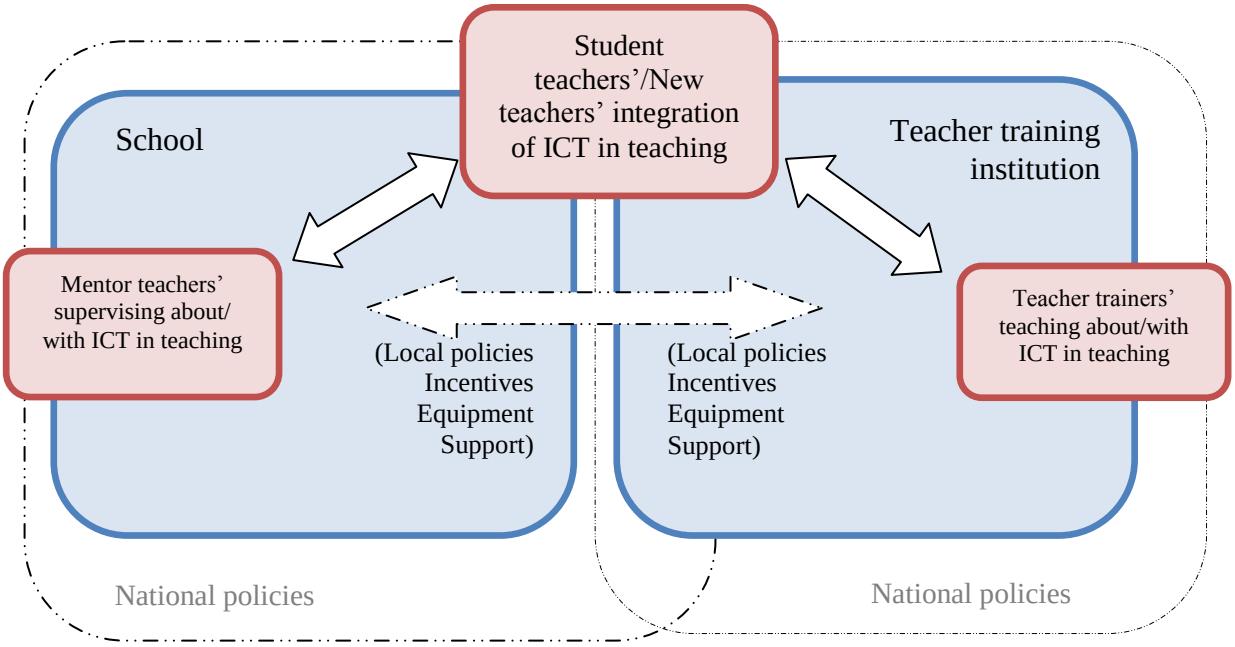


Figure 2 – Interactions through Meso and Micro levels. Macro level still not fully explored.

The factors A, C and M can exist on different levels. On a national policy level one can expect that there have to be clear expectations on what has to be done and how the outcomes should be evaluated (M). In some countries, equipment at schools and teacher training institutions (A) as well as career possibilities (M) are a national concern and defined at this level. In a general way, the policies (national/regional or institutional) have to initiate favourable conditions to enable the institutional level to provide the use of ICT. The institutional level has to provide career possibilities, other relevant incentives (M), and also access to suitable equipment (A). Support can be part of both the access factor and the competence factor (A, C). The three groups of actors need to have personal technological competence, and pedagogical competence in using technology, which both lead to confidence in their professional work (C). Positive attitudes towards technology integration in education are part of a vision and thus motivation (M).

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 mentor teachers (Karchmer-Klein, 2007; Karsenti, 2005a). Enthusiasts do seem to have room for manoeuvre, but the lack of incentives makes it difficult to involve everyone. This is probably also a reason why most studies are done on the micro-level. This might be an indicator that most projects also are on the micro-level.

To engage more people, several levels have to be involved. We can see from Lavonen et al. (2006), the PT3-projects in the USA (Aust et al., 2005; Judge & O'Bannon, 2008; Strudler et al., 2003; Whittier & Lara, 2006) and we also know from other research that a bottom-up approach needs to be met by a top-down activity and vice versa, or the project will remain an isolated island. In this field, however, 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. There is a risk that these projects remain at the state of experimentation. When the project finishes, the use of ICT disappears, because there is no generalization of the use of ICT.

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 Sweden and Belgium (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? Referring to the initial discussion that we have to prepare tomorrows teachers, the Scandinavian parents for example would answer no, (Ramboll Management, 2006). 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. 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. We have though seen an example from Quebec of how policy was implemented in a way where ICT was not seen as a pedagogical tool, even when the policy seemed quite clear on this point (Karsenti et al., 2008). 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, but in the UK at least, the equipment in general do not support a constructivist way of teaching (Bétrancourt, 2007). Bétrancourt claims that many teachers comprise a constructivist view, and because of this cannot always see how ICT can fit into their teaching.

So, what are the reasons for integrating technology in education? What is mentioned in many articles is that it should support learning. It can support learning directly, but also indirectly through making administration, communication or managing easier. 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. Most studies lack a view on ethics, which is also an important issue in relation to digital communication. In the most developed competence frameworks supported by national policies, ethics is pointed out as an aspect of ICT use in initial teacher training[24]. 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. When will we reach a stage where we can assume that students already have the basic skills, and we can start to discuss teaching and learning without first discussing basic competence? 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 (2003) describes, where the student teachers were supposed to bring the technological knowledge and the mentor teachers 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 eleven 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, teacher trainers and

[24] See review on national policies, which is part of this project as well.

mentor teachers; anything is better than nothing. This also points at that teacher trainers and mentor teachers 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 (Bétrancourt, 2007; Clifford et al., 2004; Sardone & Devlin-Scherer, 2008).

9. 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.
- Management level: Career possibilities and relevant incentives, suitable equipment, clear expectations on cooperating schools and mentor teachers in addition to what is already mentioned for a policy level.
- Local actors level (teacher trainers, mentor teachers and student teachers): 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.

Dedicated time and financial resources are needed since there is a lot of work to be done before all teacher trainers and mentor teachers change their views from teaching *about* ICT to teaching *with* ICT (words from Kirschner & Davis, 2003).

****

An area, which is not covered by the reviewed articles, is a field only mentioned in one of the articles (Judge & O'Bannon, 2007). It is the expectations on mentor teachers, which Judge and O'Bannon suspected not to be enough explicit. None of the articles selected for this review mention what is a supposed to be collaboration where all three actors (student teachers, teacher trainers and mentor teachers) are involved. Pratt (2008) studies the use of e-conferencing between students, teacher trainers and mentor teachers 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 upon, that guidance for schools has to be clarified.

Another area which is almost absent in the review is the effect of national policies on ICT in initial teacher training. In the report on national policies, which is also carried out within this study, it is shown that there is a correlation between the use of computers at school and implementation of a national policy for teacher training. What is not possible to see is what comes first. We have seen that the role of national policies is not studied to a great extent in this area. The impact of national policies on meso and micro levels will be explored and analysed through case studies and in relation to the national policy report. On the basis of these two sources of information, we will be able to determine if this impact exists and, if it exists, we can specify what kind of interactions are there. We do not know for sure how a policy best can be formulated in this field, one of the researchers in the review (Williams, 2005) claims that policies have to be flexible enough to reflect the rapid changes within the field.

In the study related to this review we will look at the areas just mentioned, but we will also look at the present situation of how ICT is used in general in initial teacher training, since it is a rapidly changing field. The review shows that the situation is similar in the OECD-countries, is it a picture that corresponds to reality or is it a result of focusing on different aspects in different countries? The objectives of the present study are:

- To provide a detailed picture of ***how technology is used in initial teacher training, from a comparative perspective***, paying particular attention to the regulatory frameworks, the identification of best practices but also to the reasons that can eventually explain why the use of technology is low in regular teacher training institutions.

- To analyse ***the views of the main stakeholders*** (teacher trainers, managers of teacher training institutions, policy makers, teacher unions, and student teachers) regarding the present use of technology in initial teacher training and their expectations for the future.

- To issue a number of ***policy recommendations*** both for teacher training institutions and governments in this domain.

10. Research questions

The following research questions will guide the study:

- *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 teachers 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 21st century skills may also have a reflection on teacher training requirements.

- *How different are the institutional frameworks and requirements?* Objectives, definitions and precise descriptions of required skills and competencies must be taken into account, as well as concrete means of implementation, methods of assessments and certification, and the balance of responsibilities between government and teacher training institutions.

- *To what extent and in what ways is technology used in teacher training institutions in OECD countries?* To get insight into the integration of technology in teacher training institutions, the kind of technology being used must be clearly defined (e.g. whiteboards, mobile devices, personal computers and different kinds of software), as well as 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?

- *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?

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.

Baron, Georges-Louis, & Bruillard, Eric. (2003). Les technologies de l'information et de la communication en éducation aux USA: Èlèments d'analyse sur la diffussion d'innovations technologiques. *Revue Française de Pédagogie* (145), 37–49.

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.

Baumberger, Bernard, Perrin, Nicolas, Betrix, Dominique, & Martin, Daniel. (2008). Intégration et utilisation des TIC par les formateurs d'eseignants. In B. Charlier & P.-F. Coen (Eds.), *Formation des enseignants et intégration des TIC: Faire le bilan pour comprendre* (Vol. 7, pp. 73–86). Neuchâtel: CDHEP.

Bergqvist, Thomas. (2005). IT och lärande – i skola och lärarutbildning. Tidskrift för lärarutbildning och forskning, 12(1), 11–22.

Bétrancourt, Mireille. (2007). Pour des usages des TIC au service de l'apprentissage. In G. Puimatto (Ed.), *Les dossiers de l'ingénierie éducative* (Juillet ed., pp. 73–92). Paris: SCÈRÈN–CNDP.

Brawner, Catherine, & 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.

Charlier, Bernadette, & Coen, François. (2008). *Formation des enseignants et intégration des TICE. Revue des HEP de Suisse romande et du Tessin, 7.*

Charlier, Bernadette, Joël, Bonamy, & Saunders, Murray. (2003). Apprivoiser l'innovation. In B. Charlier & D. Peraya (Eds.), *Technologie et innovation en pédagogie: Dispositifs innovants de formation pour l'enseignement supérieur* (pp. 43–64). Paris: De Boeck.

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

CMA. (2009). *Internet och lärarutbildningen: Om lärarstudenters och lärarutbildares attityd och användning av IT*. Stockholm: Centrum för Marknadsanalys.

Cuckle, Pat, & Stephen, Clarke. (2003). Secondary school teacher mentors' and student teachers' views on the value of ICT in teaching. *Technology, Pedagogy and Education, 12*(3), 377–391.

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.

Daele, Amaury, & Lusalusa, Simon. (2003a). Les apprentissages vécus par les étudiants. In C. Bernadette & D. Peraya (Eds.), *Technologie et innovation en pédagogie : dispositifs innovants de formation pour l'enseignement supérieur* (pp. 163–176). Paris: De Boeck.

Daele, Amaury, & Lusalusa, Simon. (2003b). Quels nouveaux rôles pour les formateurs d'enseignants? In C. Bernadette & D. Peraya (Eds.), *Technologie et innovation en pédagogie : dispositifs innovants de formation pour l'enseignement supérieur* (pp. 141–148). Paris: De Boeck.

Davis, Elisabeth A., Petish, Debra, & Smithey, 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, et al. (2007). Illustrating the "virtual" in virtual schooling: Challenges and strategies for creating real tools to prepare virtual teachers. *Internet and Higher Education 10, 27–39.*

Dawson, Kara, & Fitchman Dana, Nancy. (2007). When curriculum-based, technology-enhanced field experiences and teacher inquiry coalesce: An opportunity for conceptual change? *British Journal of Educational Technology, 38*(4), 656–667.

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*, 506–518.

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*, 187–199.

Ekholm, Mats. (2005). *Att fånga kunnandet om lärande och undervisning.* Stockholm: Utbildningsdepartementet.

Fabry, Dee, & 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 A., & 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*, 1018–1036.

Hoban, Garry F. (2005). From claymation to slowmation: A teaching procedure to develop students' science understandings. *Teaching Science, 51*(2), 26–30.

IsaBelle, Claire, Lapointe, Claire, & Chiasson, Monique. (2002). Pour une intégration des TIC à l'école: De la formation des directions à la formations des maîtres. *Revue des sciences de l'éducation, 28*(2), 325–343.

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.

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. (2005a). 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. (2005b). Les TIC et les futurs enseignants: Les facteurs qui influencent leur utilisation. In D. Biron, M. Cividini & J.-F. Desbiens (Eds.), *La formation enseignants au temps des réformes* (pp. 263–280). Sherbrook: èditions du CRP.

Karsenti, Thierry. (2006). L'e-portfolio: Un outil pour relever le défi de la difficile intégration pédagogique des TIC en éducation? In P.-D. Gagnebin (Ed.), *Les TIC et la pédagogie* (pp. 21–23). Porrentruy: HEP_BEJUNE.

Karsenti, Thierry, Brodeur, Monique, Deaudelin, Colette, Larose, François, & Tardif, Maurice. (2002). *Integrating ICT's in teacher tr@ining: A challenging balance*. Paper presented at the 2002 Pan-Canadian Education research Agenda Symposium "Information Technology and Learning", 30 April - 2 May 2002.

Karsenti, Thierry, Raby, Carole, & Villeneuve, Stéphane. (2008). Quelles compétences technopédagogiques pour les futurs enseignants du Québec? In B. Charlier & P.-F. Coen (Eds.), *Formation des enseignants et intégration des TIC: Faire le bilan pour comprendre* (Vol. 7, pp. 117–136). Neuchâtel: CDHEP.

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), 73–90.

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, September 10-12, 2008.

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.

Lebrun, Marcel. (2004). La formation des enseignants aux TIC: Allier pédagogie et innovation. *Revue internationale des technologies en pédagogie universitaire, 1*(1), 11–21.

Loveless, Avril, Burton, Jeremy, & Turvey, Keith. (2006). Developing conceptual framework for creativity, ICT and teacher education. *Thinking Skills and Creativity, 1*, 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.

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.

McGregor Tan Research. (2009). EDNA: Awareness, Perceptions & Needs of first year teachers: Market research report. Dulwich: education.au.

Merchant, Lucy, & Heptworth, Mark. (2002). Information literacy of teachers and pupils in secondary schools. *Journal of Librarianship and Information Science, 34*(2), 81–89.

Ministère d'Education. (2001). *La formation à l'enseignement.* Québec: MEQ.

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.

Neiss, Maggie L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education, 21*, 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.

OECD. (in press). *Beyond textbooks: Digital learning resources as systemic innovation in the Nordic countries.* Paris: CERI.

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: Challening our views on digital technologies and learning. *Digital kompetanse [Nordic Journal of Digital Literacy], 2*(4), 244–264.

Peraya, Daniel, Lombard, François, & Bétrancourt, Mireille. (2008). De la culture du paradoxe à la cohérence pédagogique : Bilan de dix années de formation à l'intégration des TICE pour les futur-e-s

enseignant-e-s du primaire à Genève. In B. Charlier & P.-F. Coen (Eds.), *Formation des enseignants et intégration des TIC: Faire le bilan pour comprendre* (Vol. 7, pp. 11–28). Neuchâtel: CDHEP.

Perrin, Nicolas, Betrix, Dominique, Baumberger, Bernard, & Martin, Daniel. (2008). Intégration des TIC dans la formation des enseignants: Fonctions attribuées par les formateurs en regards. In B. Charlier & P.-F. Coen (Eds.), *Formation des enseignants et intégration des TIC: Faire le bilan pour comprendre* (Vol. 7, pp. 87–116). Neuchâtel: CDHEP.

Pierson, Melissa E. (2005). *Novice teachers case studies: Technology reality during induction years.* Paper presented at the NECC Philadelphia, June 27-30, 2005. from http://www.iste.org/Content/NavigationMenu/Research/NECC_Research_Paper_Archives/NECC_2005/Pierson-Melissa-NECC05.pdf

Pierson, Melissa E., & Cozart, Alysa. (2005). Case studies of future teachers: Learning to teach with technology. *Journal of Computing in Teacher Education, 21*(2), 59–63.

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 Computing in Teacher Education, 13*(4), 573–618.

Pratt, Nick. (2008). Multi-point e-conferencing with initial teacher training students in England: Pitfalls and potential. *Teaching and Teacher Education, 24*, 1476–1486.

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.

Salaway, Gail, Caruso, Judith B, & (Nelson, Mark R.). (2008). *The ECAR Study of Undergraduate Students and Information Technology, 2008.* Boulder, CO: EDUCAUSE Center for Applied Research.

Sands, Deanna Iceman, & 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*, 817–828.

Sardone, Nancy B., & Devlin-Scherer, Roberta. (2008). Teacher candidates' views of a multi-user virtual environment. *Technology, Pedagogy and Education, 17*(1), 41–51.

Šeďová, Klara, & Zounek, Jiri. (2007). ICT a moc před tabulí [ICT and Power at the Blackboard]. In R. Švaříček & Šeďová, K. (Eds.), *Kvalitativní výzkum v pedagogických vědách. Pravidla hry [Qualitative Research in Educational Sciences: Game Rules]*. Prague: Portál.

Šeďová, Klara, & Zounek, Jiri. (2008). *Teachers among modern technologies.* Paper presented at the ECER 2008, September 10-12.

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), 29–59.

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*. Paper presented at the IST Conference.

Tapscott, Don. (1997). *Growing up Digital: The Rise of the Net Generation*. New York: McGraw-Hill.

Tapscott, Don. (2008). *grown up digital: How the net generation is changing your world.* 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.

Viens, Jacques, Peraya, Daniel, & Karsenti, Thierry. (2002). Introduction: Formation des enseignants à l'intégration pédagogique des TIC: Esquisse historique des fondements, des recherches et des pratiques. *Intégration pédagogique des TIC: Recherches et formation, 28*(2), 243–475.

Viherä, Marja-Liisa, & Nurmela, Juha. (2001). Communication capability as an intrinsic determinant for information age. *Futures, 33*, 245–265.

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. & Sujo de Montes, Laura. (2002). Does requiring a technology course in preservice teacher education affect student teacher's technology use in the classroom? *Journal of Computing in teacher Education, 18*(3), 76–80.

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), 49–55.

EXISTING OECD EDUCATION WORKING PAPERS

No.1 Teacher Demand and Supply: Improving Teaching Quality and Addressing Teacher Shortages (2002), Paulo Santiago.

No.2 Teacher Education and the Teaching Career in an Era of Lifelong Learning (2002), John Coolahan.

No.3 Towards an Understanding of the Mechanisms That Link Qualifications and Lifelong Learning (2003), Friederike Behringer, Mike Coles.

No.4 *Measuring Educational Productivity in Standards-Based Accountability Systems: Introducing the SES Return on Spending Index* (2005), Martin Hampel.

No. 5 *PISA 2000: Sample Weight Problems in Austria* (2006), Erich Neuwirth.

No. 6 Funding Systems and their Effects on Higher Education Systems . International Report (2007), Franz Strehl, Sabine Reisinger and Michael Kalatschan.

No. 7 *On the Edge: Securing a Sustainable Future for Higher Education* (2007), OECD/IMHE-HEFCE.

No. 8 *Globalisation and Higher Education* (2007), Simon Margison and Marijk van der Wende.

No. 9 *Understanding the Regional Contribution of Higher Education Institutions:* A Literature Review (2007), Peter Arbo and Paul Benneworth.

No. 10 *Effects of Tertiary Expansion. Crowding-out Effects and Labour Market Matches for the Higher Educated* (2007), Bo Hansson.

No. 11 *Skilled Voices? Reflections on Political Participation and Education in Austria* (2007), Florian Walter and Sieglinde K. Rosenberger.

No. 12 *Education and Civic Engagement: Review of Research and a Study on Norwegian Youths* (2007), Jon Lauglo and Tormod Oia.

No. 13 *School Accountability, Autonomy, Choice, and the Level of Student Achievement: International Evidence from PISA 2003* (2007), Ludger Wössmann, Elke Lüdemann, Gabriela Schütz and Martin R. West.

No. 14 *School Accountability, Autonomy, Choice, and the Equity of Student Achievement: International Evidence from PISA 2003* (2007), Gabriela Schütz, Martin R. West, Ludger Wössmann.

No.15 *Assessment of learning outcomes in higher education: a comparative review of selected practices*. (2008), Deborah Nusche.

No.16 *Approaches and Challenges to Capital Funding for Educational Facilities* (2008), Ann Gorey.

No. 17 *Recent Developments in Intellectual Capital Reporting and their Policy Implications* (2008), W. Richard Frederick.

No. 18 *Employers' Perspectives on the Roles of Human Capital Development and Management in Creating Value* (2008), L. Bassi & D. McMurrer.

No. 19 *Job-related Training and Benefits for Individuals: A Review of evidence and explanations* (2008), Bo Hansson.

No. 20 *A Framework for Monitoring Transition Systems* (2008), Rolf van der Velden.

No. 21 *Final Report of the Development of an International Adult Learning Module (OECD AL Module)*

No. 22 *What Works in Migrant Education? A Review of Evidence and Policy Options (2009)* Deborah Nusche

No. 23 *Teacher Evaluation: Current Practices in OECD Countries and a Literature Review(2009)* Marlène Isoré

No. 24 *Assessment and Innovation in Education (2009)* Janet Looney

No. 25 *Do Quasi-markets Foster Innovation in Education?(2009)*Christopher Lubienski

No. 26 *International Adult Literacy and Basic Skills Surveys in the OECD Region (2009)* William Thorn

THE OECD EDUCATION WORKING PAPERS SERIES ON LINE

The OECD Education Working Papers Series may be found at:

The OECD Directorate for Education website: www.oecd.org/edu/workingpapers

The OECD's online library, SourceOECD: www.sourceoecd.org

The Research Papers in Economics (RePEc) website: www.repec.org

If you wish to be informed about the release of new OECD Education working papers, please:

Go to www.oecd.org

Click on "My OECD"

Sign up and create an account with "My OECD"

Select "Education" as one of your favourite themes

Choose "OECD Education Working Papers" as one of the newsletters you would like to receive

For further information on the OECD Education Working Papers Series, please write to: edu.contact@oecd.org.