



Keijo Sipilä

No Pain, No Gain?

Educational Use of ICT in Teaching, Studying and Learning Processes: Teachers' and Students' Views

ACADEMIC DISSERTATION

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We are currently preparing students for jobs that don't exist...using technologies that haven't yet been invented...in order to solve problems we don't even know are problems yet.

–Richard Riley, Secretary of Education under Clinton

Abstract

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This doctoral thesis reports on studies about how Information and Communication Technology (ICT) has been utilised and implemented in schools and whether there are tensions or contradictions that might hinder its implementation from advancing in the teaching, studying and learning process. From a teaching perspective, the research themes were studying teachers' relationships to ICT from three different viewpoints: What are teachers' attitudes towards ICT? How do they utilise ICT in education? What is the perceived value of the educational use of ICT? From a studying and learning perspective, the research themes were formulated to study students' attitudes and motivation concerning ICT and virtual learning environments, as well as their perception of the use of innovative software combined with pedagogically grounded learning methods. Web-based questionnaires were used to gather the data. Both quantitative and qualitative data was collected. Quantitative analysis, statistical analysis and qualitative coding and analysis were used as statistical methodologies. The results of the five individual studies are viewed holistically through Activity Theory, which provides a means for interpreting a school's complex operational culture by structuring the dimensions comprehensively.

The five empirical studies comprising this thesis were conducted with the cooperation of teachers and students from schools in western Finland in 2008–2011. The first study sought to investigate students' attitudes towards ICT and Virtual Learning Environments (VLEs) in basic education. The second study explored the impact of laptop provision on teacher attitudes towards ICT. Study III concentrated on teachers' manners, proficiency levels and perceived values in implementing ICT into education. The fourth study focused on students using concept mapping as a learning method and concept mapping software in visual arts lessons, while the fifth study was about gathering a more holistic teacher perspective on educational technology.

The results indicate that teachers are still using ICT mainly to support traditional pedagogical practices. Although the technological framework in schools is beginning to reach a fairly good level, pedagogical thinking in educational institutions has not advanced in parallel with technological advances. Providing teachers with computer technology can assist them to integrate computers into teaching activities, which in turn will give them more support in their perceived proficiency in computer use and help them to advance to the stage of computer integration. However, making technology available in schools is not sufficient to trigger a change in pedagogical practices on its own.

The way teachers utilise student-centred approaches in their teaching, proficiency levels in relation to ICT and their self-assessed stage of ICT integration into teaching are affected by how much ICT teachers use in their teaching activities. Teachers need to be experienced enough with computers to start adapting new teaching methods and successfully using new technologies in class.

Students who are not motivated to learn, or consider themselves to be less successful in their learning, do not seem to be as motivated by ICT as those who are motivated and who perceive themselves as successful. If new technology is used to preserve old pedagogies, these new tools are not necessarily enough to raise motivation to learn: If ICT is used mainly for controlling students, for drilling practice or for sharing basic learning material, the motivational effect of the new tools will soon fade away. With pedagogically grounded methods combined with software that embraces that pedagogy (e.g. concept mapping), students can realise that concept maps promote their understanding; this can have a positive effect on their thinking skills as it makes the knowledge construction process visible.

This study puts forward the view that a national top-down driven change process with regards to implementing ICT into education has not sufficiently succeeded in provoking major, sustainable changes in the operational culture of schools. Based on the results presented in this study, overall guidelines and proposals for actions are suggested, specifically work-based learning, bottom-up approaches, mentor-teacher systems, changes in teacher training, an emphasis on teachers' professional agency development and teacher-centred, team-based learning.

Keywords: motivation, attitudes, educational use of ICT, teaching, studying, learning

Tiivistelmä

Keijo Sipilä

Vaikeuksien kautta voittoon? Tieto- ja viestintäteknikan käyttö opetus-, opiskelu- ja oppimisprosesseissa: opettajien ja oppilaiden näkemyksiä

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Tämä väitöskirja raportoi tutkimuksista, joissa selvitettiin sitä, miten tieto- ja viestintäteknikkaa (TVT) on otettu käyttöön ja hyödynnetty opetuksessa sekä sitä, onko olemassa jännitteitä tai risiititöitä, jotka mahdollisesti estävät opusteknologian käytön edistämistä opetus-, opiskelu- ja oppimisprosesseissa. Tutkimusteemana opetuksen näkökulmasta oli tutkia opettajien suhtautumista TVT:aan kolmesta eri näkökulmasta: mitkä ovat opettajien asenteet TVT:n opetuskäyttöä kohtaan? Miten TVT:aa hyödynnetään opetuksessa? Mikä opettajien mielestä on TVT:n tuoma lisäarvo opetukseen ja oppimiseen? Opiskelun ja oppimisen näkökulmasta tutkimusteemana oli selvittää opiskelijoiden asenteita ja motivaatiota TVT:tä ja virtuaalisia oppimisympäristöjä kohtaan sekä sitä, miten he kokevat innovatiivisten ohjelmistojen käytön yhdistettynä pedagogisesti perusteltuihin opetusmenetelmiin. Väitöskirjan muodostavissa tutkimusartikkeleissa keskeisen tutkimusaineiston muodosti sähköisillä kyselylomakkeella kerätty data. Dataa analysoitiin sekä kvantitatiivisesti että kvalitatiivisesti. Kvantitatiivista, tilastollista ja laadullista analyysiä käytettiin tilastollisina menetelminä. Viiden yksittäisen tutkimuksen tuloksia tarkastellaan holistisesti akvititeettiteorian (Activity Theory) läpi, joka tarjoaa struktoroidut välineet koulun monitahoisen toimintaympäristön eri ulottuvuuksien tarkasteluun.

Tämä väitöskirja koostuu viidestä osatutkimuksesta, jotka suoritettiin yhteistyössä Länsi-Suomessa sijaitsevien koulujen opettajien ja opiskelijoiden kanssa vuosina 2008-2011. Ensimmäisessä osatutkimuksessa kartoitettiin perusopetuksen oppilaiden asenteita ja oppimiseen motivoitumista suhteessa tieto- ja viestintäteknikan sekä virtuaalisen oppimisympäristön opetuskäyttöön. Toinen tutkimus keskittyi selvittämään, onko työnantajan opettajille henkilökohtaiseen käyttöön luovuttamalla kannettavalla tietokoneella vaikutusta opettajien asenteisiin TVT:aa kohtaan. Kolmas osatutkimus kartoitti opettajien opusteknologian käytön määriä, käyttötapoja, osaamisen tasoa sekä heidän arvojaan TVT:aa kohtaan opetuksessa. Neljännessä tutkimuksessa analysoitiin oppilaita heidän käyttäessään käsittekarttoja sekä oppimismenetelmänä että ohjelmistona kuvataiteen opetuksen tunneilla. Viides osatutkimus loi kokonaiskuvaa opettajien näkemyksistä TVT:n opetuskäytöstä sekä siihen mahdollisesti liittyvistä ongelmista.

Artikkelien tutkimustulokset antavat viitteitä siitä, että opettajat käyttävät yhä TVT:aa lähinnä tiedon jakamiseen, hallinnollisiin tehtäviin, arviointiin ja opetuksen suunnittelutehtäviin. Sen sijaan kommunikatiivinen, aktivoiva, luova ja ilmaisuvoimainen käyttö jää vähemmälle. Vaikka teknologinen varustelu kouluissa alkaa olla melko hyvällä tasolla, pedagoginen muutos oppilaitoksissa ei ole edennyt yhtä nopeasti kuin teknologinen kehitys. Tarjoamalla opettajille tietotekniikkaa käyttöön opettajat voidaan saada integroimaan tietokoneet opustoitintaan, mikä puolestaan tukee heitä pätevoitymään TVT:n käytössä ja auttaa heitä etenemään kohti luontevaa TVT:n opetuskäytön

integraatiota. Pelkkä teknologian tuominen kouluun ei kuitenkaan tuo muutosta opettajan käyttämiin pedagogisiin ratkaisuihin opetuksessa.

Opettajan TVT:n opetuskäytön määrällä on vaikutusta siihen, miten opettajat hyödyntävät oppilaskeskeisiä opetusmenetelmiä, TVT:n käyttötaitojen kehittymiseen sekä siihen, miten opettajat arvioivat omien TVT -taitojen kehittymistä. Opettajilla on oltava tarpeeksi kokemusta TVT:n käytöstä, jotta uuden teknologian käyttö integroituisi luontevammaksi osaksi opetusta ja sitä kautta auttaisi soveltamaan uusia opetusmenetelmiä.

Oppilaat, jotka eivät ole motivoituneita oppimaan, tai pitävät itseään vähemmän menestyksenkäsinä opiskelussa eivät ole yhtä motivoituneita TVT:n käyttöön kuin ne oppilaat, jotka ovat motivoituneita koulutyöhön ja jotka kokevat onnistuvansa opiskelussa. Jos uutta teknologiaa käytetään säilyttämään vanhoja pedagogisia malleja, uudet välineet eivät riitä nostamaan motivaatiota oppia pitkäkestoisesti: jos TVT:aa käytetään pääasiassa ohjaamaan opiskelijoita, suorittamaan yksittäisiä oppimisaihioita tai jakamaan perinteistä oppimateriaalia, uusien välineiden motivoiva vaikutus vähenee nopeasti. Pedagogisesti perusteltujen menetelmien ja ohjelmistojen käyttö edistää myös oppilaiden ymmärrystä siitä, että TVT:n avulla voidaan edistää oppimista.

Tämän väitöskirjan keskeinen johtopäätös on, että kansallinen, ylhäältä alaspäin suunnattu muutosprosessi TVT:n implementoinniksi osaksi opetusta, opiskelua ja oppimista ei ole onnistunut jalkauttamaan tarpeeksi pysyviä tai laajoja toimintakulttuurisia muutoksia oppilaitoksiin. Väitöskirjan tuloksista nousevana johtopäätöksenä on, että tarvitaan uudenlaisia toimintamenetelmiä: työpaikka-, tiimi- ja mentoripohjaista koulutusta, opettajalähtöisten, pedagogisten ideoiden tukemista ja levittämistä, opettajan ammatillisen osaamisen kehittämisen tukemista sekä opettajan ja oppilaan aktiivisen toimijan roolin korostamista oppivissa organisaatioissa.

Avainsanat: motivaatio, asenteet, opetusteknologia, opettaminen, oppiminen, opiskelu

List of articles

Study I

Sipilä, K. (2009). Students' attitudes toward ICT and VLE in basic education. In G. Siemens & C. Fulford (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications* (pp. 2304–2311). Chesapeake, VA: AACE.

Study II

Sipilä, K. (2010). The impact of laptop provision on teacher attitudes towards ICT. *Technology, Pedagogy and Education*, 19(1), 3–16.

Study III

Sipilä, K. (2011). No pain, no gain? Teachers implementing ICT in instruction. *Interactive Technology and Smart Education*, 8(1), 39–51.

Study IV

Sipilä, K. (2011). Concept mapping in visual arts lessons. *Proceedings of the 4th International Network-Based Education 2011 Conference The Social Media in the Middle of Nowhere*. Ruokamo, H., Eriksson, M., Pekkala, L., Vuojärvi, H. (Eds.). University of Lapland, Rovaniemi, Finland. (pp. 106–111).

Study V

Sipilä, K. (2013). Educational use of information and communications technology —Teachers' perspective. *Technology, Pedagogy and Education*. <http://dx.doi.org/10.1080/1475939X.2013.813407>.

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1 Introduction

My career as a basic education schoolteacher started in the early 1990s; just as Information and Communications Technology (ICT) was starting to emerge in schools in Finland. Schools started to put PC workstations that had access to the World Wide Web (WWW) and were equipped with word processing software and so on in classrooms. In the mid-'90s, the Finnish National Board of Education (FNBE) launched a program that made it possible for municipalities to have financial support when it came to providing schools with more computers and to build wider technical infrastructure in order to implement educational technology in teaching and learning. Computer technology was included in schools, but the idea of how to use it in education was far from clear. According to Yelland (2007), whilst new technologies have revolutionised society, their use in schools has basically involved supporting traditional curricula and pedagogies rather than creating new contexts for learning.

The technical development of computers, networks and technical infrastructures in general has taken huge leaps forward since the '90s. The scientific concept of learning has also changed. The focus has shifted from a teacher-centred approach to student-centred learning (SCL) or learner-centred approach; from individual learning to collaborative learning; from teaching to guidance; and from instantaneous absorption of knowledge to lifelong learning. Learning is now considered as something that is lifelong, lifewide and lifedep (Banks et al., 2007). The purpose of education and learning is to help students to develop the mental tools and learning strategies with which to acquire knowledge and that will enable them to consider different aspects of life (Hakkarainen, 2000).

As my career advanced from teacher to educational technology coordinator, I had the opportunity to closely follow the global megatrends in the field of education technology and at the same time educate teachers and plan and execute practical projects in schools. In the process, it became clear to me that although technical advances were occurring, fundamental questions such as how to utilise ICT in education in order to advance learning, how to bring teachers see the benefits in using ICT and how to teach students new skills was anything but straightforward.

During the years from the '90s to the new millennium, it became obvious that technology had changed and renewed the operational culture of schools. The first Virtual Learning Environments (VLEs) became familiar to students and teachers, the use of electronic learning materials grew, teachers were getting new technological gadgets into classrooms (interactive whiteboards, document cameras, data projectors) and various administrative tasks, along with communication between

teachers and parents, were shifting to an electronic format. There were some issues, however, that raised my curiosity to an extent that caused me to initiate academic research: Why did it seem that after a decade of technology implementation at schools, technological advances still did not seem to have an impact on education? Was it due to the lack of teacher education, attitudes or values of teachers/students, shortage of support or technical infrastructure, the shortcomings in software or VLEs, lack of vision or the absence of leadership? These were some of the questions from which the final research question was later formulated.

The main research question of this thesis is:

How have teachers implemented and experienced the use of ICT in their educational practices, and how do students regard these developments in their studying and learning?

In this thesis, I present my research, in which I focused on exploring teachers' attitudes, values, frequency, manner and proficiency of ICT use and identify the possible factors hindering the use of ICT in education. Another focus was how basic education students view the use on ICT in education, in terms of how it affects their motivation and whether they can see the potential of ICT to enhance learning. My study contributes to a large body of research that has examined the impact of educational technology on teaching, studying and learning by finding out answers to the focal questions mentioned earlier, but also by producing initiatives concerning how the integration of ICT into education could be enhanced.

The key findings of this thesis from teachers' and students' views are presented in table 1 below:

TABLE 1. Summary of the results

TEACHERS	STUDENTS
<ul style="list-style-type: none"> • Providing mobile technology to teachers can have a positive effect on their attitudes towards ICT. 	<ul style="list-style-type: none"> • The motivational factor connected to ICT in education can fade away quickly with less motivated or less successful students.
<ul style="list-style-type: none"> • Teachers are still inclined to use ICT mainly for informational, organisational, evaluative and lesson-planning activities. 	<ul style="list-style-type: none"> • Students can embrace new, pedagogically grounded learning methods that are supported with software that stresses the method being used.
<ul style="list-style-type: none"> • Pedagogical solutions, proficiency level and self-reported stage of ICT integration are dependent on how much ICT teachers use in their teaching. 	<ul style="list-style-type: none"> • Studying and learning by concept mapping offers the potential for higher-level learning.
<ul style="list-style-type: none"> • Primary teachers have more positive attitudes to the value-cost ratio of using ICT than do subject teachers. 	
<ul style="list-style-type: none"> • There are several contradictions still prevalent in schools that hinder the effective use of ICT in instruction. 	

The results of the research published in the articles are more thoroughly discussed in chapter 8, but based on the results and conclusions presented here in this thesis, I argue that the top-down driven change process with regards to implementing ICT into education has not sufficiently succeeded in provoking major, sustainable changes in the operational culture of schools. Based on the results presented here, I will present initiatives for action in order to make way for an enhanced use of ICT in education. These initiatives are introduced in chapter 9.

In the chapters to follow I will firstly introduce the goals of the study, discuss educational technology from a theoretical point of view and present the theoretical approaches of the five sub-studies. I will then continue by presenting the research themes and questions, as well as methodologies, methods and analysis used in the sub-studies. After presenting the overall results and evaluation of each sub-study, I will address the overall findings by using Activity Theory as a framework. The final chapter concludes this thesis with discussion.

2 Goals of the thesis

When starting my academic career as a researcher, I was working as an eLearning coordinator in a small municipality in Western-Finland, and noticed discrepancies concerning the use of ICT at schools. There were mixed opinions from teachers, students, politicians, Information Technology (IT) administrators and so on. This raised debates for or against such infrastructure. At the time, Finnish municipalities were forced to survive with tight budgets, so technology was always an easy target for cuts. On the other hand, for a long time, the national curriculum had stated that schools were encouraged to use technology in order to teach students the skills of tomorrow. This was one discrepancy. Another discrepancy was that not all teachers or headmasters were inclined to use ICT in class even if it was available. The third discrepancy was that the use of technology at school did not seem to alter or enhance the pedagogical tools that teachers were using.

As it was clear that there were numerous factors affecting whether ICT was used or not, I wanted to start producing an overall picture of the use and effects of ICT in schools, assessing what possible factors could be hindering it and what could be done to make way for better integration of ICT into education. The aim of this study was to get behind those personal, subjective opinions of various individuals and try to harness valid, objective evidence about the use of ICT in schools and the different factors in play.

As the research plan started to take shape, there were certain issues that I particularly wanted to study:

- How do teachers and students regard the use of educational technology? How can the frequency and manner of ICT use by teachers be characterised? What is the motivational effect of educational ICT on students?
- How do teachers value the use of ICT in learning? Are there differences in that area between class teachers and subject teachers? How do they see the input-output ratio of ICT use and its results?
- How do teachers and students perceive possibilities for the educational use of ICT in terms of enhancing learning?
- If there are factors hindering the use of ICT in schools, what are they? How proficient do teachers perceive themselves to be with regards to ICT? Are they aware of the benefits of utilising ICT at school? At what level is the technological and pedagogical support or technological infrastructure?
- How can the ICT implementation process be carried out effectively at both the organisational and personal level?

In this thesis I will apply Engeström's Activity Theory framework (1987) to (1) identify tensions or contradictions arising from the sub-studies and (2) present actions that may assist in establishing more fruitful conditions for educational technology to have an impact on teaching, studying and learning.

3 A theoretical approach for educational technology

As ICT rapidly comes to occupy a central part in our everyday practices, it is clear that being able to use ICT is one of the core competences for the 21st century. The conception of knowledge has evolved in parallel with technological advances; knowledge is seen as a dynamic concept, involving both information acquisition and competence in thinking and learning. An adult of the future needs to master several different skills that were not critical in the 20th century, specifically learning and innovation skills (e.g. communications and collaboration skills, creativity and innovation skills), digital literacy skills (e.g. information and media literacy skills) and career skills (e.g. flexibility, adaptability, social and cross-cultural interaction skills; Trilling & Fadel, 2009).

Educational institutions play a vital role in how and when these new citizen skills should be taught to students. Furthermore, the rapid transformation of society implies that students need to be prepared for jobs that might not yet even exist.

At least two views for the integration of ICT can be found. The first is that society has changed from an industrial to an information or knowledge society. This change implies that students need to be prepared for jobs that might not yet exist. Being able to use ICT is seen as one of the core competencies for the 21st century. The second rationale is the belief that ICT has the potential to enhance teaching and learning processes by providing new methods of teaching and learning (Voogt & Knezek, 2008). ICT can be seen as an object in education, affecting learning content and goals, and ICT as a medium to enhance teaching and learning processes (Voogt, 2008). The first view relates to the curriculum, whilst the second primarily involves the physical (and virtual) infrastructure for learning. From the perspective of IT as an object, the improvement of primary and secondary education centres on how learning content and goals should be attuned to the needs of society. From the perspective of IT as a medium, this improvement will concentrate on facilitating teaching and learning with IT (Voogt & Knezek, 2008).

The technological environment is constantly and rapidly evolving, making effective research on ICT in education difficult, complex and challenging. This is particularly true in terms of studying the impact of IT on student learning (Cox, 2008). Voogt and Knezek (2008) outlined the different problems related to studying the impact of ICT: First, standardised tests are not always a valid measure of the impact of IT on student learning. In addition, higher-order cognitive skills

such as problem solving are not easily determined with standardised achievement tests. Finally, it is difficult to establish an appropriate and valid research design in order to produce evidence about learning results with the help of ICT.

During the first decade of the new millennium, it was recognised that ICT can enhance learning provided that it is implemented with pedagogically grounded methods and as a mediating tool. Most ICT-based tools should be fully merged with the social practices of teachers and students; only then are their intellectual resources genuinely augmented and learning achievements correspondingly facilitated (Hakkarainen, 2009).

The integration of ICT into education can be seen either as a catalyst for change (educational push) or as a set of tools that are used to follow educational needs (educational pull; Ten Brummelhuis & Kuiper, 2008). From a research point of view, it is challenging to conclude decisively which paradigm would be the correct conclusion, as a number of factors can potentially affect the use of ICT in schools, specifically organisational factors, support factors and environmental factors (Sumner & Hostetler, 1999). Teachers' and principals' perceptions have been emphasised (Levin & Wadmany, 2008). Leskes, Grogan, Canham and O'Brien (2008) argued that the right combination of vision, compromise and commitment of administrators and teachers is crucial in making fundamental and sustainable change possible. According to Grunwald et al. (2010), the more teachers use technology, the more they recognise and value its strong positive effects on student learning and engagement. They further concluded that frequent technology users see more effect on behaviours associated with 21st-century digital competence than infrequent users do.

3.1 ICT and the teaching-studying-learning process

Uljens (1997) introduced the teaching-studying-learning process, where teaching and studying are seen as leading to competence and personal development through the process of learning. According to this reflective theory, the fundamental features of an institutionalised pedagogical process consist in an intentional, interactional teaching-studying-learning process which is culturally and historically developed and situated. This intentionality contains the cycle of pre-understanding, intention (aim, target), activity and reflection. One feature that characterises the didactic teaching-studying-learning process is purposiveness, which is usually expressed as intentionality. Uljens's process also includes a number of other aspects of pedagogical activity, namely pedagogical interaction, content and method. Uljens divided the essential dimensions of the teaching process into five aspects, specifically intentionality, context, interaction, content and methods.

Lahdes (1997) defined teaching as interaction based on educational aims and goals between the teacher and the students, with the purpose of creating and facilitating the students' prerequisites to achieve the set learning targets. Teach-

ing can promote learning, but teaching does not automatically lead to learning. Thus, we cannot guarantee that the students will learn the subject being taught in teaching with the help of ICT; rather, teaching still is a key factor in directing the students' study processes. ICT can add new possibilities for organising and enhancing all three processes. Current research indicates that ICT assists in transforming a teaching environment into a learner-centered one (Castro Sánchez & Alemán, 2011). Serhan (2009) stated that ICT encourages autonomy by allowing educators to create their own material, and provides more control over learning content than is possible in a traditional classroom setting.

Learning happens if the student is active in the learning process. ICT can be used in the process by bringing an aspect to the learning environment which supports and scaffolds personalised learning styles and needs. Learner-centred, collaborative and creative thinking should be taken into account when designing the learning environment. For example, Tissari, Vahtivuori-Hänninen, Vaatovaara, Ruokamo and Tella (2005) and Ausubel (1968) defined the aspects of meaningful learning to be, for example, constructive, cumulative, activity, self-orientated, collaborative, goal orientated, purposive and personal. It is not the case that these aspects will emerge in an optimal fashion solely through the use of the most modern tools; rather, these tools should be guided into use in a manner that promotes learning (Lehtonen, 2003) and is meaningful to the learner. ICT can assist students to focus on higher-level concepts rather than less meaningful tasks (Levin and Wadmany, 2006). McMahan (2009) showed that studying with ICT has a statistically significant correlation with the acquisition of critical thinking skills. ICT has the potential to enhance meaningful learning, as it offers new possibilities to examine, reflect, interpret, share and experience information.

Palak and Walls (2009), as well as Tezci (2011a) suggest that technology integration will not have the desired effect without student-centered classroom practices. Therefore, ICT integration in education cannot be implemented in isolation, but when it is applied in combination with diverse teaching methods and approaches, especially constructivist practices, learning outcomes may be more successful (Fu, 2013).

3.2 Digital competence

As of April 2011, 365 million Europeans were using the Internet. Europeans spend on average one day per month online. The use of social networking, photo sharing and community activities are growing rapidly, and 84.4% of European 15+ Internet users were using social networking sites. Young users are increasingly participating in social networking activities, while at the same time decreasing their use of other applications such as emails, instant messengers and portals. Older users are also increasingly employing social networks, while at the same time remaining active email users (ComScore, 2011). Digital compe-

tence is already benefitting citizens, communities and society in various areas. Van Deursen (2010) defined five areas in which citizens can gain personal benefits from Internet usage, specifically the social, economic, political, health and cultural realms. The Digital Agenda for Europe 2020 (European Commission, 2010a) confirmed digital competence as one of the key competences for individuals in a knowledge-based society, emphasising that it is essential to educate European citizens to use ICT and digital media, and particularly to attract young people to ICT.

The generation born in the early 1980s or later, which grew up surrounded by digital media, is used to utilising different learning styles from those employed by previous generations. Several terms have been invented to describe this generation from the learning perspective, for example 'digital natives' (McLester, 2007), the 'Net Generation' (Oblinger & Oblinger, 2005) and the 'IM Generation' (which stands for Instant-Message Generation; Lenhart, Rainie, & Lewis, 2001). Each of these terms focuses on different aspects of the same phenomenon. As these terms define the generation and their era, several definitions have been developed to define the skills and competence that 'new millennium learners' must master in order to thrive in society. Terms like ICT skills, technology skills, information technology skills, information literacy, digital literacy and digital skills sometimes overlap and are sometimes used interchangeable (Adeyemon, 2009). The latest definition, which covers all previous terms, is digital competence (Ilomäki, Kantosalo, & Lakkala, 2011).

Calvani, Fini and Ranieri (2009) developed a conceptual model to represent digital competence. They defined digital competence as the ability to explore and face new technological situations in a flexible way, to analyse, select and critically evaluate data and information, to exploit technological potentials in order to represent and solve problems and build shared and collaborative knowledge, whilst fostering awareness of one's own personal responsibilities and respect of reciprocal rights/obligations. This definition underlines the coexistence of dimensions characterised on the technological, cognitive and ethical levels, as well as their integration, as follows:

- The technological dimension: Being able to explore and face problems and new technological contexts in a flexible way;
- The cognitive dimension: Being able to read, select, interpret and evaluate data and information, taking into account their relevance and reliability;
- The ethical dimension: Being able to interact with other individuals constructively and with a sense of responsibility using the available technologies;
- Integration between the three dimensions: Understanding the potential offered by technologies that enable individuals to share information and collaboratively build new knowledge.

Martin and Grudziecki (2006) highlighted that digital literacy cannot be certified with a standardised diploma, but must be mapped onto the individual's situation. They suggested that three stages of development could be used: digital competence, digital usage and digital transformation. All people should have generic digital competence, on top of which they should develop their personal digital usage for professional and other specific purposes. This would also lead to innovation and enable creativity through digital transformation in processes and activities at the individual and societal levels.

Digitally competent learners display complex learning styles that are shaped by the ubiquity, accessibility and ease of use of digital materials (Lam & Ritzen, 2008). Such learners are digitally literate; able to think more visually, practice multitasking and give preference to multimedia environments; and continuously connected and 'always on' (Pedró, 2006). They are accustomed to and dependent upon receiving stimuli, feedback and comments about their progress in order to avoid becoming distracted (McLester, 2007). They are social, team-spirited and engaged; goal-oriented and pragmatic; and expect appropriate learning material to suit their individual needs (Olbinger & Olbinger, 2005).

The 'new' divide between teenagers—the generation born roughly between 1980 and 1994 is referred to as 'digital natives' (Prensky, 2001) —and their teachers, acting as digital immigrants, has been discussed from two viewpoints. Some commentators claim that digital natives are skilful in using digital tools and proficient in multitasking and experimental learning, while their teachers are not as competent in the digital world as their students are (Gaston, 2006). According to Prensky (2012), today's students are no longer the people our education system was designed to teach. From this point of view, education systems should be completely changed in order to adapt to emerging learning and cognitive styles. Today's students and knowledge workers are digital natives; they are fundamentally different from previous generations in terms of how they learn, what they value in education, how they use technology and how they interact (Bullen & Morgan, 2009).

There are researchers, however, who have argued that digital natives are not necessarily knowledgeable about or skilful in digital tools, especially in learning situations (Bennett, Maton, & Kervin, 2008). Li and Ranieri (2010) posed the following question: No matter how familiar they are with digital tools in their daily lives, are digital natives really competent in using such tools in their learning circumstances? According to Li and Ranieri, living in a digital environment does not reliably imply being digitally competent. According to Carr (2010), the Internet era has produced 'grass-hopper minds'; students who are unable to concentrate or to undertake disciplined thought. To them, knowledge is about cut and paste.

There is evidence that people are using technologies more outside educational institutions than inside them. The PISA 2009 survey showed that 86% of 15 year olds frequently utilise computers at home, but only 55% do so at school (Organisation for Economic Co-operation and Development [OECD], 2010a). Eurostat 2010 data for 16–24 year olds showed that although 92% used Internet

at home, only 47% did so in schools. The statistics also revealed that ICT and digital competence is learned mainly outside school. It seems that whilst digital competence is being learned, there is a lack of knowledge about how to utilise such skills to enhance learning in schools.

3.3 Digital learning resources and digital pedagogy

Berge (2006) defined learning resources as artefacts mediating students' learning activities, including both intellectual and physical artefacts. This view implies that it is the use of the artefact which determines whether it should be regarded as a learning resource, not the intention of the creators of the artefact. Digital learning resources enable individual learners' personal interests to be engaged by connecting web learning resources to learning standards, providing options for adjusting the challenge level of learning tasks to avoid boredom or frustration and bridging informal and formal learning inside and outside school (Brown & Adler, 2008; Collins & Halverson, 2009). Digital learning resources have the potential to support a learning environment in which students explore knowledge and enhance their learning (Combes & Valli, 2007). Technology can also be used to create learning resources that provide immediate feedback modelled on games to help engage and motivate learners (Gee, 2004); digital learning resources exist at the intersection of content, pedagogy and technology. The availability, accessibility and innovativeness of materials play a key role in terms of using e-learning materials in education.

Considerable amounts of funding have been provided to support the development and production of digital learning objects that maintain the traditional use of technology in mimicking existing activities electronically, rather than thinking of new approaches that the medium affords; routine activities are being introduced on the computer as a way of making them more interesting for children, but really, such computer-based activities are not needed to practice such skills (Yelland, 2007). It is pointless from a pedagogical point of view to make computers and educational digital media available in schools if their use is not properly embedded in suitably articulated educational itineraries in which the whole learning context is taken into account, including the pedagogical and curriculum objectives, the tools and the way in which they are used, the teaching/learning paths, the different actors and their social relationships (Dias De Figueiredo & Afonso, 2006). Proper contextualisation becomes decisive in making educational software effective; otherwise, the potential of even the best program will remain largely unexploited. The design of effective contexts of use for ICT-based tools is a complex process that also requires changes in the content, organisation and management of classroom activity, innovations that are difficult for a teacher to accomplish effectively (Bottino & Robotti, 2007).

Digital pedagogy is a new way of working and learning with ICT to facilitate quality learning experiences for 21st-century learners. Digital pedagogy moves

the focus from ICT tools and skills to a way of working in the digital world. It is a teaching–learning approach in which digital technologies promote learning. There is a link between teacher beliefs associated with constructivist approaches and using ICT as a partner to facilitate creative thinking and learner-centred activities (Prestridge, 2010). Designing sound pedagogy for digital curriculum resources involves engaging the learner in a technology-rich environment, ensuring curriculum relevance and using strategies that encourage a quality educational experience.

The only way to successfully use technology in basic education is to provide means for students to utilise it from their own starting points and according to their own needs. This is where student-centred learning in tandem with technology has huge potential. Kember (1997) described two broad orientations in teaching: the teacher-centred/content-oriented conception and the student-centred learning (SCL)-oriented conception. He went on to define SCL as a process where students construct knowledge and the lecturer is a facilitator of learning rather than a presenter of information. Lea, Stephenson and Troy (2003) summarised student-centred learning to include the following:

1. A reliance on active rather than passive learning;
2. An emphasis on deep learning and understanding;
3. Increased responsibility and accountability on the part of the student;
4. An increased sense of autonomy in the learner;
5. Interdependence between the teacher and learner;
6. Mutual respect within the learner-teacher relationship; and
7. A reflexive approach to the teaching and learning process on the part of both the teacher and learner.

SCL relates primarily to the constructivist view of learning, as it places importance on activity, discovery and independent learning (Carlisle & Jordan, 2005). Implementation of ICT into these processes can have an important role in enhancing learning. Arko-Cobbah (2004) referred to the central role of ICT as a central component of the learning process, especially when it comes to SCL. Lu, Ma, Turner and Huang (2005) showed how wireless internet has a positive and significant influence on student-centred learning in pedagogical, technological and cultural learning as a step beyond normal wired internet. A technology-rich environment can serve as a physical space for student collaboration, discovery and innovation to support the learning that takes place inside the classroom. It can also create an inviting out-of-classroom environment for active learning, growth and enrichment through student-focused research assistance, outreach to all students and innovative instructional services which enable students to work at their own pace (Stoffle et al., 2010). As this thesis is about finding ways to implement technology into classrooms, the physical environment of the classroom has an important role.

3.4 Web 2.0: New technological possibilities for studying and learning

In 2005, Tim O'Reilly introduced the term 'Web 2.0' for collaborative, user-centric content production and interactive content access. Grosbeck (2009) defined Web 2.0 as the social use of the Web which allows people to collaborate, to actively create content, to generate knowledge and to share information online. According to Augustsson (2010), Web 2.0 tools are suited for collaborative learning, collective knowledge building, knowledge management, social networking and social interaction. Web 2.0 applications often enable users not only to consume, but also to create information and contribute to sites by publishing content (Churchill, 2007). From this perspective, Web 2.0 is also referred to as 'read-write' Web (Richardson, 2006). Applications that allow this to happen can be referred to as 'infoware'. The two types of such applications most widely used are blog and wiki systems. Additionally available tools include really simple syndication (RSS) feeds, online video sharing (e.g. YouTube, Google Video) and online social networking sites (e.g. Facebook, LinkedIn, Ning).

Before the era of Web 2.0, the Internet was already widely used in education, but it was used as a one-way information delivery technology. The use of technology was largely understood as a way to find information, used locally installed software to produce material singlehandedly in ICT classrooms or provide read-made learning material from a virtual learning environment. Web 1.0 made content available online, which was a significant development as it allowed easy access (at least in principle) to view (or read) information (Richardson, 2005). However, this 'access' is often seen as the staple functionality in Web 1.0, which is why it is often referred to as the 'read-only Web'.

With Web 2.0, it was possible to use the Internet as a tool for content creation, not only individually, but also socially and collaboratively. The evolvement of web-based technology and software produced a way to use the Internet as a two-way channel; after creating content collaboratively, it was also possible to share that content or knowledge easily on the web. The new tools offer ways to use the web in a constructive manner, in the same way as scientific conception of knowledge had defined learning. These new tools or social software have been evolving rapidly, constantly producing innovative solutions to collaborate on the web.

McKelvie, Dotsika and Patrick (2007) stated that social software is a community-driven technology which facilitates interaction and collaboration and depends largely on social convention. Social software allows learners to generate knowledge and share their learning experiences at a collective level, as well as allowing users to openly reflect upon what they have learnt. eLearning distinguishes itself from social software in that it is predominately associated with electronic instruction and is better suited for education and training purposes. Web 2.0 is transforming the way in which people learn, as this learning is predominately social and self-directed in nature, whereas eLearning is normally

associated with individual learning. The use of social software and Web 2.0 technologies have given rise to the term 'Learning 2.0', which broadly summarises all opportunities arising from the use of social media for learning, education or training (Connolly et al., 2011).

Current views of learning regard the notion of a teacher-dominated classroom and curriculum as obsolete, and embrace learning environments and approaches where students take control of their own learning, make connections with peers and produce new insights and ideas through inquiry (McLoughlin & Lee, 2007). Thus, to keep pace with the content creation processes enabled by Web 2.0 and social software, it appears to be necessary to go beyond the acquisition and participation dichotomy. Paavola and Hakkarainen (2005) proposed the knowledge creation metaphor of learning, which builds on common elements of Bereiter's (2002) theory of knowledge building, Engeström's (1987, 1999) theory of expansive learning and Nonaka and Takeuchi's (1995) model of knowledge creation.

Web 2.0 applications' strengths lie in promoting proactive participation and collaborative sharing. Because of this ability, they bear great potential in educational settings. Web 2.0 applications make it possible to uphold critical and analytical thinking, facilitate intuitive and associational thinking and support analogical thinking through easy access to rich information and various opinions (Safran, Helic, & Gutl, 2007). Web 2.0 applications encourage students to collaborate, experiment and interact, and as such, are excellent tools for student-centred learning activities. In an Interactive Educational Systems Design (IESD) study, 50% of teachers indicated that the students were more motivated to learn as a result of Web 2.0 use in their district, representing an increase in student academic engagement of 39%, and that it improved students' collaboration skills by 38% (IESD, 2011).

According to Boyd (2007), the social aspects of Web 2.0 support three activities that characterise student-centred learning: conversational interaction, social feedback and support for social networks and relationships between people to enhance the learning experience.

Web 2.0 applications enable students to become creators/broadcasters of multimedia information. RSS makes it possible to follow topics that interest in an automatic manner: The information is delivered when it becomes available. Podcasting enables students to create and share their own recordings via the Internet and to subscribe to podcasts of interest. This information-pull method is one of the common features of Web 2.0 technology.

The collaborative and activating role of Web 2.0 applications engage students in collective, social spaces or networks. It has never been as easy to connect with other individuals, experts in certain field or communities of same interest as it now is through social media.

Resource sharing applications enable students to share videos, pictures, notes, presentations, sound, articles, bookmarks, etc. With open referencing systems ('folksonomy'), it is possible to add comments, rate and tag resources and use

those references as a way of finding information of personal importance with the help of collective perception ('wisdom of the crowds'). Cloud-based application and media storage providers offer students the freedom to store information online and access it from any online device. The need for locally installed computer software is rapidly losing its importance at schools; it is possible to retrieve, analyse, generate, produce, collaborate and share information with online applications.

Web 2.0 has gradually turned the Internet into a platform containing tools that were traditionally installed locally on a computer. The documents reside online where they can be accessed or edited by a predefined user group (Churchill, 2007). Furthermore, the tools used are available free of charge. The majority of Web 2.0 applications are free to use; this is called open source software. This ideology extends to content management and learning management software as well.

Web 2.0 applications are ideal for collaborative knowledge building, group work, sharing knowledge and expertise, evaluation and so on. Churchill (2007) presented a list of how these new tools could promote learning, as follows:

- New forms of assessment such as digital portfolios (e.g. students' blogs that contain digital stories, interactive and visual representations, and other multimedia artefacts that demonstrate their learning);
- Use of Internet-mediated social learning spaces (which build on ideas and experiences from social spaces such as MySpace), and new forms of collaborative learning (e.g. along the lines of wikis);
- New models and methods for design of learning objects and other kinds of digital curriculum materials that utilise emerging forms of multimedia expressions, open source, and remixing of data (mashups);
- New models for resources sharing and support for the technology integration of communities of teachers (e.g. along the lines of YouTube);
- New generations of learning management systems (LMSs), or possibly no LMS at all, but rather, modular content and service management platforms that allow various Web 2.0 services to be selected and integrated into a customised solution (e.g. Drupal).

Lim, So and Tan (2010) looked at Web 2.0 tools from the technological, social and epistemological perspectives. Web 2.0 tools rely on promoting social networking easily and simply. In the social dimension, Web 2.0 tools put people in the context of other people. This contradicts the Web 1.0 era, which emphasised independent, self-paced learning. On the epistemological dimension, the notion of knowledge creation in a Web 2.0 environment emphasises participation, where knowledge is considered to be public, and contradictions are worked out through debate.

Web 3.0 is about Read/Write/Collaborate. If Web 1.0 connected information, Web 2.0 connected people (social Web), Web 3.0 connects knowledge. E-Learn-

ing 3.0 will have at least four key drivers: distributed computing, extended smart mobile technology, collaborative intelligent filtering, 3D visualisation and interaction (Rubens, Kaplan, & Okamoto, 2011). Goroshko and Samoilenko (2011) considered that e-Learning 3.0 will be both and intelligent. Intelligent agents will facilitate the human thinking greatly.

The employment of new mobile technology such as tablets and other portable media devices is currently changing the way in which technology can be implemented in classrooms. Emerging social media and mobile tools have the potential to offer novel affordances that can help to support and promote self-regulated learning processes that are central to learning (Laru, 2012).

4 Why is change needed?

ICT plays an ever-greater role in the everyday life of citizens, communities, educational institutions and businesses. Society is being transformed into an information or knowledge society (e.g. Anderson, 2008). We have moved from an industrial age production era to a knowledge age economy. The shift has been as fundamental as moving from the agrarian to the industrial age many decades ago. We are now witnessing a revolution formed by the creation and the development of the Internet. The Internet has had a fundamental impact on the way people work, communicate and spend their leisure time. Its impact on education has involved, *inter alia*, the creation of online learning and digital learning materials. Learning has become possible as asynchronous and lifelong, while teaching has also been provided with a magnitude of new methods and technologies that are said to have a profound effect on learning.

Technological evolution in educational institutes without a doubt has an effect on teachers and students. Technological or other advancements can be introduced to schools, but if there is a need to fundamentally change the operational culture, it is vital to implement those changes in a manner that both teachers and students accept. Thus, it is important to explore these individuals' opinions and attitudes towards those changes.

Along with rapid progress of ICT, the conception of knowledge has also evolved. Technology and networks have brought us to a situation where huge amounts of information are at our disposal. This wealth of information also brings conflicts, diversity and uncertainty; information needs to be processed, analysed, structured and assessed in order to transform it into knowledge. The diffusion of ICT into society brings an increasing demand for new educational approaches and pedagogies that foster lifelong learning (Fischer & Konomi, 2005). There is a growing emphasis on the need not only to enable and support the acquisition of knowledge and information, but also to develop the skills and resources necessary to engage with social and technological change, and to continue learning throughout life (Owen, Grant, Sayers, & Facer, 2006). There has been rapid expansion and proliferation of technologies that are more focused on creating communities in which people come together to collaborate, learn and build knowledge (McLoughlin & Lee, 2007).

The diversification of life trajectories, multiple career paths, re-skilling and flexible working hours are driving education towards learning on demand. In such a digital world, with high connectivity and ubiquitous, demand-driven learning, learners are becoming active participants or co-producers rather than

passive consumers of content, so that learning is a participatory, social process supporting personal life goals and needs (McLoughlin & Lee, 2007). We have come to a point where it is not enough for a school to 'transfer knowledge', with students passively receiving it. ICT offers ways to learn that have not existed before, but also challenges us to develop new ways to learn actively and with new skills. Students should learn not only the knowledge but also the skills that they will need when they move to their adult life. At present, schools are still too focused on feeding readymade learning paths, content and knowledge split into different school subjects. Instead, schools should give room for solving authentic problems, making multidisciplinary analysis and learning new skills that are developed whilst learning new ideas.

Finland has been successful in all recent studies that have measured basic education students' learning in different school subjects. This trend has continued in the most recent international studies published in 2012, specifically Progress in International Reading Literacy Study (PIRLS) and Trends in International Mathematics and Science Study (TIMSS). The results of these studies showed that Finnish 4th and 8th graders are performing very well in reading achievement and mathematics and science achievement. The earlier Programme for International Student Assessment (PISA) surveys showed that the skills of Finnish students were amongst the best in all domains assessed. These studies showed that Finnish students are good at both reproducing the knowledge that is taught in school and adapting it to problem-solving tasks; however, these studies also showed that Finnish students are not achieving high rankings in being motivated to learn. Having good learning results without really being motivated hints that the Finnish education system is good at providing equal learning opportunities to all students but does not succeed in inspiring students. The results give indications to believe that students are learning because they are getting a good education; they are learning by performing, not because learning is necessarily fun or interesting. This is where ICT and new educational technology hand-in-hand with new pedagogically grounded teaching and learning methods could have a positive effect.

4.1 Guidelines for change

The Europe 2020 strategy (European Commission, 2010) acknowledged that a fundamental transformation of education and training (E&T) is needed to address the new skills and competences required if Europe is to remain competitive, overcome the current economic crisis and grasp new opportunities. Innovation in education and training is a key priority in several flagship initiatives of the Europe 2020 strategy.

The Society for Technology in Education introduced the following conditions that should be fulfilled in order to effectively leverage technology for learning:

- Shared vision;
- Empowered leaders;
- Implementation planning;
- Consistent and adequate funding;
- Equitable access;
- Skilled personnel;
- Ongoing professional learning;
- Technical support;
- Curriculum framework;
- Student-centred learning;
- Assessment and evaluation;
- Engaged communities;
- Support policies;
- Supportive external context. (ISTE, 2009)

Researchers, practitioners and policymakers at EDU-sumMIT 2011 (Searson, Laferriere, & Nikolow, 2011) agreed about the international relevance of this list, while noting that local, national and regional factors should also be taken into account.

In its strategy for learning and competence for 2020, the FNBE (2011) stated that it will be developed into a national centre of expertise in the educational use of ICT in the education and digital learning environments. The strategy outlined how learning and teaching will emphasise collaborative approaches, involvement and interaction, combined with building knowledge and competence. In this way, Finland will become the leading developer of learning culture in the world. Learning and teaching will emphasise collaborative approaches, involvement and interaction, combined with building knowledge and competence. Electronic learning materials and diverse learning environments will form a key part of learning and teaching. Determined solutions will guide the development of digital infrastructures and digital skills at all levels of education.

The Finnish national core curriculum for basic education (2004) specified the objectives and core contents of cross-curricular themes, subjects and subject groups in basic education intended for pupils receiving compulsory education. The national core curriculum for basic education constitutes regulations for providers of basic education when it comes to making decisions respecting the curriculum.

The national core curriculum states that basic education has to offer a fundamental knowledge of technology, its development and its impacts; guide the pupils towards sensible choices; and lead them to consider the ethical, moral and equality issues associated with technology. The instruction must advance understanding of the operating principles of tools, equipment and machines, and teach pupils how to use them.

The National Plan for Educational Use of Information and Communications Technology report (Ubiquitous Information Society Advisory Board, 2010) laid out the strategic policies and actions to develop the learning environments of

Finnish educational institutions in order to meet the needs of an information society more effectively. The report set out policies for actions on how to carry out a systemic change, where the entire education system and schools' operational cultures are reformed to conform to the current conception of learning. According to the report, success in making this change requires promotion of the following elements:

- National objectives and systemic change;
- Pupils' future skills;
- Pedagogical models and practices;
- E-learning materials and applications;
- Infrastructure and support services;
- Teacher identity, teacher training and pedagogical expertise;
- Operational culture and leadership at school; and
- Business and network cooperation.

The guidelines and strategies laid out policies to be implemented on a national level in Finland, but on the other hand, cross-European research has shown alarming findings at the local, personal level. The ICT in Education (European Commission, 2013) survey of schools collected and benchmarked information from 31 European countries on the access, use, competence and attitudes of students and teachers regarding ICT in schools. From the Finnish perspective, the results are disappointing in terms of how much ICT is actually used in education: Finland ranked at the bottom in terms of 8th-grade students' reports on how often they are able to use ICT in education. Teachers utilise ICT mainly for administrative and preparatory purpose; this result is verified also in the findings presented in this thesis.

4.2 Factors influencing teachers' educational use of ICT

Another undertaking of the National Plan for Educational Use of Information and Communications Technology (Ubiquitous Information Society Advisory Board, 2010) was to identify obstacles to establishing educational use of ICT. These were listed as follows:

- Varying and inadequate standards of technological infrastructure at different schools;
- Lack of technical and pedagogical support;
- Low usage of pedagogical models and practices geared towards supporting learners' active involvement and collaborative learning;
- Lack of availability, quality and dissemination of e-learning materials;
- Challenges for the schools operational culture;

- The need to develop school management practices and engage in change management;
- The need for partnerships between businesses and schools in order to organise services; and
- The necessity of bringing teacher training up to date.

While there are obstacles, there are also factors that can have either a negative or a positive influence on the educational use of ICT at a personal, systemic or technological level. Based on literature review and relevance concerning this thesis, the factors are first summed up and then presented in the following paragraphs. Later the factors are partly utilised as a means of explaining the findings of the sub-studies. The factors are as follows:

- Systemic or organisational factors;
- Personal, technical and institutional characteristics;
- Attitudes;
- Beliefs;
- ICT competence;
- Computer self-efficacy;
- Gender;
- Teaching experience;
- Professional development;
- Teacher education;
- Accessibility;
- Support.

Systemic or organisational factors

According to Thompson (2010), schools can be seen as organizations or as sense-making, intelligent collectives. Thompson continues by stating that doing things in a novel manner while sharing experiences simultaneously brings about reform in schools. Niemi, Kynäslähti and Vahtivuori-Hänninen (2013) see schools as systems or even as collective sense-making communities, and that ICT practices have relevance to cultural issues in school communities; successful ICT integration requires pedagogical, but also organisational qualities. Säljö (2010) states that as new artefacts created with ICT are introduced to schools, they change the organisation and its culture.

Personal, technical and institutional characteristics

Personal characteristics such as educational level, age, gender, educational experience, experience with computers for educational purposes and attitude towards computers can influence the adoption of technology (Schiller, 2003). The characteristics of technology influence the process of adopting it. It is important to have knowledge about teachers' perceptions of innovation when it comes to successful

adoption of technology in learning. Watson (2006) regarded this as a particular kind of instructive innovation. Smarkola (2007) confirmed that the perceived usefulness and ease of computer technology by teachers predicted its acceptance.

Institutional factors improve teachers' existing attributes. According to Vannatta and Fordham (2004), the time teachers commit to teaching and their level of technology training are reliable factors of technology use in classrooms.

Attitudes

Teachers are inclined to use their own experiences and practical, commonplace knowledge as a basis for their decision making in teaching, rather than adopting ideas and guidelines stated in theoretical, science-based reports or the curriculum. It is generally accepted that as teachers gain experience with computer technology, the use of computers in the classroom will evolve to involve more computer applications more often and more flexibly. However, even if most teachers have sufficient skills for everyday and routine working practices, many of them still have difficulties in finding a meaningful pedagogical use for technology (Ilomäki, 2008). According to results presented in this thesis, the situation has not improved substantially in five years.

Krumsvik (2011) emphasised how important it is that pedagogy, subjects and digital competence 'merge together' so that new trends in the digitised schools of today can be exploited by teachers. According to Krumsvik, this also shows the complexity of the digital competence that every teacher has to deal with in our digitised schools.

The attitudes of teachers and their willingness to embrace the technology have significant effects on the success of student learning with computer technology (Huang & Liaw, 2005; Teo, 2006). ICT attitudes have a significant relationship with and predict competence (Jegede, Dibu-Ojerinde, & Ilori, 2007). According to Haaparanta (2008), teachers' future use of computers is predicted far more strongly by the teachers' perceived usefulness of computers than with the teachers' perceived ease of computer use. Other related studies on teachers' attitudes towards ICT found significant positive correlations between teachers' levels of ICT use and their attitudes towards ICT: e.g. Al-Zaidieen et. al (2010) found that teachers had a low level of ICT use for educational purpose, but hold positive attitudes towards the use of ICT. They found a significant positive correlation between teachers' level of ICT use and their attitudes towards ICT.

Albirini's (2006) findings suggest that teachers have positive attitudes toward ICTs in education. The results point to the importance of teachers' concept of technology itself, their experiences with it, and the cultural conditions that surround its introduction into schools, in shaping their attitudes toward technology and its subsequent diffusion in their educational practice. Bullock (2004) found that teachers' attitudes are a major factor in enabling/disabling the adoption of technology. Anyan, Owens and Magoun (2000) also found a dependency

(although weak) on the teaching level: Elementary school teachers were less positive in their attitudes than their middle or high school colleagues.

According to expectancy-value theory (Fishbein & Ajzen, 1975), behaviour is guided by the expectancies a person has and by the self-perceived value of the goal that a person is trying to achieve. If there is more than one behaviour to choose from, the behaviour selected will be the one that has the largest combination of expected success and value. Expectancy-value theories characterise people as goal-oriented beings. According to this model, a person is more likely to adopt innovations if the perceived value of the innovation and the expectancy of success are high, and if it is believed that these values are regarded to add value more than the perceived costs of implementation are likely to be. ICT as an innovation can be seen as a major disturbance that has shaken the previous order and brought about significant, unpredictable changes (Kompf, 2005). Venkatesh, Morris, David and David (2003) listed four predictors that have significance when teachers make decisions about utilising ICT in education: performance expectancy, effort expectancy, social influence and facilitating conditions.

Beliefs

Teachers form their own beliefs about the role of ICT as a teaching tool, the value of ICT for student learning outcomes and their own personal confidence and competency (Prestridge, 2010). These beliefs intersect with teachers' established pedagogical beliefs. This intersection can be a 'collision' or 'collusion', both having implications for how ICT is used in the classroom, as an add-on to established curriculum practices or as a tool that effects change in their practice (Prestridge, 2007). Schools are often conservative institutions and it can be difficult to introduce new ideas to teachers. Teachers need to believe that technology brings an added value to learning; it has to be relevant and useful. Teachers do not adopt new technology unless they see its benefits in improving or enriching teaching, studying and learning. Teachers' practical knowledge is primarily viewed as developing out of their own professional experiences (e.g. Carr, 2004; Zanting et al., 2003). From this perspective, teachers learn a great deal by experiencing various situations while working.

Clark and Peterson (1986) stated that teachers have theories and belief systems that influence their perceptions, plans and actions. They went on to say that if teachers' implicit theory about, for example, effective teaching or learning were contrary to that embodied in a new curriculum, they would be unlikely to adopt the innovation with enthusiasm.

ICT competence

Van Braak, Tondeur and Valcke (2004) defined computer competence as being able to handle a wide range of varying computer applications for various purposes. Peralta and Costa (2007) found that technical competence influenced

Italian teachers' use of ICT in teaching. Jones (2004) concluded that teachers' competence is directly related to confidence. Teachers' confidence also relate to their perceptions of their own ability to use computers in the classroom. Tondeur, van Braak and Valecke's (2006) research on the impact of a national curriculum on the use of ICT in primary schools found that Flemish primary school teachers still stress about their technical ICT skills. This factor is relevant to research presented in this thesis, as the level of teachers' ICT competence was one of the areas that were studied.

Computer self-efficacy

Christensen and Knezek (2006) described computer self-efficacy as confidence in computer competence. Bandura's (2001) theory proposed that an individual creates a database on how certain actions will drive certain outcomes. This database then becomes a resource that helps the individual determine what outcome can be expected from different circumstances, and also to determine how he or she should behave in order to produce a specific desired outcome. Teachers' actions are based upon their belief systems. The key to change is in their belief that they have the power to produce change with their actions. Further, in order to achieve certain outcomes, teachers need a strong sense of self-efficacy. Their perceived self-efficacy is a crucial link to the decisions that they make, which in turn has an effect on their teaching methods (Sipilä, 2010).

Knezek and Christensen (2002) revealed that teachers' competence with computer technology is a key factor in the effective use of ICT in teaching. It is also clear that self-efficacy is not the only factor that has an effect on changing teaching and learning. The role of leadership, experience and knowledge of computers and attitudes towards computers are vital to the successful implementation of change (Piper, 2000).

Gender

Meelissen and Drent (2008) stated that female teachers assess their knowledge and skills in ICT considerably less positively than male teachers do. Shapka and Ferrari (2003) suggested that female teachers are less likely to apply computers for various teaching and learning purposes. King, Bond and Blandford (2002) pointed out that gender should not be an issue with regards to basic ICTs skills. However, other studies have provided evidence that gender inequalities are emerging in new areas of ICTs use. Males tend to be more intensive users of the Internet, enjoy more competitive forms of e-learning and encounter different problems while using ICTs (Colley, 2003). A study by Anyan et al. (2000) (which looked at teacher attitudes towards ICTs and considered the teachers' gender, teaching experience and teaching levels) concluded that female teachers had a better attitude towards technology than their male colleagues. According to Jamieson-Proctor, Burnett, Finger and Watson (2006), female teachers are significantly less confident than their male counterparts in using ICT with students

for teaching and learning, and there is evidence of significant resistance to using ICT to align curriculum with new times and new technologies. Recently, Yukselturk and Bulut (2009) stated that the gender gap has narrowed over the past years with the advent of social media and web 2.0 technologies. When looking at younger generations, the picture appears to be more nuanced; the OECD Centre for Educational Research and Innovation (CERI, 2010) found that both boys and girls seem to be involved and interested in using ICT different tools, both at school and elsewhere.

Teaching experience

There have been mixed results concerning whether teaching experience has an impact on teachers utilising ICT in education. For example, Gorder (2008) reported that teacher experience is significantly correlated with the actual use of technology. Baek, Jong and Kim (2008) claimed that experienced teachers are less ready to integrate ICT into their teaching. Lau and Sim (2008) revealed that older teachers more frequently use computer technology in classrooms than younger teachers. Russell, O'Dwyer, Bebell and Kay (2010) argued that the quality of ICT integration was related to the years of teacher service, but according to Granger, Morbey, Lotherington, Owston and Wideman (2002) there was no relationship between teachers' teaching experience and their use of ICT.

It is often perceived that members of the younger generation coming into the teaching profession from university studies are acquainted with technology and able to utilise it in their teaching without any difficulties. In reality, however, this is a misconception: Younger teachers are not necessarily eager to use technology or possess the skills to the use of technology in enhancing teaching and learning. Experienced teachers, in contrast, have the confidence to reflect on and analyse the effects of their own teaching and apply the results to their future plans and actions (Clark & Peterson, 1986).

Professional development

The professional development of teachers is affected by the development of three types of knowledge (Uzunboylu, Bicen, & Cavus, 2011), specifically the growth of scientific knowledge, which is needed in order to develop the necessary skills for the search, selection and analysis of information; the rise of the popularity of digital culture, in which critical thinking processes are more important in that they result from a constant need for information; and the development of learning processes without time restrictions, that is, learning that can be done anytime and anywhere. Chai, Koh, Tsai and Tan (2011) added another type of knowledge: the technological knowledge of the pedagogical content which arises as a response to the problems caused by the integration of ICT into the classroom—this comes with the development of the teaching-learning process. Piper and Austin (2004) concluded that teachers' attitude towards working with the

computer and their perceptions of leadership and professional development have an impact on their beliefs about using the computer in an instructional setting. Hallam (2008) presented evidence that differences between teachers with and without computer anxiety appear to be related to differences in social resources within the sociocultural environment of computing.

Teacher education

Teacher educational institutions today are supposed to provide pre-service teachers with the necessary knowledge, skills and attitudes to teach with ICT by including introductory ICT courses in their curriculum (Polly, Mims, Shepherd, & Inan, 2010). Introductory ICT courses do not provide sufficient skills for pre-service teachers to be able to unite technology with pedagogy, as they are often carried out as separate 'stand-alone' ICT courses. Empirical evidence shows that pre-service teachers still do perceive themselves to be adequately prepared to effectively integrate ICT into their classrooms (Kay, 2006). Pre-service teachers fail to obtain sufficient competence in the educational use of ICT during their studies (Meisalo, Lavonen, Sormunen, & Vesisenaho, 2010). Although educational technology leaders have been calling for content-based, pedagogically forward-thinking technology integration, professional development for teachers still emphasises and is organised according to technologies' affordances and constraints (Friedhoff, 2008).

To integrate different elements that are involved in incorporating ICT into classrooms, Mishra and Koehler (2006) introduced the concept of Technological Pedagogical Content Knowledge (TPACK). TPACK characterises the integrative knowledge base which teachers need to effectively teach with ICT, involving the dynamic interactions between technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK) (Mishra & Koehler, 2006). This approach is also relevant regarding this thesis because it might offer solutions to many of the discrepancies currently prevailing in the Finnish approach to implementing ICT into educational practices, as described in chapter 9.

Accessibility

The basic barrier or enabler of technology use in schools is infrastructure, including computers and other technologies, computer labs and Internet access, among other things. Schools need to provide adequate physical and technological infrastructure in order to make way for integrating ICTs into teaching processes. According to Plomp, Anderson, Law and Quale (2009), access to ICT infrastructure and resources in schools is a necessary condition for the integration of ICT into education. Yildirim (2007) found that access to technological resources is one of the most effective elements for teachers' pedagogical use of ICT in teaching. Teachers, whose students have lab and classroom access to ICT, or have a 1:1 environment, are more likely to use ICT than their peers who

only have access to a computer lab; having some flexibility as to where students can access the Internet enables teachers to use more ICT with their students (Light & Pierson, 2011).

Support

Teachers need support in their endeavours to integrate ICT into teaching. Whereas technical support is the most obvious type to consider, pedagogical support and leadership support are also needed. Besides technology, teachers need to have pedagogical support to ensure that ICT is being utilised in the classroom with pedagogically grounded teaching methods. A study by Wong and Li (2008) revealed that leadership promotion of collaboration and experimentation and teachers' dedication to student-centred learning influenced effective ICT transformation. The support aspect was explored in study V of this thesis.

4.3 Students' perspectives on educational technology

New technology opens up new possibilities for differentiated learning and a more student-centred approach to education. With virtual learning environments, the student can be given alternative routes to learning based on his or her personal needs. With Web 2.0, the student can utilise a wide variety of authoring tools such as podcasting, video, blogging, social bookmarking, social networking, virtual world activities and wikis. Student Web 2.0 authoring is improving learning in a variety of ways: It can engage and empower students, increase peer learning and creative expression, develop literacy and communication skills and inculcate lifelong learning (Barnes & Tynan, 2007; Brown & Adler, 2008). Digitally competent students prefer efficiency, novelty and interactivity in their learning activities (Hartman, Dziuban, & Brophy-Ellison, 2007). Technologically mediated learning environments offer adaptive features for learning. In this generation of social networking, students are more used to active participation and the opportunity to choose the mode and direction of learning activities (Barnes, Marateo, & Ferris, 2007). The traditional classroom setting of one to many limits the ability of the instructor to tailor the learning activities to fit individual students; in contrast, Web 2.0 technologies offer novel, technologically engaging content to maximise their individual engagement with course material (Monaco & Martin, 2007). In a study by the National School Boards Association (2007), it was reported that online sharing by students in social network sites involves both learning and education. Sixty per cent of students surveyed reported using social network sites in order to discuss educational topics in general, and 50% reported talking specifically about their schoolwork (National School Boards Association, 2007).

Student engagement increases student achievement (Handelsman, Briggs, Sullivan, & Towler, 2005). Even though students like using computers and soft-

ware, the way they are used in schools does not necessarily motivate students to be active in higher-level learning. Computers and software are often utilised to achieve low-level learning goals, applying teaching methods that do not give way to new pedagogical ideas or learning theories that could enhance learning and empower students to learn in new ways. If ICT or VLEs are used mainly to control students, for drilling practice or for sharing basic learning material, the motivational effect of the new tools will soon fade away.

Motivation is about the reasons for behaviour—why we do what we do. It concerns the psychological processes behind student behaviour in learning situations. It is important to understand the difference between motivation and engagement, as students can be motivated but disengaged. Russell, Mackay and Jane (2003) found primary and secondary students to have high learning motivation, but with minimum levels of interest in their classroom work. Inner motivation to learn does not help if schoolwork is not stimulating. The motivation of students to learn regarding the use of ICT and VLEs has been studied before. In their study, Bovée, Voogt and Meelissen (2007) found that when computers are used more often in education, students enjoy school more. Swan, Van Hooft, Kratcoski and Unger (2005) reported that the use of mobile computing improved students' motivation to learn and engage in learning activities. Lim and Tay (2003) reported students' engagement to be on a greater level of higher-order thinking when they were using ICT tools.

Tsai, Kunter, Ludtke, Trautwein and Ryan (2008) stated that student-activating learning methods are not only intellectually challenging, but also emotionally and motivationally engaging. Elementary teachers indicated that the greatest factor in student success may be their motivation to learn (62% vs. 44% for high school teachers). In a study by Bebell and Kay (2010), teachers reported improvements in student engagement and motivation resulting from their participation in a pilot program that provided 1:1 technology access to all students and teachers. Here, 83% of the teachers thought that engagement had improved for their traditional students, compared to 84% for at-risk/low-achieving students and 71% for high achieving students. The pilot program enhanced their students' motivation. Seventy-six per cent of 1:1 teachers reported that student motivation improved for their low achieving students compared to 73% for traditional students and 59% for high-achieving students.

Time is also a factor in how computers are used in schools. The Norwegian National Network for IT-Research and Competence in Education (ITU, 2005) found that students in Norwegian primary schools had little opportunity to acquire experience using computers and utilising ICT in their studies. This was due to the limited amount of time spent at the computer during the course of a normal school week. Twenty per cent of 7th- and 9th-grade students reported no weekly use of computers in school, while 50% to 60% of the students said that they used computers less than one hour per week. If students use computers at school for a very limited period of time and if, for the most part, computers are

used for the simplest of tasks such as the Internet and word processing, there really is a need for schools to develop the use of ICT in a way that will enhance learning. High accessibility of computers at school for teachers would significantly lower computer anxiety and raise computer self-efficacy (Chen, 2012).

As previous chapters have involved covering the theoretical aspects of learning and educational technology, chapter 5 below will present the theoretical approaches utilised in sub-studies presented in this thesis.

5 Theoretical approaches of the studies

This thesis consists of five studies, which all approached the research questions presented in chapter 6 from different angles. At the beginning of this chapter I will briefly present the theoretical approaches used in the first four sub-studies. Then I will concentrate on Activity Theory (AT) (used as a theoretical framework in study V), which offers a lens for examining a school's complex operating culture and presents a model for analysing interactions between various stakeholders within a school. AT will also be used as a theoretical framework for drawing conclusions from all five sub-studies.

5.1 Socio-constructivist learning

The socio-constructivist approach emphasises the active construction of knowledge in a social context (Säljö, 2001). This approach has also been a cornerstone in Finnish pedagogical reforms. This approach extends constructivism into social settings, wherein groups construct knowledge for one another, collaboratively creating a small culture of shared artefacts with shared meanings. Constructivist learning is epitomised by key interactions with others and the environment (Driscoll, 2005) and meeting the needs of the learner at their instructional level. Constructivism is often associated with independent learning, self-regulation and student-centred learning. Problem solving, hands-on activities and real-world scenarios provide new experiences and encourage learners to use active techniques as they assimilate or accommodate new knowledge (Chen, Wan, & Son, 2008).

Socio-constructivist learning has largely been adopted as the base ideology of Finnish basic education. It was logical to use that approach in study I, as this focuses on how students have acculturated the use of ICT and VLE in schools. One of the main principles that socio-constructivist learning theory stresses is the promotion of conceptual changes in the learner's mind. When traditional cognitive learning research focused on studying individual problem-solving processes, principles of shared cognition stated that the necessary knowledge and expertise are seldom in the possession of one individual (Asanti, Lehtinen, & Palonen, 2002). Socio-constructivist learning theory suggests that learners construct or build knowledge. Knowledge building can be defined as the production and continual improvement of ideas of value to a community (Scardamalia &

Bereiter, 2003); it places emphasis on ideas as conceptual artefacts that can be improved in community discourse (Bereiter, 2002).

The aspect of socio-constructivist learning was introduced into the Finnish national core curriculum for basic education in the 1990s, but it was not until the dawn of the web 2.0 era in the new millennium with its social media tools, e-learning platforms, and web-based collaboration, that the necessary tools were finally available for schools to integrate technology into teaching and learning in a way that would promote learning according to socio-constructivist learning theory principles. Through social interaction and visualisation, design ideas, proposed solutions and decisions that are made verbally and visually explicit and visible, the involvement of students in modelling practices can help them to build domain expertise, epistemological understanding and the skills to create and evaluate knowledge. ICT plays an important role, providing technology-mediated learning environments which included the tools and practices needed for building learning communities within and beyond classrooms (Hakkarainen, 2010).

Scardamalia and Bereiter (2003) described the 'knowledge age' as an era in which the ability to innovate is decisive in relation to the health and wealth of society. Defined as the deliberate creation and improvement of knowledge that has value for a community (Scardamalia & Bereiter, 2003), knowledge building is synonymous with knowledge creation (Nonaka & Takeuchi, 1995). Knowledge building stands out as most directly addressing the need for knowledge-creating talent.

Bielaczyc (2006) stated that the central challenge in implementing knowledge-building pedagogy in schools lies in creating the appropriate social infrastructure around the implementation of technology, specifically in classroom practices and online activities involving the use of the technological environment. Thus, old 'transfer metaphor' model of education (where knowledge is passively received) is rejected. As Ilomäki (2007) stated, schools that successfully adopt ICTs into teaching and learning can have a positive impact on adjusting both teaching and learning methods to meet the demands of the curriculum and modern learning theories.

Inquiry-based teaching and learning methods have become more popular in Finland in the new millennium (Muukkonen-van der Meer, 2011). New technologies are finally establishing a way to make it easier for learners to reflect, collaborate and share their conceptions (Lonka, 2011). Instead of studying for isolated courses or subjects, new methods are designed to engage the learner into a personally meaningful study project (Muukkonen-van der Meer, 2011). Scardamalia (2002) defined this as an epistemic agency, which indicates that students deal with goals, motivation, evaluation and long-term planning instead of leaving these to teachers or managers. These new teaching and learning methods play an essential role in integrating technology into classrooms and are important concepts in this thesis as well.

5.2 Expectancy-value theory

Study II explored the impact of laptop provision on teacher attitudes towards ICT. Its theoretical framework is based on expectancy-value theory (Fishbein & Ajzen, 1975). According to this, behaviour is guided the expectancies a person has and by the self-perceived value of the goal that he or she is trying to achieve. If there is more than one behaviour to choose from, that chosen will be the one that has the largest combination of expected success and value. Expectancy-value theories characterise people as goal-oriented beings. According to this model, a person is more likely to adopt innovations if the perceived value of the innovation and the success expectancy are high and if these values are perceived to give more than the perceived costs of implementation. In study II, the innovation was the provision of mobile laptops to teachers by their employer.

ICT as an innovation can be seen as a major disturbance that has shaken the order and brought about significant, unpredictable changes (Kompf, 2005). If expectancy-value theory is used when looking at teachers' decisions to implement computer technology in instruction, then the decision will be based on how highly the teachers value the innovation and how much they expect the costs of this implementation to be. Expectancy-value theory provided a good reflection ground to analyse the results in study II, as the focus was to explore whether the provision of laptop computers would have an effect on their attitudes towards ICT in education and in general.

5.3 Efficacy theory

Study III was about exploring teachers' manners, proficiency levels and perceived values in implementing ICT in instruction. Bandura's (2001) self-efficacy theory provided a theoretical context, which helped the researcher to understand how technology affects teachers. This theory proposes that an individual creates a database on how certain actions will drive certain outcomes. This database then becomes a resource that helps the individual to determine what outcome can be expected from different circumstances, and to determine how he or she should behave in order to produce a specific desired outcome. Teachers' actions are based upon their belief systems. The key to change is in their belief that they have the power to produce change with their actions. Further, in order to achieve certain outcomes, teachers need a strong sense of self-efficacy. Their perceived self-efficacy is a crucial link to the decisions that they make, which in turn establish their teaching methods.

Study III focused on finding possible connections between teachers' frequency of ICT use and their perceived values about ICT in education; this viewpoint was fruitful when combined with self-efficacy theory. Teachers must have an understanding of the change process before they are able to lead complex behavioural

changes, such as using computers in the classroom. Fullan (2001) noted that there are no shortcuts for leading complex change. It is also clear that self-efficacy is not the only factor that has an effect on changing teaching and learning. The role of leadership, experience and knowledge of computers and attitudes towards computers are vital to the successful implementation of change (Piper, 2000).

5.4 Fusion of horizons theory

As study IV explored concept mapping in visual arts lessons, Gadamer's (1979) fusion of horizons theory offered a way to integrate concept mapping—which is about linking head and sub-concepts in a logical and hierarchical manner—to a theoretical approach where understanding is considered to be a process of the 'fusion of horizons'. This involves the formation of a new context of meaning that enables integration of what is otherwise unfamiliar. Understanding and interpretation always occurs from within a certain 'horizon', which is determined by our historically determined situation (Malpas, 2009). In Gadamer's view, understanding is essentially a matter of conceptual articulation where the primacy is given to language and conceptuality. Language is about communication. It is about transferring, aggregating and processing information. These same principals are used in concept mapping.

5.5 Activity theory

Study V explored the educational use of ICT from teachers' perspectives. As the purpose in this study was to take a more holistic view of how teachers perceived the use of ICT in education, there was a need to find a theoretical approach that would offer a way to distinguish and explain various factors that have an effect on human behaviour in complex, dynamic systems. Engeström (1987) introduced Activity theory (AT) as a model for conceptualising all purposeful human activity as the interaction of the following elements: subject, object, tools, community, rules and division of labour. Kuutti (1995) defined AT as a general framework for studying human activity in different forms as development processes. Moreover, Kuutti broadly described AT as a philosophical and multidisciplinary framework for studying different forms of human practices as development processes, with the individual and systemic levels interlinked. In this way, AT provided a perspective that supported the idea in study V that ICT must be studied within the learning environment and the broader context in which it is situated. It later became clear that, of the five different theoretical frameworks used in the sub-studies, AT provided the best conceptual foundation to explain the various factors affecting human behaviour in complex, dynamic educational systems. AT was thus chosen to be the theoretical foundation of this thesis.

Activity is understood as a purposeful interaction of the subject with the world, a process in which mutual transformations between the poles of 'subject-object' are accomplished (Kaptelinin & Nardi, 2006). The focus in the framework of AT is in manufacturing or processing an object, which is transformed into an outcome. The process needs a subject, which can be either a person or a group of persons tied to a certain activity. The object (or objective) is the target of the activity within the system. External mediating artefacts are the tools, which help to achieve the outcomes of the activity. The community consists of one or more persons who share the objective with the subject. Rules can be seen as the explicit and implicit regulations, norms and conventions that constrain actions and interactions within the activity system. The division of labour defines how tasks are divided between members of the community, as well as how power and status are divided (Centre for Activity Theory and Developmental Work Research, 2003).

Kuutti (1995) defined activities as longer-term formations that consist of several steps or phases. He then broke activities into shorter-term processes: Activities consist of actions or chains of actions, which in turn consist of operations. Considering this framework in educational surroundings is clarified by the following example: activity (teaching) à action (teaching how to write an essay) à operation (selecting appropriate wording). Activities are always changing and developing. ICT can provide support throughout all of these steps and can work as a catalyst for change.

Educational institutions are complex systems, organisational entities, which makes them challenging to study. The activity-theoretic concept offers a framework that appears to be particularly useful for describing and explaining human behaviour in complex, dynamic systems (Sujan, Rizzo, & Pasquini, 2002). The interaction of humans in schools has been present from the beginning of educational institutions, but ICT is shaping the development of that interaction in numerous ways. The activities, rules, actions and interactions in schools have evolved over a long period of time, undergoing a continuous adaptation process. The introduction of ICT into the activity systems of schools is likely to bring about contradictions. Contradictions within activity systems are both catalysts and opportunities for systemic change (Sujan et al., 2002).

Lawrence and Lentle-Keenan (2013) have applied an AT framework to the teaching environment from a point of view where teaching is seen as the central activity (Figure 1).



FIGURE 1. AT framework (as conceptualised by Engeström, 1987) applied to teaching (Lawrence & Lentle-Keenan, 2013)

From this framework, Lawrence and Lentle-Keenan go on to postulate that in order to achieve an outcome (teaching goal), schools use Web-based technologies to manipulate the outcome. These tools can, however, have an effect on how teachers think about what they are doing; the affordances of the tools, for example, can limit the ways that students are able to utilise them in their studying.

Leontiev (1978) pointed out that educational agents do not act in isolation, but are a part of a community (e.g. a classroom). Therefore defined the structure of human activity as having three stages: the collective activity, which has a motive; individual actions, which are directed towards goals; and operations, which are influenced by conditions. Tensions and opportunities are bound to emerge as new technologies are introduced and implemented into school's communities. These tensions should not be denied but rather seen as seeds to transformation (Engeström & Sannino, 2010).

According to Miettinen (2009), contradictions can only be grasped when analysed within a dynamic system, not as separate entities, since they consist of two forces that influence the system from opposite directions. Engeström (1987) distinguishes four levels of contradictions:

1. Primary inner contradictions (double nature) within each constituent of the central activity: e.g. how students learn theoretical mathematics in school compared to learning practical mathematics in the workplace;
2. Secondary contradictions between the constituents of the central activity: e.g. the introduction of the virtual learning environment presents a contradiction for the teacher, as a conflict between time and proficiency level towards the software being used;

3. Tertiary contradictions between the motive of the dominant form of the central activity and the motive of a culturally more advanced form of the central activity: e.g. the ICT classroom's objective of providing students with better skills in ICT differs from the school's objective of increasing school ranking by improving examination results;
4. Quaternary contradictions between the central activity and its neighboring activities: e.g. parents do not enter or update students' information in a particular software, so that when statistics are collected, data is missing.

During a change process, there can be several contradictory goals, tools, roles, policies and norms within and across communities' activity systems. Divaharan and Cher Ping (2010) point that these tensions or contradictions should be confronted from within. Tensions or contradictions are necessary driving forces of transformation (Laferriere, Hamel, & Searson, 2013).

Demiraslan and Usluel (2008) adopted the basic structure of activity elements to analyse ICT integration in schools. The following elements were used in study V in order to clarify and make a graphical image of various factors that may contradict or hinder the use of ICT in education:

Subject

- Teacher (teaching experience, teaching approach, the personal, administrative and instructional use of ICT, the place of ICT in daily life, the necessity of knowledge and competence related to ICT).

Object

- The goals of using ICT in the teaching-learning process (knowledge and competence acquisition and problem solving).

Tools

- ICT and other tools ICT, methods used and problems encountered.

Rules

- The evaluation criteria, expectations of the teacher and rules of the school.

Community

- Students, teachers, school administration and ICT coordinators.

Division of labour

- The roles and responsibilities of students and teachers, cooperation among teachers and the support of administration.

Outcome

- The reflection of the use of ICT in the teaching-learning process on the learning of students and instruction.

If we look at the activity system of a school, teaching is one of the key elements and teachers have an active role, but this point of view is not of course the only one. Learning is just as essential, meaning that students play just as vital a role in the teaching-studying-learning process.

Larkin (2013) applied AT from a student point of view and shifted the focus from teaching to learning. Figure 2 below presents this view.

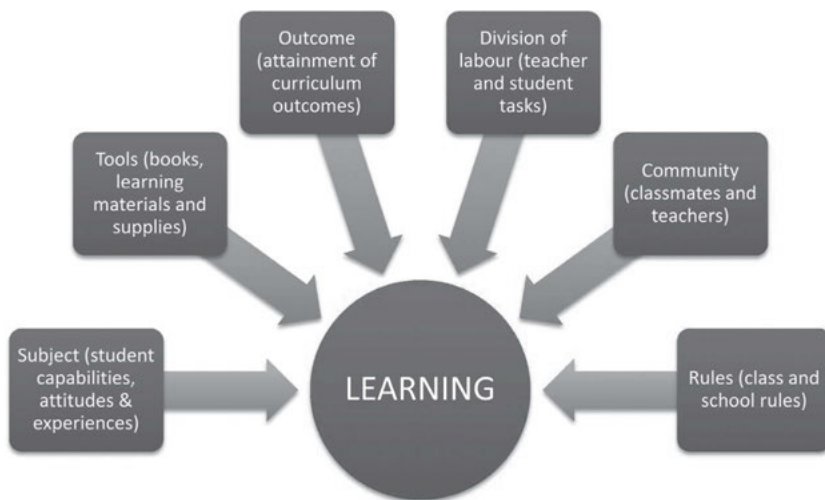


FIGURE 2. AT applied to learning, as devised by Larkin (2013)

Learners (students) use various tools (books etc.) in order to achieve the outcome (attainment of curriculum outcomes) in a community of classmates and teachers, completing various tasks and following the rules of their class and school. These are the minimal elements of the activity system framework. However, in order to understand the impact of ICT, other factors need consideration, including the object of the particular activity in which technology is used, and also the cultural influence of the teachers and the school in terms of learning. Community is another aspect that needs to be included, because students relate to their community via rule, and the community relates to the object via division of labour (Roschelle, 1998).

Ekundayo (2012) brings the perspectives of teacher and student together to form an activity system. Table 2 below presents the elements of the activity system and their definitions in the context of this thesis, drawing on Ekundayo's definitions.

TABLE 2. Elements of the activity system and their definitions

Category	Definition	Elements of analysis
Subjects	The humans from whose perspective the activity is being explored	<ul style="list-style-type: none"> • Teachers • Students
Objective	The object of the activity is to teach and learn in class activities.	<ul style="list-style-type: none"> • Teachers imparting knowledge to their students • Students learning formally and informally
Tools	ICT and non-ICT tools that mediate the interaction between the subjects and the objects of classroom activity	<ul style="list-style-type: none"> • ICT tools (computers, mobile devices, e-learning materials, VLEs etc.) • Non-ICT tools (books, classroom infrastructure, learning supplies etc.)
Rules	Procedures and policies that mediate between the subjects and their community	<ul style="list-style-type: none"> • School rules • Curriculum
Community	The socio-cultural context and environment of the activity system	<ul style="list-style-type: none"> • Municipal and national education administration • School staff • IT managers • Parents
Division of labour	Differing roles and responsibilities work together to achieve the object of the activity.	<ul style="list-style-type: none"> • Teachers prepare learning materials, coordinate learning activities and assess students' performances • Students produce results which are expected to meet the standards set by the curriculum, while at the same time learning skills needed in society

Ekundayo's more holistic view of teachers, students and ICT as parts of an activity system offers a wider perspective to explore the use of educational technology, and will be used later in chapter 9 to sum up the results from the sub-studies through the lens of Activity Theory. Finding an appropriate theoretical approach that views these processes from a specific angle is helpful in providing researchers with a framework through which to study these phenomena.

The processes and phenomena that occur in educational institutions concerning teachers and students, teaching, studying and learning are multidimensional and varied. According to Lund and Hauge (2011) as the complexity of learning environments increase it can make difficult for teachers to plan or predict how learning activities are enacted in class. Educational technology has without a doubt added another part to the complexity. The next section will approach it from various theoretical aspects.

6 Research methodologies

The research described in this chapter was conducted at the primary, secondary and upper secondary educational levels in 2006–2011. The studies were reported in several research articles, five of which are included in this thesis (see Appendices). Three have been published in refereed international scientific journals and two in refereed international conference proceedings. In this chapter, I present the central methodological issues of the studies (see Tables 3 and 4), introducing the research questions, data, methodological approaches, theoretical framework and methods and analysis used. Overviews and discussions of the studies are taken up in chapter 7.

6.1 Research themes and questions

As mentioned in the introduction, there were some issues in the researcher's work as an e-learning coordinator that raised enough curiosity to initiate academic research on the following topic: Why did it seem that—after a decade of technological implementation in schools—educational technology was more or less used for supporting traditional pedagogical practices? Was it because of the lack of teacher education, attitudes or values of teachers/students, shortage of support or technical infrastructure, the shortcomings in ICT, software or VLEs with regards to motivating learning, lack of vision or the absence of leadership?

These general issues of interest were constructed into five sub-studies that were carried out in schools in western Finland, as described in Table 3.

TABLE 3. Research themes and questions

Aims and contributions	Research questions
<p>Study I Exploring students' attitudes toward ICT and VLEs in basic education</p>	<p>Does motivation, age or self-estimated level of success in learning make a difference to students' attitudes toward VLEs or ICT? Is there a difference in attitudes toward VLEs and ICT amongst students who like studying compared to those who do not?</p>
<p>Study II Exploring the impact of laptop provision on teachers' attitudes towards ICT</p>	<p>Do teachers who have a personal laptop computer have different attitudes towards ICTs compared with teachers who do not have one? Does gender have an effect on the attitudes of teachers within the comparison groups? Does teaching experience have an effect on the attitudes of the teachers within the comparison groups? Does being a classroom teacher or a subject-specific teacher make a difference in attitudes towards ICT?</p>
<p>Study III Exploring teachers' manners, proficiency levels and perceived values in implementing ICT in instruction</p>	<p>What is the frequency and manner of teachers' ICT implementation in Finnish basic education schools? Does the frequency of ICT use have an effect on teachers' teaching style? At what stage of ICT integration do teachers perceive themselves to be? What kinds of differences are there in the functional use of ICT and the proficiency levels of ICT use between primary and secondary teachers? What kinds of differences are there in how primary and secondary teachers perceive the values and cost of ICT use in teaching?</p>
<p>Study IV Exploring concept mapping in visual arts lessons</p>	<p>How well do students succeed in constructing concept maps from written material and lectures and how do their maps differ from a map constructed by an expert? How does a student's ability to understand reading material affect his or her ability to construct concept maps? How do students perceive and experience the use of the concept mapping method in their learning?</p>
<p>Study V Exploring the educational use of ICT from teachers' perspectives</p>	<p>How do teachers perceive the systemic support for using ICT in education as being organised? According to teachers, what are students' awareness of and potential for using ICT in studying and learning? At what level are teachers' ICT competence, frequency and functional use of ICT? Does teaching experience, teaching level or gender of teachers have an effect on these factors? From the teacher's perspective, are there factors causing contradictions or hindering the expansion of ICT use in teaching?</p>

The main research question of this thesis is as follows:

How do teachers and students perceive the role of educational technology in teaching, studying and learning processes?

The aim in study I was to explore basic education students' attitudes (N=758) towards ICT and VLEs, as well as to find out whether they see the benefits of new technological tools in promoting their learning. The following research questions were addressed:

1. Does motivation, age or self-estimated level of success in learning make a difference to students' attitudes toward VLEs or ICT?
2. Is there a difference in attitude toward VLEs and ICT amongst students who like studying compared to those who do not?

In study II, I had the opportunity to explore the impact of laptop provision on teacher (N=69) attitudes towards ICT. At the time, the practice of giving teachers laptop computers for their personal use was quite new in Finland, so it was interesting to get inside information about how this change would affect teachers. Study II focused on the following research questions:

1. Do teachers who have a personal laptop computer have different attitudes towards ICTs compared with teachers who do not have one?
2. Does gender have an effect on the attitudes of the teachers within the comparison groups?

Study III continued the analysis carried out in study II by focusing on teachers' (N=99) manners, proficiency levels and perceived values in implementing ICT in instruction. The main research questions were as follows:

1. What is the frequency and manner of teachers' ICT implementation in Finnish basic education schools?
2. What kinds of differences are there in the functional use of ICT and the proficiency levels of ICT use between primary and secondary teachers?
3. What kinds of differences are there in how primary and secondary teachers perceive the values and cost of ICT use in teaching?

Study IV brought students (N=11) back to the fore. As study I explored student attitudes, study IV concentrated on finding out how students would react when they were introduced to both new software and new pedagogical approaches in one of their school subject lessons, specifically concept mapping in visual arts lessons. The following research questions were introduced:

1. How well do students succeed in constructing concept maps from written material and lectures and how do their maps differ from a map constructed by an expert?
2. How does a student's ability to understand reading material affect his or her ability to construct concept maps?
3. How do students perceive and experience the use of the concept mapping method in their learning?

Study V took a more holistic viewpoint, looking at the educational use of ICT from the perspective of teachers (N=292) to identify various factors teachers might perceive to help or hinder the use of educational technology. Study V also mined for teachers' opinions about students' understanding and ability to utilise technology in learning. The main research questions were formulated as follows:

1. How do teachers perceive the systemic support for using ICT in education as being organised?
2. According to teachers, what are students' awareness of and potential for using ICT in studying and learning?
3. From the teachers' perspective, are there factors causing contradictions or hindering the expansion of ICT use in teaching?

6.2 Research methodologies

Table 4 below presents the methodological solutions of the sub-studies. The detailed descriptions are given after the table.

TABLE 4. Research design

Methodological Approaches, Methods, Data Sources and Analysis			Publications
Study I	<i>Socio-constructivist learning theory</i> Online questionnaire Students aged 7–13 (N=758)	Numerical data Quantitative analysis Statistical analysis: • Reliability analysis • Descriptive statistics • Variable analysis • T-test • Pearson’s chi-squared test	Refereed international conference proceedings: Sipilä, K. (2009). Students’ attitudes toward ICT and VLE in basic education. <i>Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications</i> (pp. 2304–2311). Chesapeake, VA: AACE.
Study II	<i>Bandura’s Efficacy theory, (Social Learning Theory)</i> Online questionnaire Teachers (N=69)	Numerical data Quantitative analysis Statistical analysis: • Reliability analysis • Descriptive statistics • Variance analysis • Cross-tabulation • Pearson’s chi-squared test	Refereed international scientific journal: Sipilä, K. (2010). The impact of laptop provision on teacher attitudes towards ICT. <i>Technology, Pedagogy and Education</i> , 19(1), 3–16.
Study III	<i>Expectancy-value theory</i> Online questionnaire Teachers (N=99)	Numerical data Quantitative analysis Statistical analysis: • Reliability analysis • Descriptive statistics • Analysis of variance • T-test • Pearson’s chi-squared test	Refereed international scientific journal: Sipilä, K. (2011). No pain, no gain? Teachers implementing ICT in instruction. <i>Interactive Technology and Smart Education</i> , 8(1), 39–51.
Study IV	<i>Gadamer’s Fusion of Horizons theory</i> Online questionnaire Students (N=11)	Numerical and textual data Concept maps Quantitative analysis Qualitative coding and analysis: • Colour coding • Content analysis • Concept analysis	Refereed international conference proceedings: Sipilä, K. (2011). Concept mapping in visual arts lessons. <i>Proceedings of the 4th International Network-Based Education 2011 Conference The Social Media in the Middle of Nowhere</i> . Ruokamo, H., Eriksson, M., Pekkala, L., Vuojärvi, H. (Eds.). University of Lapland, Rovaniemi, Finland. (pp. 106–111).
Study V	<i>Activity theory</i> Online questionnaire Teachers (N=292)	Statistical analysis: • Descriptive statistics • Frequency distribution • Cross-tabulation Quantitative and thematic analysis: • Transcribing, combining and cataloguing (themes and sub-themes)	Refereed international scientific journal: Sipilä, K. (2013). Educational use of information and communications technology—Teachers’ perspective. <i>Technology, Pedagogy and Education</i> . Published online. http://dx.doi.org/10.1080/1475939X.2013.813407 .

As the studies presented here evolved over several years and covered various fields of studies, it was necessary to use mixed methods in the studies, although the majority of the studies were carried out by using quantitative and statistical analysis. The first three studies focused on acquiring quantitative, statistical data and the

last two studies were about getting personal information from respondents by taking a more active part in school or analysing open-ended questions thematically.

The mixed methods approach has challenges. In mixed methods research, exact procedures and techniques of collecting and merging data have not yet been established; there is still an undefined 'grey area' in such research (Creswell & Plano Clark, 2007). In these sub-studies, the aim was to use methods that could provide a relevant understanding of the particular questions and to keep in mind the limitations and potential of the methods. The reasons for relying on multiple methodologies derive from multidimensional research tasks and from the fact that the researcher wanted to become familiar with the field of educational studies through a wide perspective.

6.3 Research data, methods and analysis

The research described in the sub-studies was conducted at the primary, secondary and upper secondary education levels in various schools in western Finland in 2006–2011. Online questionnaires were used as the data gathering method in all of the studies except study IV, where qualitative coding and analysis was also used.

The research data in study I consisted of 758 students' (N=758) responses to an online questionnaire. The invitation to take part in this questionnaire was originally sent to basic education students in 13 municipalities in Finland. Because of how the invitation to participate into the study was forwarded, it is not possible to state the response rate. The questionnaire comprised 5 background questions and 45 questions concerning motivation and the use of VLEs and ICT in learning. Twenty of the statements in the questionnaire were designed to measure students' attitudes toward using VLEs; 15 concerned motivation; and 10 concerned ICT.

The research data in study II consisted of 69 teachers' (N=69) responses to an online questionnaire. An invitation to take part in this questionnaire was originally sent to 196 teachers, which was the number of basic education teachers in Lieto at the time. The response rate was 31%. The basis of the questionnaire was the *Survey of Teachers' Attitudes toward Information Technology Questionnaire* (TAT v.3.2a), which was developed by the Institute for the Integration of Technology into Teaching and Learning (IITTL). The original questions were first translated into Finnish and then edited to suit the needs of the study. The final questionnaire had 168 questions that were divided into 12 different sections, which were Likert questions (e.g. 'To me multimedia is important – not important') and statement sentences (e.g. 'I want to learn a lot about computers') with answer options on a scale from one to five (*strongly agree – strongly disagree*). Both positive and negative types of questions were used randomly throughout the questionnaire.

The questionnaire used to collect data for study III was constructed based on the *Technology Implementation Questionnaire* (TIQ) developed by Wozney, Venkatesh and Abrami (2006). The original questionnaire was translated to Finnish.

The final version's first section had background questions and questions about the school's technical resources. Section II focused on teachers' frequency, manner and proficiency in implementing ICT in teaching. Section III included 19 belief items (values and costs) concerning the use of computer technology in the classroom. The data were collected with an online questionnaire, to which 99 teachers from five different municipalities in Finland replied. Due to the manner in which the invitation to participate was delivered, it is not possible to define the response rate. Descriptive statistics, frequency distribution, cross-tabulation, t-test, Mann-Whitney test, χ^2 test and one-way analysis of variance (ANOVA) tests were used to analyse data.

In study IV, the data were gathered through observation of students, analyses of personal documents and an online questionnaire. The following research provides an insightful look at the learning experience of a group of secondary school students (N=11) as they were taught to use the Institute of Human and Machine Cognition (IHMC) Concept Map (Cmap) software and guided in utilising it in their visual arts studies. These students were chosen based on voluntary participation in a visual arts course as a part of their 9th-grade studies.

Students were instructed to construct a concept map individually based on selected reading material. Another assignment was to build a concept map based on lecturing, text and a game on the Internet. Their success in constructing maps was evaluated by comparing their results to their score in a reading comprehension exercise, and by comparing their individual maps to an expert map constructed by their teacher. Finally, students' reactions and thoughts about the use of concept mapping in their learning were gathered in an online questionnaire.

In study V, the data were gathered with a questionnaire directed towards teachers in five Finnish municipalities. The questionnaire used to collect data for this study had five background questions (municipality, gender, teaching experience, school and teaching level). Fourteen Likert-type questions on a scale of 1 to 5 concerned overall systemic support, practices and goals of using ICT and students' potential and knowledge in using ICT in studying and learning. 27 questions were introduced in order to investigate how the respondents assessed themselves as ICT users and whether they hoped to have training in these particular types of competencies. One question was asked about the functional use of ICT. Many of the Likert-type questions had an open text field attached to them labelled 'Improvement necessity/contradictions'. Additionally, there were two open-ended questions asking respondents to describe things that would require improvement in technical and pedagogical support, e-learning material, in-service training and equipment/infrastructure. Respondents were also asked to define ICT factors that would need improvement from the school subject point of view. Finally, the respondents were asked to evaluate how often they had the possibility to provide students with computers.

In all of the studies, quantitative analysis of the research data was performed statistically with *SPSS*, a computer statistics program. Negatively oriented belief

statements were reverse coded after data collection to facilitate their interpretation. Missing data were replaced with the variable response mean. The consistency of the data was assured by looking at descriptive statistics, correlation coefficients and other statistical methods. Concept validity and the structure of the scale were assessed using factor analysis.

Thematic analysis was used in study IV to analyse the responses to open-ended questions in the questionnaire. This was done by representing a view of reality via systematically working through text from open-ended questions to identify topics. These were then progressively integrated into higher-order themes via the processes of de-contextualisation and re-contextualisation. Quantitative and qualitative analysis was used to explore teachers' perspectives and perceptions about using ICT more widely in education.

7 Overview and evaluation of the studies

The purpose of this chapter is to briefly introduce the findings from the sub-studies, and to evaluate and discuss the studies from a retrospective view. This chapter does not present the methodological choices or the data sets for the individual studies, as this was addressed in Chapter 6. The chapter also serves to familiarize the reader with each of the sub-studies without having to read their full reports, which can be found in appendices I-V. The results from individual studies are presented in Chapter 9, in which they are also discussed through the Activity Theory framework.

7.1 Study I: Students' attitudes toward ICT and VLE in basic education

SIPILÄ, K. (2009). STUDENTS' ATTITUDES TOWARD ICT AND VLE IN BASIC EDUCATION. IN G. SIEMENS & C. FULFORD (EDS.), *PROCEEDINGS OF THE WORLD CONFERENCE ON EDUCATIONAL MULTIMEDIA, HYPERMEDIA AND TELECOMMUNICATIONS* (PP. 2304-2311). CHESAPEAKE, VA: AACE.

This study represents the first step into the world of students as a researcher through forming an overall understanding about how educational use on information technology has been adapted into use by both educational institutions and students. As VLEs had changed the way networked computers were used in teaching and learning and it was becoming clearer that learning is not so much about the outcome of studying as the process itself, it was necessary to study how students in primary and secondary schools in Finland react to these theoretical, pedagogical and technological innovations. New technology opens up new possibilities for differentiated learning and a more student-centred approach to education. With VLEs, the student can be given alternative routes to learning based on his or her personal needs. They also give teachers more opportunities to modify their teaching and focus on the learning process rather than the learning outcome. One of the key factors in implementing new technology in schools is how motivated students are in using it: Do they see the benefits of new tools in promoting their learning?

The study showed that students who are not motivated to learn, or evaluate themselves to be less successful in their learning, do not seem to be as motivated by ICT or the use of VLEs as those students who are motivated and who perceive themselves as successful. These students value the use of ICT and VLEs. The simple explanation for this phenomenon could be that students consider the tools and methods used in school as a whole; when new tools are used to preserve old pedagogies, these new tools do not increase motivation to learn.

The study indicated that ICT alone is not enough to trigger the change for achieving better learning outcomes. Providing students with a VLE will not automatically result in in-depth learning (Earle, 2002). Technological tools must be profoundly integrated with the curriculum and pedagogically grounded in order to activate higher-order thinking in students. If a student lacks motivation to learn, drilling practices and tasks giving feedback may automatically result in student entering answers or values, waiting for negative feedback and then continuing with more guesswork. With ICT, it is possible to give students more autonomy in their learning, but at the same time, it is vital to provide scaffolding structures to contribute to the learning process.

The strength of the study relate to the large amount of responses to the questionnaire, which adds credibility. The study gave more intricate knowledge about how students of different age groups value using ICT in education and whether or not it motivates them in their studies.

The weakness of the study lies in the fact that the data collected with an online questionnaire was not objective; the questions and statements in the questionnaire were designed to collect views, not absolute facts. Nevertheless, the findings of the study emphasise the fact that when developing technological tools or pedagogical practices in order to enhance teaching and learning in educational institutions, it is always important to understand how students react to these changes.

This study was to be the first of the two conference proceedings articles to be included in this thesis. Since it was published in 2009, it is the first in the chronological list; my actual first study took a long route to travel from conference proceedings to a journal article published in 2010 and it is now presented here as the second study. As it was the researcher's intention to cover both students and teachers as subjects, and since teachers were studied in Study II (which was the chronological starting point for me as a researcher), it was natural to shift the view from teachers to students. To some extent, this study was still about finding a way to go deeper into the world of academic research. Nevertheless, the topic was very relevant at the time, since the use of VLE was stirring debate about its usefulness compared to cost efficiency.

7.2 Study II: The impact of laptop provision on teacher attitudes towards ICT

SIPILÄ, K. (2010). THE IMPACT OF LAPTOP PROVISION ON TEACHERS' ATTITUDES TOWARDS ICT. *TECHNOLOGY, PEDAGOGY AND EDUCATION*, 19(1), 3-16.

Study II was about teachers, their attitudes, and their actions that reflect those attitudes. Teachers' actions are based upon their belief systems. The key to change is in their belief that they have the power to produce change with their actions. Furthermore, in order to achieve certain outcomes, teachers need a strong sense of self-efficacy. Their perceived self-efficacy is a crucial link to the decisions that they make, which in turn will establish their teaching methods. Teachers must have an understanding of the change process before they are able to lead complex behavioural changes, such as using computers in the classroom.

As part of the latest ICT education strategy, Lieto, a small municipality in south-western Finland, decided to make an effort to provide a personal mobile laptop computer to every teacher. In 2006, teachers in four of the nine basic education establishments were provided with laptops. I had the opportunity to study the effects of this laptop provision. The aim of my second study was to investigate if there is a difference in attitudes towards ICT by teachers who have a personal laptop computer (provided by the employer) compared to teachers who have not. Once again, the research subject arose from the researcher's work by providing an opportunity to explore whether this kind of investment from municipalities would serve the purpose and have a positive effect on teachers. The results showed that it did.

The results revealed that those teachers who had a personal laptop computer provided were more positive in their attitudes towards ICT in education and ICT in general. Teachers with laptops had a much stronger belief in the value of utilising ICTs in teaching and learning, developing teaching methods, and developing their own professional skills with the use of ICTs. According to this research, providing teachers with laptops can be seen as a factor that can influence teachers concerning how they utilise mobile technology at work and in their spare time. This is consistent with other findings. Wozney et al. (2006) found that personal use of computers outside of teaching activities was the most significant predictor of teacher use of technology in the classroom.

Since the number of participating teachers was rather small, and the study was limited to teachers in the municipality of Lieto, this study does not draw conclusions about teachers' attitudes in a wider or general sense; instead, it suggests that providing teachers with laptops seems to be a step in the right direction. As Roschelle, Pea, Hoadley, Gordin and Means (2000) stated, an education system is like a locked puzzle: If you want to move or relocate one piece in the puzzle, it is only possible to do so if other surrounding pieces are evolving at the same time.

7.3 Study III: Teachers' manners, proficiency levels and perceived values in implementing ICT in instruction

SIPILÄ, K. (2011). NO PAIN, NO GAIN? TEACHERS IMPLEMENTING ICT IN INSTRUCTION. *INTERACTIVE TECHNOLOGY AND SMART EDUCATION*, 8(1), 39–51.

ICT-based tools should be fully merged with the social practices of teachers and students; only then are their intellectual resources genuinely augmented and learning achievements correspondingly facilitated (Hakkarainen, 2009). Teachers are the key players in this process, so it is important to understand how they adapt to the technological and pedagogical reform requirements presented by the curricula and educational theorists.

The purpose of this study was to investigate the differences between 99 Finnish primary and secondary teachers (n=99) in their frequency and nature of ICT use, levels of ICT implementation, functional uses and perceived values of the educational use of ICT.

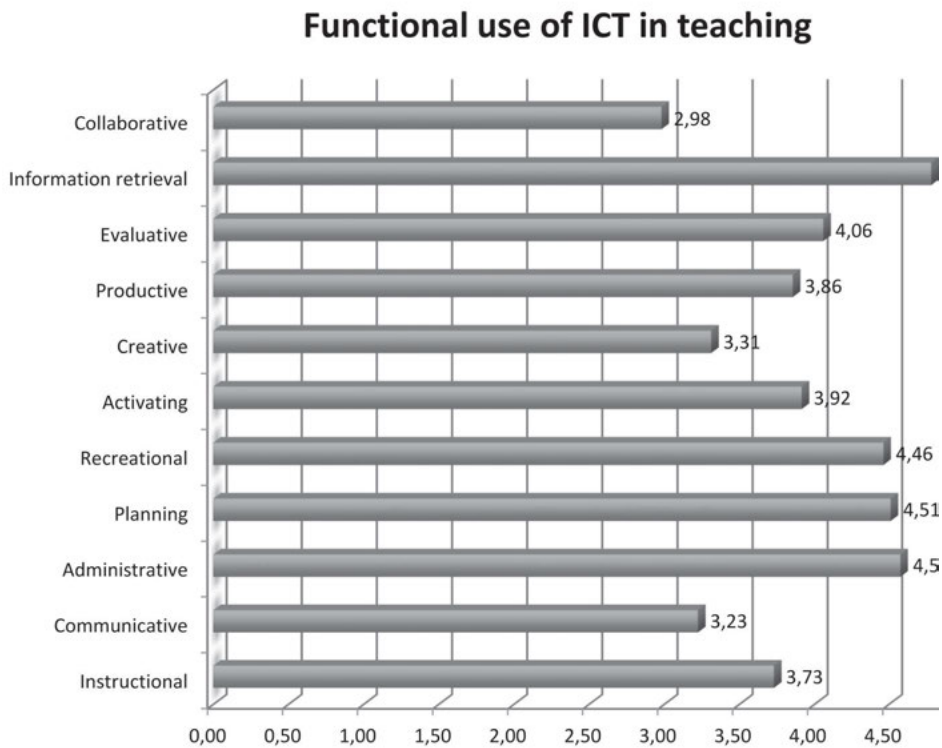


FIGURE 3. Teachers' mean values of functional use of ICT in education (n=99).

As Figure 3 demonstrates, it seems that teachers in primary education are still using ICT mainly for informational, organisational, evaluative and lesson-planning activities instead of communicative, activating, creative and expressive purposes. This result was evident in two separate studies presented in this thesis (study III and study V). Although the technological framework in schools is beginning to reach a fairly good level, pedagogical thinking in educational institutions has not advanced in parallel with technological development. Providing teachers with computer technology will lead them to integrate computers into teaching activities, which in turn will give them more support in their perceived proficiency in computer use and help them to advance in their stage of computer integration.

The systemic support, technical framework and basic ICT competence of teachers have clearly taken steps forward, but the large-scale leap in learning ignited by technology is yet to come. After almost two decades of ICT implementation in schools, there are still contradictions between the formal structure of educational institutions (national development processes, curriculum, teacher training) and daily classroom practices (teaching, studying, learning). Theory and practice need to come closer together.

According to this study, primary and secondary teachers differed drastically in their views about the expectancy of cost and perceived value in implementing ICT in teaching. Secondary teachers' value-cost ratio is not as value-orientated as that of primary teachers; secondary teachers do not expect to gain as much from ICT as primary teachers do.

Utilising self-reported measures of computer use, proficiency levels and stages of integration means that the data collected will not be objective information, thereby affecting the reliability of analysis. Finally, the relatively small sample size (N=99) does not encourage making wide generalisations; this was a clear setback, as the sample size was originally expected to be substantially larger. The original decision to use the five municipalities in question to collect data was made because the schools in these municipalities represented different stages of VLE use, and this would have offered another interesting factor to analyse in the results. As the sample size collected did not meet expectations, this aspect of the study had to be rejected.

7.4 Study IV: Concept mapping in visual arts lessons

SIPILÄ, K. (2011). CONCEPT MAPPING IN VISUAL ARTS LESSONS. IN H. RUOKAMO, M. ERIKSSON, L. PEKKALA, & H. VUOJÄRVI (EDS.), *PROCEEDINGS OF THE 4TH INTERNATIONAL NETWORK-BASED EDUCATION 2011 CONFERENCE, THE SOCIAL MEDIA IN THE MIDDLE OF NOWHERE*, UNIVERSITY OF LAPLAND, ROVANIEMI, FINLAND, 106–111.

Study IV was a case study where 11 Finnish secondary school students were introduced to the use of concept mapping software as a tool in their visual arts lessons about National Romantic style. The intent was to create and then evaluate changes in the way technology is used and how students regard the use of concept mapping in learning. The methods of observation of students, analyses of personal documents and an online questionnaire were chosen from the action research strategy.

The theoretical framework of this study was based on Gadamer's (1979) conception of understanding to be a process of the 'fusion of horizons', which involves the formation of a new context of meaning that enables integration of what is otherwise unfamiliar. In Gadamer's view, understanding is essentially a matter of conceptual articulation where primacy is given to language and conceptuality.

The subjects of this research consisted of a group of eleven 9th grade secondary school students, aged 15 years, who had all chosen a course in visual arts as one of their voluntary courses. The qualitative part of the case study was employed during a one month time period, over which the students learned to use the software. Through the teacher's eight lessons, they came to understand the basics of concept mapping by constructing a map with some superordinate terms from a given topic and studying the given assignments. The researcher's role was that of an on-site participant-observer during those lessons.

The small group of students who took part in this study found it easy, favourable and useful to employ concept mapping techniques and software as a means of learning. The results were encouraging and further supported the idea that concept mapping, with the aid of computer software, could be one of the first 'killer applications' that can unite computer technology seamlessly into the learning process, bring the pedagogically grounded use of ICT into classrooms and promote learning through conceptual changes. With concept mapping, students are able to view, refine, edit and share their knowledge 'horizon' in a way that was not possible before.

In order to use ICT in formal teaching through the modern conception of learning as a social constructivist activity, teachers should use student-centred approaches in their teaching. This is where concept maps would have an important role; it is imperative to obtain more knowledge about how students react

when the introduction of a new way of conceptualising ideas influences their traditional learning styles and ways of constructing knowledge.

The weakness of the study lies in the fact that the amount of students taking part in utilising concept maps in their learning proved to be small. The fact that only 11 students were going to choose this particular voluntary course was not known when the instruments and the study as a whole were designed. As the results were so positive, it would be interesting to duplicate the research with larger group of students.

On the other hand, the strength of this study is that it united using both new technology and new pedagogy in teaching, studying and learning. The study was able to provide implications that students come to realise how pedagogically grounded methods combined with software could affect their learning. ICT should only be implemented in education if it adds something new to teaching, studying or learning.

7.5 Study V: Educational use of ICT from teachers' perspectives

SIPILÄ, K. (2013). EDUCATIONAL USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY—TEACHERS' PERSPECTIVE. *TECHNOLOGY, PEDAGOGY AND EDUCATION*. PUBLISHED ONLINE. [HTTP://DX.DOI.ORG/10.1080/1475939X.2013.813407](http://dx.doi.org/10.1080/1475939X.2013.813407).

The fifth and final study was devised in order to gather more profound views from teachers with regards to the implementation of ICT in education, and to determine whether there were any tensions or contradictions that, in their opinion, lessened the opportunities for successful ICT implementation. This study investigated teachers' perceptions of how ICT is being incorporated into teaching and learning, the level of teachers' digital competence and what factors, in their opinion, might be hindering the use of ICT in schools. In study V, 292 Finnish teachers (N=292) took part in the survey. The quantitative approach was chosen as a basis for this study and an online questionnaire was used as the data-gathering method. Data gathering was conducted on three occasions in 2011. The data were gathered with a questionnaire directed to teachers in five Finnish municipalities. Activity Theory was chosen as the pedagogical framework and thematic analysis was used to identify, analyse and report patterns (themes) within the data. The results were analysed through AT in order to find possible contradictions.

Figure 4 below illustrates contradictions teachers experienced in their work with regards to utilising ICT in education.

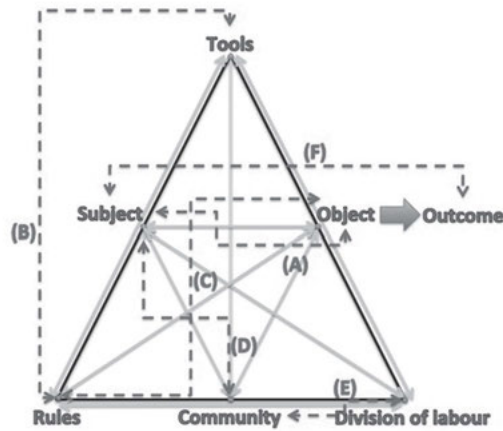


FIGURE 4. Contradictions stated by the respondents illustrated from the Activity Theory perspective.

Figure 4 illustrates that there are several contradictions still prevalent among different components, as illustrated using AT. It seems to be unclear to teachers what is being sought by integrating technology into classrooms (A: subject-object). Nor is it clear what the final outcome should be (F: subject-outcome). Teachers seem to think that increasing the amount of technological equipment in classrooms and increasing training for teachers would solve the current issues (B: rules-tools). On the other hand, teachers do realise that technology alone does not trigger change in the operational culture of educational institutions; there is a need for new kinds of pedagogical methods as well (C: rules-object; D: subject-community). Schools are in need of joint efforts, collaborative knowledge-building and shared experiences in order to focus as a community on how to further develop the use of ICT at school to foster learning (E: community-division of labour).

At the moment, teachers in general do not have the means or knowledge to fully use ICT to promote learning. There are still technological issues to be solved. At the school level, it is unclear what direction the school should take as an organisational entity. Hands-on guides are needed to clarify what to do with ICT in specific subjects. ICT should be seen as a mediating tool instead of an extracurricular subject. As teachers are starting to integrate Web 2.0 tools and mobile technologies into more or less traditional learning methods, curricula and everyday school life, this presents new challenges related to supporting collaborative learning (Arvaja, Hämäläinen, & Rasku-Puttonen, 2009).

This study indicated that half of the teachers who took part considered themselves to be both unqualified and unprepared to use ICT in education in a way that would add value to teaching and learning. It also presented evidence for the notion that a teacher who has advanced digital competence will frequently use ICT in education. The systemic support, technical framework and basic ICT com-

petence of teachers have clearly taken steps forward, but the large-scale leap forward in learning ignited by technology is yet to come. After almost two decades of ICT implementation in schools, there are still contradictions between the formal structure of educational institutions (national development processes, curriculum, teacher training) and daily classroom practices (teaching, studying, learning).

The study also provided evidence in line with earlier studies: Male teachers are more likely to perceive themselves as having higher levels of ICT competence. Educational technology has the tendency to attract male teachers in general.

This study was originally devised to gather a large amount of data by inviting teachers from several municipalities in western Finland to take part in a survey. The potential number of respondents was over 1,000, but as often happens, the potential is not the same as reality. Still, the 292 respondents produced a substantial amount of data that provided the possibility to make conclusions about how teachers today see the usefulness of ICT being implemented. This paper addressed the issue from several viewpoints: identifying factors seen by teachers as affecting the development of ICT competence, its integration in teaching and learning, finding out specific details as to how well teachers perceive the overall process of the handling of ICT integration into education in their school, what in their opinion are the obstacles hindering the process and determining teachers' levels of ICT implementation and the manner of teachers' technology use in instruction and teaching practices.

Activity Theory proved to be an appropriate conceptual and methodological tool in this study. It provided a possibility to systematically analyze the various elements in the research context. The use of AT allowed both a theoretical and practical examination of the implementation of ICT by providing a structure for examining the factors that teachers felt would assist or hinder the use of ICT in education. AT was particularly appropriate in its ability to explore and explain the ongoing interaction that occurred between various elements in the activity system. Using AT as a lens to study the impact of technology on educational settings led to results that might be valuable in improving understanding about the deployment of technology at a school level.

8 Summary of the results through Activity Theory

The main research question of this thesis was:

How have teachers implemented and experienced the use of ICT in their educational practices, and how do students regard these developments in their studying and learning?

This research task was covered through five empirical studies that all had a different approach and sub-questions to produce an overall picture of the main issue. The key findings of the five sub-studies were introduced in chapter 1 (Table 1) and were covered more thoroughly in chapter 7. In this chapter, the results are looked at holistically through the lens of Activity Theory. The contradictions and tensions that were found in the studies are seen, through the lens of AT, as possibilities for improving processes in activity systems. These possibilities will be presented in Table 5 below. The activity elements and the findings are also discussed in the light of current research literature.

TABLE 5. Findings seen as possibilities to evolve different dimensions of the school's activity system through AT.

Dimension	Possibilities	Prerequisites for realisation
Subject: <ul style="list-style-type: none"> teachers students 	Teachers benefit from new technology in preparing and executing teaching practices as well as evaluating learning outcomes. Students are more motivated and engaged in learning.	IT infrastructure is working; teachers' proficiency levels and attitudes towards ICT are positive; teachers value the use of ICT as adding value to their work. Students have ubiquitous access to technology, have sufficient ICT skills and possess positive attitudes towards learning.
Object: <ul style="list-style-type: none"> succeeding in teaching attainment of curriculum outcomes 	Teachers embrace the use of ICT as a factor diversifying their teaching methods and even resulting in higher order learning. Students can use ICT to collaborate and elaborate their studies and enhance their learning results.	Teachers need to experience good practices from real life ICT utilisation examples first hand; theoretical models are not sufficient. Students should be accustomed to novel learning methods as early as possible; their perception of how school should be can be very traditional.
Tools: <ul style="list-style-type: none"> devices software IT infrastructure e-material 	Ubiquitous computing tools enable teachers and students to utilise ICT diversely in teaching, studying and learning processes.	Functioning IT infrastructure requires financial contribution from schools, municipalities and national level.
Rules: <ul style="list-style-type: none"> curriculum 	Curriculum with pedagogically grounded ICT implementation examples and pedagogical models scaffolds teachers in relation to ICT use.	Pedagogically grounded ICT implementation with examples and pedagogical models are written into the core curriculum.
Community <ul style="list-style-type: none"> teachers students principal 	Teachers and students are active participants, engaged in evolving the operational culture of the school collaboratively with the help of ICT.	The principal has to be committed to actively developing collaboration. The school, as an expert organisation, must embrace openness and knowledge sharing.
Division of labour: <ul style="list-style-type: none"> Training resources Pedagogical/ technological support 	Bottom-up approach with work-based learning and continuous teacher-centred team-based learning promote teachers' professional agency and development.	Teachers and students realise that modern teaching and learning methods enhance learning. Concrete, practical tutorials and good practices are nationally produced and made available for utilisation.

8.1 Subject

Teachers need to have an understanding about how to incorporate ICT into education using the appropriate pedagogical teaching methods, as well as the right learning materials and tools. Study III revealed that teachers do not believe that they possess the abilities or skills to utilise educational technology to its full extent. The development of pedagogical content knowledge is central to the discussion of the ways in which teachers represent the knowledge, skill and understanding of the curriculum context and ICT capability to learners of different ages, learning styles, motivations and interests (Loveless, DeVoogd, &

Bohlin, 2001). TPACK arises from multiple interactions among content, pedagogical, technological, and contextual knowledge. It encompasses understanding and communicating representations of concepts using technologies; pedagogical techniques that employ technologies appropriately to teach content in differentiated ways according to students' learning needs; knowledge of what makes concepts difficult or easy to learn and how technology can help redress conceptual challenges; knowledge of students' prior content-related understanding and epistemological assumptions, along with related technological expertise or lack thereof; and knowledge of how technologies can be used to build on existing understanding to help students develop new epistemologies or strengthen old ones (Harris, Mishra, & Koehler, 2009).

Teachers need to master innovative teaching practices. Innovative teaching supports students' developments of the skills that will help them thrive in their future life and work. Teachers should use practices that have been shown to have strong relationships with 21st-century learning outcomes; student-centred pedagogies that promote personalised learning; ways to extend learning beyond the classroom; and ICT integration into pedagogy as a tool to enhance learning (Shear, Gallagher, & Patel, 2011). Hattie (2009) identified the following teaching practices as the five most effective: teachers enabling students to learn and use self-learning, specific responses to student work, use of self-verbalisation, metacognition strategies and problem-solving teaching. ICT can be used successfully in all of these practices. Innovative teaching is any kind of teaching which addresses creativity and applies it to methods and contents and includes both the processes of teaching for creativity and teaching creatively (Ferrari et al., 2009): The former term refers to any teaching that tries to develop learners' own creative thinking and performance, whereas the latter has to do with the implementation of innovative teaching practices to make learning more interesting and effective.

Gilbert (2009) stated that the role of a 21st-century teacher is to help young people learn where to find knowledge; to know what to do with it when they get it; to differentiate good knowledge from bad knowledge, to know how to apply it, synthesise it and be creative with it; to add to it; and to know which bit to use and when and how and to remember key bits of it.

8.2 Object

Technology cannot improve organisational performance or learning if it is not used. The main focus in schools should centre on how teachers can be assisted in using ICT more frequently and effectively in terms of learning in their classrooms. If ICT could be introduced and used by teachers in a format that generated positive feelings regarding its perceived usefulness and perceived ease of use as a teaching and learning resource, it is arguable that this would assist in encouraging positive attitudes towards ICT use as well as actual ICT use in classrooms.

Teachers are sometimes criticized for having negative attitudes towards the pedagogical use of ICTs, applying pedagogical methods that embrace old-fashioned and established habits, and for resistance to renewing their practices through critical self-assessment (Lin, Singer, & Ha, 2010). This became evident also in studies III and V.

When we are about to make changes to educational structures, it should be remembered that it is the learner who should be everyone's main concern. Every change that we make in the context of learning should be made so that learning is promoted, both at the individual and systemic levels. ICT in education is not ultimately about what kind of technology is provided to teachers; rather, it is about having the right kind of equipment on hand for the learner and providing him or her with pedagogically grounded learning methods and tools.

8.3 Tools

The expectation that teachers will utilise ICTs in schools is reasonable only when the technical infrastructure, equipment and support are available and sufficient. Study II yielded evidence that teachers' attitudes can be made more positive towards the use of technology if they are provided with technological tools. Making pedagogical decisions about how to teach is not purely routine thinking; pedagogical thinking guides the decision-making process when a teacher is choosing from different options in order to achieve certain goals. If a teacher has the ability, means and skills to easily adopt technology in teaching and learning, ICTs will increasingly be used in schools. Providing teachers with laptop computers and with technical and pedagogical support will affect a teacher's readiness and willingness to bring ICT to students; in order to achieve this, it is necessary to provide ICT as part of the infrastructure of a school. Technological infrastructure must be implemented at a sufficient level. Lund and Hauge (2011) state that teacher's creativity, subject content knowledge and ability to react to sudden challenges are important qualities, but these are not sufficient to turn complex learning environments into productive teaching environments. They continue by arguing that designs are needed in order to offer support for teachers as they plan, device and orchestrate tasks, activities and resources.

New technologies open up new possibilities with regards to teaching, studying and learning. Mobile devices, cloud-based documents and a whole new generation of educational applications have placed learning much more firmly in the control of students, giving them scope to work and collaborate with whom they want, whenever they want; these developments are not going to do away with the need for teachers, but they are going to call for a new pedagogy (Steed & Knight, 2012). The new classroom pedagogy needs the teacher to step back from imparting knowledge from the top of the classroom and instead teach children internet search skills, critical thinking, problem solving and decision making, communica-

tion and presentation skills, among other things: Teachers mediate student learning by enabling them to create new knowledge either collaboratively or independently and helping them to acquire meaning from their learning (Lydon, 2012).

Study I implied that the motivational factor of educational technology will fade away amongst students if the use of those tools is not pedagogically grounded. As mobile technologies, including tablet computers, have now been introduced to schools, things are about to change. Study IV, on the other hand, indicated that if students are introduced to a learning method that is supported by a specific software (concept mapping), students understand the possible positive effect this can have on their learning.

Mobile learning through wireless mobile technology allows anyone to access information and learning materials from anywhere and at any time (Ally, 2009). Personal, mobile and wireless technologies are already a part of the lives of learners, while the development of social media has led to new ideas about what it means to participate in educational activities (Lewis, Pea, & Rosen, 2010). Despite a rapid development of mobile technology and widespread enthusiasm, it is a fact that mobile learning has not yet seriously impacted education and the projects addressing the adoption of mobile ICTs in schools can still be regarded as spearheads (Pozzi, 2007). There are various handheld devices currently available for mobile learning, which vary in relation to the different handheld technologies embedded in them, such as the iPod, PDA, smartphone and laptop. Education technologies, including mobile learning, online learning and conventional face-to-face learning, are integrated in accordance with their respective advantages, in which mobile learning appears to be a bridge and therefore forms a new style of blended learning (Liu, Liu, & Yu, 2008). The nomadic learner and worker who travel frequently from place to place will similarly use mobile technology to access information and learning materials from anywhere and at any time (Ally, 2009). Mobile technology empowers students to source data, construct interpretations and write their own material based on the data they have retrieved. With mobile technology, students are able to learn at their own pace; moreover, they are provided with the means to be productive and creative, and they can work collaboratively or independently and be more engaged with learning. The increasing use of mobile social media in education is stitching learners' formal and informal learning contexts together and bridging individual and social learning, which is leading towards seamless learning (Laru, 2012).

There is an increasing focus on effective personal learning environments as characterised by a pool of technology devices, software and services; access to variety of digital tools simultaneously for anyone, anywhere, anytime; and choices about which technology is most appropriate in a given situation (Dabbagh & Kitsantas, 2011). A student has a personal relationship with the use of technology. This should be taken into account in schools; a personal mobile device enables students to use technology in learning seamlessly and to form a Personal Learning Environment (PLE). A PLE is not only about software or tools.

Rather, it is as a set of learning tools, services and artefacts collected from diverse backgrounds and environments to be used by people in their formative actions (Almenara & Diaz, 2012). Fiedler and Pata (2009) defined PLE as a collection of tools, materials and human resources which a person knows and has access to in the context of an educational project at a given point in time. There is a strong pedagogical perspective in the philosophy of the PLE concept, as it focuses on the autonomy of the learner and self-directed learning. The PLE is something that one builds autonomously to suit one's own needs and fulfil the type of learning one wants to pursue. This pedagogical perspective challenges the usual one applied in a VLE (Charlier, Henri, Peraya, & Gillet, 2010). PLE is adaptable to learner's needs. Learning is something that is controlled by the learner, not by teachers or developers.

Learning environments of the future will be integrated, with a variety of spaces and services, contact teaching and digital tools, as well as internet- and mobile-based working and learning platforms dovetailing together; the seamless fusion of pedagogic and psychological know-how and technology supporting active learning and inclusive methodology is important (Lonka, 2012). Constructivist learning involves learning that is enhanced and mediated with appropriate tools, activating both students and teachers to participate in the process of learning (Dabbagh & Kitsantas, 2011). We need to grow towards a learning environment where digital services and devices are ubiquitous and available to learners whenever they are needed.

8.4 Rules

ICT should be infused throughout the entire curriculum in teacher education institutions so that pre-service teachers have the opportunity to (a) understand the educational reasons for using ICT, and (b) experience how ICT can support teaching and learning across different subject domains (Tondeur, Roblin, van Braak, Fisser, & Voogt, 2012). Without such integrated approaches, the knowledge and the skills pre-service teachers gain are likely to remain isolated and unexploited (Polly et al., 2010). There is a need for a more holistic view of ICT and education. It is important to realise that different disciplines have different practices, needs and ways of learning: Teachers need to obtain diverse knowledge about technology, pedagogy and content that is subject related. Educational technology changes more than the tools used.

The way forward in developing pedagogical practices in schools could be about changing the ways students are assessed during their learning processes and questioning who should be making the assessments in practice. As study III showed, teachers are more inclined to use ICT tools in, for instance, evaluative tasks, thus using new technology to support old pedagogy. The change could mean focusing on the students' strategies in using mobile technology as a tool for

thinking and interacting with others, and for searching, processing, and producing information (Häkkinen & Hämäläinen, 2012). The challenge in this kind of assessment is that it has to cross disciplines and reach beyond strict consideration of the mastery of contents.

8.5 Community

Systemic change provokes actions that promote the development of the school system as a whole: Effective implementation of change calls for a clear vision, strategic intent and strategic leadership (FNBE, 2011). The Finnish National Plan for Educational use of ICT lays out strategic plans for all schools to make diverse use of ICT in education and in support of learning: updates of schools' infrastructure and equipment, cost-efficient technical solutions, of high quality and chosen with due consideration for the perspective of sustainability (FNBE, 2011). In addition to an effective infrastructure and equipment, all schools also need to be provided with adequate technical and pedagogical support services.

The Finnish national core curriculum is currently undergoing a renewal process, where the curriculum should be put in place in use in two to three years. Because the core curriculum includes the objectives and core contents of different subjects, the principles of a good learning environment, working approaches and the concept of learning, it has a crucial effect on our school's operational culture. Studies III and V give support to the idea that, even though systemic top-down driven change is said to be essential to promote the development of the school system as a whole, it is not adequate to launch substantial, widespread change in schools' activity systems. There is a need for bottom-up change processes as well. Changes also require an operational culture where the performance objectives for different areas are clearly defined and resources are allocated to guarantee achievement of the objectives (Leviäkangas, Hautala, Schneitz, & Lim, 2010).

On a local level, education providers (municipalities) and schools are renewing their educational technology strategies in order to meet the requirements set in a national strategy and plan. If the national plan and core curriculum do not deliver technological standards, pedagogical guidance, financial support and teacher training programs at sufficient levels nationally, it will be up to individual municipalities' priorities and funds to support the integration of ICT into education. Leaving development to individual municipalities would only lead to increased inequality in education, as opposed to the aim of the Basic Education Act: The goal of education shall be to secure adequate equity in education throughout the country.

Besides enhancing learning in school subjects and developing students' collaborative and communicative skills through cooperation between home and school, ICT should also be used at school to develop citizenship and learning-to-learn skills. The aim is to develop pupils' proficiency in applying information in every-

day school life and outside school (Tuomi et al., 2010). In addition, ICT may be used to consolidate pupils' roles in support of planning studies, identifying their own learning styles and self-assessment (Korhonen & Lavonen, 2010).

Educational institutions and ecosystems have to evolve in order to meet the demands of the society and students. The systemic change of education means changes in policies, funding, school leadership and framework, curriculum and teaching practices, with the focus on the learner. While the public education system was remarkably effective at meeting educational needs during the industrial age, it is fundamentally inadequate for meeting our vastly different educational needs in the information age and beyond (Duffy, Rogerson, & Blick, 2000). Even though we have moved into the information age, the basic ideas about what schools are and should be like are still coming from the previous era. We have been acculturated to view schools in a certain way, and until we can evolve our mental models of what schools should be like, we will not achieve fundamental changes in education (Tyack & Cuban, 1995).

8.6 Division of labour

Teachers should have a mentor, teacher educator or expert present at the school when, for instance, they are going through a process of developing their ICT proficiency. Such a person acts as facilitator in the development of reflection. What characterises the facilitator is his or her mastery of a public language to describe the practice and learning of teachers, their ability to engage in constructive dialogue with teachers about their work, to help teachers take charge of their own learning and their occasional withdrawal of support at appropriate times so that teachers can develop independence (Calderhead & Gates, 1993).

According to Richardson and Placier (2001) the top-down approach to change is considered to be painful and difficult for teachers who are expected to implement externally generated ideas in their classrooms. Traditional staff development interventions fail when brought in from external agencies introduced briefly and have limited follow-up activities. Richardson and Placier went on to state that in the bottom-up approach, the change comes from the autonomy, growth and problem-solving ability of people who make up the system, that is, the teachers.

9 Implications and discussion

Based on the results that emerged from the sub-studies presented in this thesis, I argue that a national top-down change process with regards to implementing ICT into education has not sufficiently succeeded to provoke major, sustainable changes in operational culture of schools. Based on the results presented in this study, Table 6 below presents overall initiatives and proposals for actions in order to make way for a more enhanced use of ICT in education. These initiatives do not all arise from the results of the sub-studies, but are introduced here because they are all seen as important aspects of the diverse activity system of a school.

TABLE 6. Initiatives for actions

INITIATIVE	SPECIFICATIONS	GOAL	PROCEDURE
Bottom-up approach with in-service teachers with emphasis on teacher's professional agency development	Work-based learning Teacher-centred team-based learning Mentor-teacher system	Teachers and students are active participants, engaged in evolving operational culture of the school.	Pedagogical models are produced from empirically successful implementation processes that have been done by the teachers at the schools.
Changes in pre-service teacher training	Pre-service teachers lack necessary basic training on educational use of ICT during their studies.	Teacher students are systematically brought up-to-date on their knowledge of educational ICT use.	Modernisation of degree requirements with media education, diverse ICT skills and pedagogical use of ICT.
Curriculum changes	The current curriculum does not provide tools for teachers to implement ICT into education.	Pedagogically grounded ICT implementation with examples and pedagogical models is in written into the core curriculum.	National core curriculum renewal group implements the necessary inserts into the new core curriculum.
Equality between schools	National quality criteria for the minimum technical infrastructure of schools.	Ensuring that every student has equal opportunities to utilise ICT in schools.	Added financial support to those municipalities that cannot afford to provide technology to schools.
Pedagogy first	The change in operational culture of school does not happen with technology only.	Pedagogically grounded, learner-centred teaching methods that include the use of ICT as a mediator are implemented.	Concrete, practical tutorials and good practices are nationally produced and made available.

Educational institutions are not traditionally considered to be spearheads of evolution, but rather to be one of the last places to react to changes that are happening outside of the school. If we look at how classrooms have changed in the last century in terms of their physical environment, we realise that there is almost no difference. Pedagogical changes have also been minor. Technology has brought an x-factor to classrooms, a factor that has the potential to trigger change in what kind of environment a school needs and how learning is enhanced from teachers' and learners' points of view. We know that technology alone does not trigger the change, but if it is implemented into education in a pedagogically grounded way and with physical solutions that encourage active and constructivist learning, we will be on a path that will lead to change.

The first decade of the 21st century has brought rapid evolution into pedagogical thinking in education, often assisted by technological advancements. When the studies presented in this thesis were conducted, there were various technologically assisted pedagogical trends that were more or less becoming accepted and more widely used in education. The world is entering the age of mobilism (Norris & Soloway, 2011). The diffusion of ICT is a complex phenomenon, but one that has significant consequences for individuals and organisations; its complexity arises from the multifaceted nature of the interaction between the technology and the context in which it is embedded (Dutta, Roy, & Seetharaman, 2012).

At the moment, technological and social change and globalisation are exponentially accelerating. The knowledge society needs workers whose main capital is knowledge. What differentiates knowledge work from other forms of work is its primary task of 'non-routine' problem solving that requires a combination of convergent, divergent and creative thinking (Reinhardt, Schmidt, Sloep, & Drachsler, 2011). The comprehensive nature of knowledge work in today's connected workplace requires virtually all workers to obtain these skills at some level; this has led public education and systems to become increasingly focused on life-wide and lifelong learning in order to ensure that students receive skills necessary to be productive knowledge workers of the 21st century. Moravec (2008) defines this new breed of worker on the basis of an old hunter-gatherer, nomad, as it is evolved to a knowmad—a creative, imaginative and innovative person who can work with almost anybody, anytime and anywhere. Whereas industrialisation required people to settle in one place to perform a very specific role or function, the jobs associated with knowledge and information workers have become much less specific in regard to task and place.

Metacognition, self-evaluation and information and digital literacy are identified as essential learning skills that pupils need to take advantage of technology's potential of enhancing exploratory learning (Yang, 2012). Yang also stressed the importance of information and digital literacy. The learner of tomorrow will be characterised by greater personalisation, creativity and engagement. These new technologies make it possible for young people to find the learning

style that is most suited to them and to progress at their own rate to the final goal (Steed & Knight, 2012).

The results of the studies presented in this thesis support earlier studies in showing that although technology has found its place in schools in Finland and new ways of integrating ICT into education are being used, we cannot speak about a radical change. However, the beginning of the 21st century's second decade has brought a leap forward in what kind of technology has been employed in classrooms. Various mobile devices such as tablets and other media devices and new applications that utilise new technology in an innovative way are finally making it possible to bring into action the visions of how ICT could someday evolve teaching, studying and learning. It is finally beginning to be possible to push education further with the aid of technology, pedagogy guiding the change. We can produce pedagogical models that take technology into account and provide appropriate procedures. Still, the educational system is a large vessel, and turning its direction will require time and effort.

Now that we really are moving into a more ubiquitous use of technology, the devices will be available in learners' learning environment on a 1:1 basis; the future will show how this change will affect teaching and learning, as well as learning results and motivation to learn. As it is finally possible to utilise a mobile device that offers more unique, personalised and versatile means to enhance learning with technology and use them as easily as traditional books, pencils and so on, this leap will be an important evolution to study further.

9.1 Methodological evaluation

The use of several theoretical approaches in the five sub-studies presented in this thesis was deliberate, and offered a way for me to familiarize myself with the field of educational research through a multi-coloured lens. At the same time, I realized that once a theoretical framework is chosen to interpret the results of an individual study, it narrows down the perspective from which the results are interpreted.

The research methods used in the sub-studies were largely about using online questionnaires and analyzing the results statistically. Choosing more versatile methodological approaches would have helped me to achieve, for example, triangulation of methods, but I wanted to stay on the path that I had originally chosen because I believed that statistical analysis would serve me better in exploring the use of educational technology from teachers' and students' points of view.

One criticism of the validity of the sub-studies may be that teachers are replying to questions as they think they are supposed to. Another area for criticism could be that the researcher was known to some respondents in some of the studies. However, I have a strong belief that Finnish teachers are being honest in their answers; this belief is substantiated by the fact that there were statisti-

cally significant differences found in many of the results, and also by the fact that among attitude questions, for example, there were great differences between teachers.

Going through the journey of publishing five peer-reviewed articles in international journals and conference proceedings was not in any way easy. Throughout the process of researching, processing and writing the sub-studies and this thesis, the manuscripts of the articles and of this introduction have been reviewed by several readers: my supervising professor, reviewers from journals and conference committees, participants in conferences, fellow PhD students in doctoral courses and even friends. All of these have been immensely helpful in providing constructive feedback and suggestions on how to improve the quality, validity, and reliability of my work.

9.2 Future studies

As I have mentioned earlier, the introduction of mobile technology and tablet devices has had an irreversible effect on what the future of educational technology looks like. At a time when technology is becoming ubiquitous in schools' everyday activities, there are unique opportunities to study this stream of change. The initiatives that I introduced in Table 6 provide a plentitude of possibilities to study, but my personal interests lie in studying bottom-up change processes, as I have already witnessed in practice how this kind of change process does mediate change effectively in schools.

Another point of interest as a researcher is to study further whether introducing mobile technology combined with the evolving physical environment of the learning environment, the enhancement of pedagogical methods and introducing e-books would have an effect on students' motivation and learning. As the core curriculum is currently being renewed, it will be interesting to see whether it will be able to meet the demands of the rapidly changing technological environment and the pedagogical thinking behind the use of educational technology. Will the new curriculum be able to provide a norm combined with allocating resources in order to guide pedagogical and technological change towards the correct path in practice? Or will it remain only able to offer theoretical guidance, detached from schools' reality? That remains to be seen.

References

- Adeyemon, E. (2009). Integrating digital literacies into outreach services for underserved youth populations. *Reference Librarian*, 50(1), 85–98.
- Albirini, A. (2006). Teachers' attitudes toward information and communication technologies: The case of Syrian EFL teachers. *Computers and Education*, 47(4), 373–398.
- Almenara, J. C., & Diaz, V. M. (2012). ICT training of university teachers in a personal learning environment. Project DIPRO 2.0. *New Approaches in Educational Research*, 1(1), 2–6.
- Anderson, R. (2008). Implications of the information and knowledge society for education. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 5–22). New York: Springer.
- Anyan, J., Owens, C., & Magoun, D. (2000). The effects of technology on the attitudes of classroom teachers (E-TACT). In D. Willis, J. Price, & J. Willis (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2000* (pp. 1528–1533). Chesapeake, VA: Association for the Advancement of Computing in Education.
- Arko-Cobbah, A. (2004). The role of libraries in student-centred learning: The case of students from the disadvantaged communities in South Africa. *International Information and Library Review*, 36, 263–271.
- Arvaja, M., Hämäläinen, R., & Rasku-Puttonen, H. (2009). Challenges for the teacher's role in promoting productive knowledge construction in computer-supported collaborative learning contexts. In O. Lindberg & A. Olofsson (Eds.), *Online learning communities and teacher professional development: methods for improved education delivery* (pp. 263–280). Hershey, PA: IGI Global. Retrieved October 9, 2010, from <http://www.igi-global.com/chapter/challenges-teacher-role-promoting-productive/36945/>
- Asanti, R., Lehtinen, E., & Palonen, T. (2002). Työelämän Muutokset ja Osaamisen Haasteet [Changes in working life and challenges in proficiency]. In E. Lehtinen & T. Hiltunen (Eds.), *Oppiminen ja opettajuus* (pp. 87–108). Turku, Finland: Turun opettajankoulutuslaitos.
- Augustsson, G. (2010). Web 2.0, pedagogical support for reflexive and emotional social interaction among Swedish students. *Internet and Higher Education*, 3(4), 197–205.
- Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. New York: Holt, Rinehart & Winston.
- Baek, Y. G., Jong, J., & Kim, B. (2008). What makes teachers use of technology in the classroom? Exploring the factors affecting facilitation of technology with a Korean sample. *Computers and Education*, 50(8), 224–234.
- Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, 52, 1–26.
- Banks, J. A., Au, K. H., Ball, A. F., Bell, P., Gordon, E. W., Gutiérrez, K. D., . . . Zhou, M. (2007). *Learning in and out of school in diverse environments. Life-long, life-wide, life-deep*. Seattle: The LIFE Center and the Center of Multicultural Education, University of Washington.
- Barnes, C., & Tynan, B. (2007). The adventures of Miranda in the brave new world: Learning in a Web 2.0 millennium. *Journal of the Association for Learning Technology (ALT-Journal)*, 15(3), 189–200. Retrieved August 21, 2012, from <http://repository.alt.ac.uk/724/>
- Barnes, K., Marateo, R. C., & Ferris, S. P. (2007). Teaching and learning with the net generation. *Innovate*, 3(4), 1–8. Retrieved August 20, 2012, from <http://www.innovateonline.info/index.php?view=article&id=382>

- Bebell, D. & Kay, R. (2010). One to One Computing: A Summary of the Quantitative Results from the Berkshire Wireless Learning Initiative. *Journal of Technology, Learning, and Assessment*, 9(2), 1–60.
- Bennett, S., Maton, K., & Kervin, L. (2008). The ‘digital natives’ debate: A critical review of the evidence. *British Journal of Educational Technology*, 39(5), 775–786.
- Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Berge, O. (2006). Reuse of digital learning resources in collaborative learning environments. Series of dissertations submitted to the Faculty of Mathematics and Natural Sciences, University of Oslo, 546.
- Bielaczyc, K. (2006). Designing social infrastructure: Critical issues in creating learning environments with technology. *Journal of the Learning Sciences*, 15, 301–329.
- Bottino, R. M., & Robotti, E. (2007). Transforming classroom teaching and learning through technology: Analysis of a case study. *Educational Technology & Society*, 10(4), 174–186.
- Bovée, C., Voogt, J., & Meelissen, M. (2007). Computer attitudes of primary and secondary students in South Africa. *Computers in Human Behavior*, 23(4), 1762–1776.
- Boyd, D. (2007). The significance of social software. In T. N. Burg & J. Schmidt (Eds.), *Blogs talks reloaded: Social software research and cases* (pp. 15–30). Norderstedt, Germany: Books on Demand.
- Brown, J., & Adler, R. (2008). Minds on fire: Open education, the long tail, and learning 2.0. *EDUCAUSE Review*, 43(1), 16–32. Retrieved August 20, 2012, from <http://www.educause.edu/ir/library/pdf/ERM0811.pdf>
- Bullen, M., & Morgan, T. (2009). The net generation in higher education. *International Journal of Excellence in eLearning*, 2(1), 1–13.
- Bullock, D. (2004). Moving from theory to practice: An examination of the factors that preserve teachers encounter as they attempt to gain experience teaching with technology during field placement experiences. *Journal of Technology and Teacher Education*, 12(2), 211–237.
- Calvani, A., Fini, A., & Ranieri, M. (2009). Assessing digital competence in Secondary Education – Issues, Models, Instruments. In M. Leaning (Ed.), *Issues in information and media literacy. Education, Practice and Pedagogy* (pp. 153–172). Informing Science Press, Santa Monica (CA).
- Carlile, O. Jordan, J. (2005). It works in practice but will it work in theory? The theoretical underpinnings of pedagogy. In G. O’Neill, S. Moore, B. McMullin, (Eds). *Emerging Issues in the Practice of University Learning and Teaching*. Dublin: AISHE, 2005. <http://www.aishe.org/readings/2005-1/>
- Carr, N. (2010). *The shallows: How the Internet is changing the way we think, read and remember*. London: Atlantic.
- Carr, W. (2004). Philosophy and education. *Journal of Philosophy of Education*, 38(1), 55–73.
- Castro Sánchez, J. J. and Alemán, E. C., 2011. Teachers’ opinion survey on the use of ICT tools to support attendance-based teaching. *Journal Computers and Education*, 56, 911–915.
- Centre for Activity Theory and Developmental Work Research. (2003). The activity system. Retrieved December 12, 2010, from <http://www.edu.helsinki.fi/activity/pages/chatanddwr/activitysystem>
- CERI, OECD. (2010). *Are the new millennium learners making the grade? Technology use and educational performance in PISA*. Paris: CERI.
- Chai, C. S., Koh, J. H. L., Tsai, C. C., & Tan, L. L. W. (2011). Modeling primary school pre-service teachers’ Technological Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education*, 57(1), 1184–1193.
- Charlier, B., Henri, F., Peraya, D. & Gillet, D. (2010). From personal learning to personal learning environment. In F. Wild, M. Kalz, & M. Palmér, (Eds.), *Proceedings of the 3rd Workshop on Mashup Personal Learning Environments*, CEUR-WS (p. 638).
- Chen, K. (2012). Elementary EFL teachers’ computer phobia and computer self-efficacy in Taiwan. *Turkish Online Journal of Educational Technology*, 11(2), 100–107.

- Chen, P., Wan, P., & Son, J. E. (2008). Web 2.0 and education: Lessons from teachers' perspectives. In C. Bonk et al. (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education* (pp. 2555–2559). Chesapeake, VA: AACE.
- Christensen, R., & Knezek, G. (2006). Pathway for preparing tomorrow's teacher to infuse technology. *Computers in the Schools*, 23, (3), 1–21.
- Churchill, D. (2007). Web 2.0 and possibilities for educational applications. *Educational Technology*, 47(2), 24–29.
- Clark, C., & Peterson, L. (1986). Teachers' thought processes. In M. C. Wittrock (Ed.), *Handbook of Research on Teaching* (3rd ed.) (pp. 255–296). New York: MacMillan.
- Colley, A. M. (2003). Gender differences in adolescents' perceptions of the best and worst aspects of computing at school. *Computers in Human Behavior*, 19, 673–682.
- Collins, A., & Halverson, R. (2009). *Rethinking education in the age of technology: The digital revolution and schooling in America*. New York: Teachers College Press.
- Combes, B., & Valli, R. (2007). The future of learning objects in educational settings. In K. Harman & A. Koohang (Eds.), *Learning objects: Applications, implications, & future directions* (pp. 423–461). Santa Rosa, CA: Informing Science Press.
- ComScore. (2011). 2010 Europe digital year in review.
- Connolly, T. M., Hailey, T., Baxter, G. J., Stansfield, M. H., Carole, C., Can, C., & Dimitrova, N. (2011). Teachers' views on Web 2.0 in education: An evaluation of a large-scale European pilot. *Proceedings of International Conference on European Transnational Education (ICEUTE)*, Salamanca, 511–516.
- Cox, M. (2008). Researching IT in education. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 965–981). New York: Springer.
- Creswell, J., & Plano Clark, V. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.
- Dabbagh, N., & Kitsantas, A. (2011). Personal learning environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *Internet and Higher Education*, 15(1), 3–8.
- Demiraslan, Y., & Usuel, Y. K. (2008). ICT integration processes in Turkish schools: Using activity theory to study issues and contradictions. *Australasian Journal of Educational Technology*, 24 (4), 458–474. Retrieved August 20, 2012, from <http://www.library.dcu.ie/Eresources/databases-az.htm>
- Dias De Figueiredo, A., & Afonso, A. P. (2006). *Managing learning in virtual settings: The role of context*. Hershey, PA: Information Science Publishing.
- Divaharan, S., & Ping L.C. (2010). Secondary school socio-cultural context influencing ICT integration: A case study approach. *Australasian Journal of Educational Technology*, 26(6), 741–763.
- Driscoll, M. P. (2005). *The psychology of learning for instruction* (3rd ed.). Boston: Pearson Education, Inc.
- Duffy, F. M., Rogerson, L. G., & Blick, C. (2000). *Redesigning America's schools: A systems approach to improvement*. Norwood, MA: Christopher-Gordon Publishers, Inc.
- Dutta, A., Roy, R., & Seetharaman, P. (2012). System dynamics modeling of ICT diffusion. *Proceedings of the Pacific Asia Conference on Information Systems (PACIS)*. Retrieved August 7, 2012, from http://pacis2012.org/files/papers/pacis2012_T2_Dutta_87.pdf
- Earle, R. S. (2002). The integration of instructional technology into public education: Promises and challenges. *Educational Technology*, 42(1), 5–13.
- Ekundayo, M. S. (2012). *The use of activity theory to explain the complexities surrounding the use of ICT in overcrowded university classrooms: the case of Nigeria*. Doctoral dissertation. Auckland university of Technology.
- Engeström, Y. (1987). *Learning by expanding*. Helsinki, Finland: Orienta-Konsultit Oy.
- Engeström, Y. (1999). Innovative learning in work teams: Analyzing cycles of knowledge creation in practice. In Y. Engeström, R. Miettinen, & R.-L. Punamäki (Eds.), *Perspectives on activity theory* (pp. 377–404). Cambridge, UK: Cambridge University Press.

- Engeström, Y., & Sannino, A. (2010). Studies of expansive learning: Foundations, findings and future challenges. *Educational Research Review*, 5(1), 1–24.
- Erstad, O. (2003). Electracy as empowerment: Student activities in learning environments using technology. *Young*, 11, 11–28.
- European Commission. (2010). Europe 2020. A European strategy for smart, sustainable and inclusive growth. Retrieved October 10, 2012, from <http://ec.europa.eu/research/era/docs/en/investing-in-research-european-commission-europe-2020-2010.pdf>
- European Commission. (2010). A digital agenda for Europe COM(2010)245 final. Retrieved July 7, 2012 from http://ec.europa.eu/information_society/digital-agenda/publications/index_en.htm
- European Commission. (2013). Survey of schools: ICT in education. Luxembourg: Publications Office of the European Union.
- Fiedler, S., & Pata, K. (2009). Distributed learning environments and social software: In search for a framework of design. In S. Hatzipanagos & S. Warburton (Eds.), *Handbook of research on social software and developing community ontologies* (pp. 145–158).
- Finnish National Board of Education (2004). National Core Curriculum for Basic Education. Retrieved February 21, 2013, from http://www.oph.fi/download/47675_POPS_net_new_2.pdf
- Finnish National Board of Education (2011). The strategy of the Finnish National Board of Education: ‘Learning and competence 2020’. Retrieved February 21, 2013, from http://www.oph.fi/download/135542_learning_and_competence_2020.pdf
- Fischer, G., & Konomi, S. (2005). Innovative media in support of distributed intelligence and lifelong learning. In *Proceedings of the Third IEEE International Workshop on Wireless and Mobile Technologies in Education* (pp. 28–30). Los Alamitos, CA: IEEE Computer Society.
- Fishbein M., & Ajzen I. (1975). *Belief, attitude, intention, and behaviour: An introduction to theory and research*. Reading, MA: Addison-Wesley Publishers.
- Friedhoff, J. R. (2008). Reflecting on the affordances and constraints of technologies and their impact on pedagogical goals. *Journal of Computing in Teacher Education*, 24, 117–122.
- Fu, J.S. (2013). ICT in Education: A Critical Literature Review and Its Implications. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 9(1), 112–125.
- Fullan, M. (2001). *Leading in a culture of change*. San Francisco: Jossey-Bass.
- Gadamer, H. (1979). *Truth and method*. London: Sheed and Ward.
- Gaston, J. (2006). Reaching and teaching the digital natives. *Library Hi Tech News*, 23(3), 12–13.
- Gee, J. P. (2004). *Situated language and learning*. New York: Routledge.
- Gilbert, I. (2009). *Why do I need a teacher when I've got Google? Things every teacher should know*. Taylor & Francis.
- Gorder, L. M. (2008). A study of teacher perceptions of instructional technology integration in the classroom. *Delta Pi Epsilon Journal*, 50(2), 63–76.
- Goroshko, O. I., & Samoilenko, S. A. (2011). Twitter as a conversation through e-learning. Context. *Revista de Informatica Sociala*, 15, 7–25.
- Granger, C. A., Morbey, M. L., Lotherington, H., Owston, R. D., & Wideman, H. H. (2002). Factors contributing to teachers’ successful implementation of IT. *Journal of Computer Assisted Learning*, 8, 480–488.
- Grosbeck, G. (2009). To use or not to use Web 2.0 in higher education? *Procedia—Social and Behavioral Sciences*, 1(1), 478–482.
- Grunwald and Associates. (2010). Educators, technology and 21st-century competence: Dispelling five myths. Walden University, Richard W. Riley College of Education. Retrieved from February 21, 2013, from <http://www.WaldenU.edu/fivemyths>
- Haaparanta, H. (2008). *Computers in primary school teachers’ everyday life: Teachers’ well being, burnout, school information strategy and technology acceptance*. Thesis. Tampere University of Technology, Tampere (Publication 761).
- Hakkarainen, K. (2000). Foreword. How people learn: Brain, mind, experience, and school. In J. D. Bransford, A. L. Brown, & R. R. Cocking (Eds.), *National Research Council*. Washington, DC: National Academy Press.

- Hakkarainen, K. (2009). A knowledge-practice perspective on technology-mediated learning. *Computer-Supported Collaborative Learning, 4*, 213–31.
- Hakkarainen, K. (2010). Communities of learning in the classroom. In K. Littleton, C. Wood, & J. Kleine Staarman (Eds.), *International handbook of psychology in education* (pp. 177–225). Bingley, England: Emerald.
- Hallam, T. (2008). *Sociocultural influences on computer anxiety among preservice teachers: An exploratory study*. (Unpublished doctoral dissertation). University of Akron, Akron, OH.
- Handelsman, M. M., Briggs, W. L., Sullivan, N., & Towler, A. (2005). A measure of college student course engagement. *Journal of Educational Research, 98*, 184–191.
- Harjanne, P., & Tella, S. (2007). Foreign language didactics, foreign language teaching and transdisciplinary affordances. In A. Koskensalo, J. Smeds, P. Kaikkonen, & V. Kohonen (Eds.), *Foreign languages and multicultural perspectives in the European context* (pp. 197–225). Dichtung – Wahrheit – Sprache. Berlin: LIT-Verlag.
- Hartman, J. L., Dziuban, C., & Brophy-Ellison, J. (2007). Faculty 2.0. *Educause Review, 42*(5), 64–76. Retrieved August 20, 2012, from <http://net.educause.edu/ir/library/pdf/ERM0753.pdf>
- Hattie, J. (2009). *Visible learning for teachers: Maximizing impact on learning*. London: Routledge.
- Heikkilä, A., & Lonka, K. (2006). Studying in higher education: Students' approaches to learning, self-regulation, and cognitive strategies. *Studies in Higher Education, 31*, 99–117.
- Hidi, S., & Renninger K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111–127.
- Huang, H., & Liaw, S. (2005). Exploring user's attitudes and intentions toward the web as a survey tool. *Computers in Human Behavior, 21*(5), 729–743.
- Häkkinen, P., & Hämäläinen, R. (2012). Shared and personal learning spaces: Challenges for pedagogical design. *Internet and Higher Education, 15*(4), 231–236.
- Ilomäki, L. (2007). School in front of challenges of knowledge society, again and again. Eden conference. Retrieved October 15, 2008, from <http://www.slideshare.net/mkfc/liisa-ilomaki>
- Ilomäki, L. (2008). *The effects of ICT on school: Teachers' and students' perspectives*. (Unpublished doctoral dissertation). Annales Universitatis Turkuensis B 314. University of Turku, Finland.
- Ilomäki, L., Kantosalu, A., & Lakkala, M. (2011). *What is digital competence?* Brussels: European Schoolnet.
- Interactive Educational Systems Design. (2011). National survey report digital districts: Web 2.0 and collaborative technologies in U.S. Schools, Interactive Educational Systems Design, Inc. New York, NY. Retrieved September 5th, 2012, from <http://www.digitaldistrictsurvey.com>
- International Society for Technology in Education (ISTE). (2009). *Essential conditions: Necessary conditions to effectively leverage technology for learning*. Retrieved October 4, 2013 from <http://www.iste.org/docs/pdfs/netsessentialconditions.pdf>
- ITU monitor. (2005). Retrieved October 7, 2008, from <http://www.itu.no/ituenglish/1093980667.4/1158725912.54>
- Jamieson-Proctor, R., Burnett, P. C., Finger, G., & Watson, G. (2006). *Australasian Journal of Educational Technology, 22*(4), 511–530.
- Jegede, P., Dibu-Ojerinde, O., & Ilori, M. (2007). Relationships between ICT competence and attitude among some Nigerian tertiary institution lecturers. *Educational Research and Review, 2*(7), 172–175.
- Jones, D. (2004). The conceptualization of e-learning: Lessons and implications. *Studies in Learning, Evaluation, Innovation and Development, 1*(1), 47–55. Central Queensland University, Rockhampton.
- Kaptelinin, V. & Nardi, B.A. (2006). *Acting with technology: Activity theory and interaction design*. Cambridge, MA: MIT Press.
- Kay, R. H. (2006). Evaluating strategies used to incorporate technology into pre-service education: A review of the literature. *Journal of Research on Technology in Education, 38*, 383–408.
- Kember, D. (1997). A reconceptualisation of the research into university academics' conceptions of teaching. *Learning and Instruction, 7*(3), 255–275.

- King, J., Bond, T., & Blandford, S. (2002). An investigation of computer anxiety by gender and grade. *Computers in Human Behavior*, 18, 69–84.
- Knezek, G., & Christensen, R. (2002). *Technology, Pedagogy, Professional Development and Reading Achievement. (KIDS) project findings for 2001–2002, Year Three Report*. Denton, TX: Institute for the Integration of Technology into Teaching and Learning (IITTL).
- Kompe, M. (2005). Information communication and technology and the seduction of knowledge, teaching and learning: what lies ahead for education. *Curriculum Enquiry*, 5(2), 213–215.
- Korhonen, T., & Lavonen, J. (2010). 'Meidän luokan juttu'-tieto- ja viestintäteknologia kodin ja koulun yhteistyön tukena ['Our class's own thing'—ICT in support of co-operation between home and school]. University of Jyväskylä, Finland.
- Krumsvik, R. (2011). Digital competence in the Norwegian teacher education and school. *Högre Utbildning*, 1(1), 39–51.
- Kuutti, K. (1995). Activity theory as a potential framework for human-computer interaction research. In B. A. Nardi (Ed.), *Context and consciousness: Activity theory and human-computer interaction* (pp. 17–44). Cambridge, MA: MIT Press.
- Laferrière, T., Hamel, C. & Searson, M. (2013). Barriers to successful implementation of technology integration in educational settings: a case study. *Journal of Computer Assisted Learning*. 29(5), 463–473.
- Lahdes, E. (1997). *Peruskoulun uusi didaktiikka*. [The new didactics of basic education] Helsinki: Otava.
- Lam, I., & Ritzen, M. (2008). Tools and pedagogies that fit the ne(x)t generation of students. In A. Tait, & A. Szücs (Eds.), *New learning cultures: How do we learn? Where do we learn?* (p. 42). European Distance and E-Learning Network.
- Larkin, M. L. (2010). *Investigating Student Netbook Usage Using Activity Theory*. Thesis. School of Education and Professional Studies (Gold Coast) Faculty of Education, Griffith University.
- Laru, J. (2012). *Scaffolding learning activities with collaborative scripts and mobile devices*. Juvenes Print(125), Tampere: Juvenes Print.
- Lau, B. T., & Sim, C. H. (2008). Exploring the extent of ICT adoption among secondary school teachers in Malaysia. *International Journal of Computing and ICT Research*, 2(2), 19–36.
- Lawrence, B. & Lentle-Keenan, S. (2013). Teaching beliefs and practice, institutional context, and the uptake of Web-based technology. *Distance Education*, 34(1), 4–20.
- Lea, S. J., Stephenson, D., & Troy, J. (2003). Higher education students' attitudes to student centred learning: Beyond 'educational bulimia'. *Studies in Higher Education*, 28(3), 321–334.
- Lehtonen, M. (2003). Simulations as mental tools for network-based group learning. In P. Nicholson, J. B. Thompson, M. Ruohonen, & J. Multisilta (Eds.), *E-training practices for professional organisations*, 167, Kluwer Academic Publishers, 11–17.
- Lenhart, A., Rainie, L., & Lewis, O. (2001) *Teenage life online: The rise of instant-message generation and the internet's impact on friendship and family relationships*. Washington, DC: Pew Internet and American Life Project.
- Leontiev, A.N. (1978). *Activity, Consciousness, and Personality*. Hillsdale: Prentice-Hall.
- Leskes, A., Grogan, W. R., Canham, R. P., & O'Brien, J. (2003). Designing institutional change. *Liberal Education*, 89(1), 32–41.
- Levin, T. and Wadmany, R. (2006). Teachers' beliefs and practices in technology-based classrooms: A developmental view. *Journal of Research on Technology in Education*, 39, 417–441.
- Levin, T., & Wadmany, R. (2008). Teachers' views on factors affecting effective integration of information technology in the classroom: Developmental scenery. *Journal of Technology and Teacher Education*, 16(2), 233–263.
- Leviäkangas, P., Hautala, R. Schneitz, A. & Lim, H. C. (2010). Singaporen perusopetuksen tietotekniikkavisio ja -strategia—benchmarkkaus ja vertailu Suomeen [Singapore's information technology vision and strategy for primary education—benchmarking and comparison with Finland].
- Lewis, S., Pea, R., & Rosen, J. (2010). Beyond participation to co-creation of meaning: Mobile social media in generative learning communities. In R. Pea & J. Rosen (Eds.), *Social Science Information*, 49(3), 351–369.

- Leontiev, A. N. (1978). *Activity, consciousness, and personality*. Hillsdale, NJ: Prentice-Hall.
- Li, Y., & Ranieri, M. (2010). Are 'digital natives' really digitally competent? A study on Chinese teenagers. *British Journal of Educational Technology*, 41(6), 1029–1042.
- Light, D., & Pierson, E. (2011). Increasing ICT use with students around the world: Intel® Teach Essentials survey results from 13 participating countries. EDC/Center for Children and Technology. Retrieved September 23, 2012, from <http://download.intel.com/education/EvidenceOfImpact/GlobalFollowUpIntelTeachSurveyReport2011.pdf>
- Lim, C., & Tay, L. (2003). Information and communication technologies (ICT) in an elementary school: Students' engagement in higher order thinking. *Journal of Educational Multimedia and Hypermedia*, 12(4), 425–451.
- Lim, W. Y., So, H. J., & Tan, S. C. (2010). eLearning 2.0 and new literacies: Are social practices lagging behind? *Interactive Learning Environments*, 18(3), 202–218.
- Lin, C., Singer, R., & Ha, L. (2010). Why university members use and resist technology? *Journal of Computing in Higher Education*, 22(1), 38–59.
- Liu, Y., Liu, J., & Yu, S. (2008). A case study on mobile learning implementation in basic education. In H. Zhou (Ed.), *International Conference on Computer Science and Software Engineering* (5), 593–597.
- Lonka, K. (2012). Engaging learning environments for the future. In R. Gwyer, R. Stubbings, & G. Walton (Eds.), *The road to information literacy: Librarians as facilitators of learning*. The Hague: De Gruyter. IFLA Publications 157, 15–30.
- Lonka, K. (2011). Teaching and learning blog. Retrieved September 20, 2012, from <http://blogs.helsinki.fi/wdc-2012/oppimisen-uudet-tilat-eng>
- Loveless, A., DeVogd, G. L., & Bohlin, R. M. (2001). Something old, something new...Is pedagogy affected by ICT? In A. Loveless & V. Ellis (Eds.), *ICT, pedagogy and the curriculum*. (pp. 63–83), London and New York: Routledge-Falmer.
- Lu, E. Y., Ma, H., Turner, S., & Huang, W. (2005). Wireless internet and student-centred learning: A partial least-squares model. *Computers and Education*, 49, 530–544.
- Lund, A., & Hauge, T. E. 2011. Designs for Teaching and Learning in Technology-Rich Learning Environments. *Nordic Journal of Digital Literacy*, 6(4), 258–272.
- Lydon, L. (2012). Tablets in the Classroom: Towards a New Pedagogy. Retrieved October 7, 2012 from <http://www.elearnium.com/2012/05/part1.html>
- Malpas, J. (2009). Hans-Georg Gadamer. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy*. Retrieved from <http://plato.stanford.edu/archives/sum2009/entries/gadamer>
- Markham, K. M., Mintzes, J. J., & Jones, M. G. (1994). The concept map as a research and evaluation tool: Further evidence of validity. *J. Res. Sci. Teach.*, 31, 91–101.
- Martin, A., & Grudziecki, J. (2006). DigEuLit: Concepts and tools for digital literacy development. *ITALICS: Innovations in Teaching & Learning in Information & Computer Sciences*, 5(4), 246–264.
- McKelvie, G., Dotsika, F., & Patrick, K. (2007). Interactive business development, capturing business knowledge and practice: A case study. *The Learning Organization*, 14(5), 407–422.
- McLester, S. (2007). Technology literacy and the MySpace generation: They're not asking permission. *Technology & Learning*, 27, 16–22.
- McLoughlin, C., & Lee, M. J. W. (2007). Social software and participatory learning: Pedagogical choices with technology affordances in the Web 2.0 era. *Proceedings ascilite Singapore*.
- Mcmahon, G. (2009). Critical thinking and ICT integration in a Western Australian secondary school. *Educational Technology and Society*, 12, 269–281.
- Meelissen, M. R., & Drent, M. (2008). Gender differences in computer attitudes: Does the school matter? *Computers in Human Behaviour*, 24(3), 969–985.
- Meisalo, V., Lavonen, J., Sormunen, K., & Vesisenaho, M. (2010). ICT in initial teacher training. Finland. Country report. In OECD & CERl, *New millennium learners*. Department of Teacher Education, University of Helsinki and School of Applied Education and Teacher Education, University of Eastern Finland.

- Miettinen, R. (2009). Contradictions of high technology capitalism and the emergence of new forms of work. In A. Sannino, H. Daniels, & K. Gutiérrez (Eds.), *Learning and expanding with activity theory* (pp. 160–175). Cambridge, UK: Cambridge University Press.
- Mishra, P., & M. Koehler. (2006). Technological pedagogical content knowledge: A new framework for teacher knowledge. *Teachers College Record*, 108, 1017–1054.
- Monaco, M., & Martin, M. (2007). The millennial student: A new generation of learners. *Athletic Training Education Journal*, 2, 42–46.
- Muukkonen-van der Meer, H. (2011). Perspectives on knowledge creating inquiry in higher education. (Doctoral dissertation). University of Helsinki, Institute of Behavioural Sciences, Studies in Psychology. Helsinki: Helsinki University Print.
- National School Boards Association. (2007). Creating and connecting: Research and guidelines on social and educational networking. Retrieved September 22, 2012, from www.nsba.org/SecondaryMenu/TLN/CreatingandConnecting.aspx
- Niemi, H., Kynäslähti, H. & Vahtivuori-Hänninen, S. (2013). Towards ICT in everyday life in Finnish Schools: Seeking conditions for good practices. *Journal of Learning, Media and Technology*, 38(1), 1–15. Retrieved October 6, 2013 from <http://www.tandfonline.com/doi/abs/10.1080/17439884.2011.651473>
- Nonaka, I. & Takeuchi, H. (1995). *The knowledge creating company: how Japanese companies create the dynamics of innovation*, New York: Oxford University Press.
- Norris, C. A., & Soloway, E. (2011). Learning and schooling in the age of mobilism. *Educational Technology*, 51(6), 3–10. Retrieved October 22, 2012, from <http://ezproxy.usq.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=eht&AN=68945513&site=ehost-live>
- Oblinger, D.G., & Oblinger, J.L. (2005). *Educating the Net Generation*. Boulder, Colorado.
- O'Reilly T. (2005). What is Web 2.0—Design patterns and business models for the next generation of software. Retrieved June 30, 2012, from <http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html>
- Organisation for Economic Co-operation and Development. (2010b). PISA 2009 Results: Executive Summary. OECD.
- Owen, M., Grant, L., Sayers, S., & Facer, K. (2006). *Social software and learning*. Bristol, UK: Futurelab. Retrieved April 11, 2012, from http://www.futurelab.org.uk/download/pdfs/research/opening_education/Social_Software_report.pdf
- Paavola, S., & Hakkarainen, K. (2005). The knowledge creation metaphor—An emergent epistemological approach to learning. *Science and Education*, 14(6), 535–557.
- Palak, D. and Walls, R. T. (2009). Teachers' beliefs and technology practices: A mixed-methods approach, *Journal of Research on Technology in Education*, 41, 157–181.
- Pedró, F. (2006). The new millennium learners: Challenging our views on ICT and learning. OECD-CERI. Retrieved September 22, 2012, from <http://www.oecd.org/dataoecd/1/1/38358359.pdf>
- Peralta, H., & Costa, F. A. (2007). Teachers' competence and confidence regarding the use of ICT. *Educational Sciences Journal*, 3, 75–84.
- Piper, D. (2000). *Facilitating change: Factors influencing teachers' practices of using computers in the classroom*. Ann Arbor, MI: UMI Dissertation Services.
- Piper, D., & Austin, D. (2004). The relationship of leadership, experience and computer attitudes on teachers' self-efficacies of computer technology use in the classrooms. In R. Ferdig & C. Crawford (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference*, Atlanta, GA, USA (pp. 1635–1642).
- Plomp, T., Anderson, R. E., Law, N., & Quale, A. (Eds.). (2009). *Cross-national information and communication technology: policies and practices in education*. Charlotte, NC: Information Age Publishing.
- Polly, D., Mims, C., Shepherd, C. E., & Inan, F. (2010). Evidence of impact: Transforming teacher education with preparing tomorrow's teachers to teach with technology (PT3) grants. *Teaching and Teacher Education*, 26, 863–870.

- Pozzi, F. (2007). The impact of m-Learning in school contexts: an 'inclusive' perspective. In C. Stephanidis (Ed.), *Universal access in HCI* (pp. 748–756). LNCS 4556. Springer-Verlag.
- Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, 9(5), 1–6.
- Prensky, M. (2012). *From digital natives to digital wisdom. Hopeful essays for 21st century learning*. Thousand Oakes, CA: Sage.
- Prestridge, S. (2007). Engaging with the transforming possibilities of ICT. *Australian Educational Computing*, 22(2), 3–9.
- Prestridge, S. (2010). The alignment of digital pedagogy to current teacher beliefs. ACEC2010: Digital diversity conference.
- Project Tomorrow. (2011). The new 3 E's of education: Enabled, engaged, empowered: How today's educators are advancing a new vision for teaching and learning. Retrieved September 20, 2012, from: www.tomorrow.org/speakup/pdfs/SU10_3EofEducation_Educators.pdf
- Reinhardt, W., Schmidt, B., Sloep, P., & Drachler, H. (2011). Knowledge worker roles and actions—Results of two empirical studies. *Knowledge and Process Management*, 18(3), 150–174.
- Richardson, V., & Placier, P. (2001). Teacher change. In V. Richardson (Ed.), *Handbook of research on teaching*. Washington, DC: American Educational Research Association, pp. 905–947.
- Richardson, W. (2005). The educator's guide to the read/write web. *Educational Leadership*, 63(4), 24–27.
- Richardson, W. (2006). *Blogs, wikis, podcasts, and other powerful web tools for classrooms*. Thousand Oaks, CA: Corwin Press.
- Roschelle, J. (1998). Activity Theory: A Foundation for Designing Learning Technology? *The Journal of the Learning Sciences*, 7(2), 241–255.
- Roschelle, J., Pea, R., Hoadley, C., Gordin, D., & Means, B. (2000). Changing how and what children learn in school with computer-based technologies. *The Future of Children. Children and Computer Technology*, 10(2), 76–101.
- Rubens, N., Kaplan, D., & Okamoto, T. (2011). E-Learning 3.0: Anyone, anywhere, anytime, and AI. *International Workshop on Social and Personal Computing for Web-Supported Learning Communities* (SPeL 2011).
- Ruokamo, H., & Tella, S. (2005). Multidisciplinary network-based mobile education (NBME) and teaching-studying-learning (TSL) processes: The MOMENTS integrated metamodel. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2005* (pp. 324–329). Chesapeake, VA: AACE.
- Russell, J., Mackay, A., & Jane, G. (2003). *Messages from the myriad: Improving the middle years of schooling*. Melbourne, Australia: IARTV Jolimont.
- Russell, M., O'Dwyer, L. M., Bebell, D., & Tao, W. (2007). How teachers' uses of technology vary by tenure and longevity. *Journal of Educational Computing Research*, 37(4), 393–417.
- Safran, C., Helic, C., & Gutl, C. (2007). E-Learning practices and Web 2.0. *Proceedings of ICL* (pp. 1–8). Villach, Austria.
- Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Eds.), *Liberal education in a knowledge society*, pp. 76–98. Chicago: Open Court.
- Scardamalia, M., & Bereiter, C. (2003). Knowledge building. In J. W. Guthrie (Ed.), *Encyclopedia of education* (2nd ed.) (pp. 1370–1373). New York: Macmillan Reference.
- Schiller, J. (2003). Working with ICT: Perceptions of Australian principals. *Journal of Educational Administration*, 41(3), 171–185.
- Schwarz, C., Reiser, B., Davis, E., Kenyon, L., Achér, A., Fortus, D., . . . Krajcik, J. (2009). Developing a learning progression for scientific modeling: Making scientific modeling accessible and meaningful for learners. *Journal of Research in Science Teaching*, 46(6), 632–654.
- Searson, M., Laferriere, T., & Nikolow, R. (2011). *TWG 7: Barriers to successful implementation of technology integration in educational settings*. EDUSummIT 2011, 8–10 June 2011, Paris. Retrieved October 4, 2013, from http://whitelabel.kennisnet.nl/fileadmin/contentelementen/kennisnet/EDUSummIT/Documenten/2011/7_EDUSummIT_2011_BarriersEssentials.pdf

- Serhan, D. (2009). Preparing preservice teachers for computer technology integration. *International Journal of Instructional Media*, 36, 439–447.
- Shapka, J.D., & Ferrari, M. (2003). Computer-related attitudes and actions of teacher candidates. *Computers in Human Behaviour*, 19(3), 319–334.
- Shear, L., Gallagher, L., & Patel, D. (2011). ITL research 2011 findings: Evolving educational systems. SRI International.
- Sipilä, K. (2010). The impact of laptop provision on teacher attitudes towards ICT. *Technology, Pedagogy and Education*, 19(1), 3–16.
- Smarkola, C. (2007). Technology acceptance predictors among student teachers and experienced classroom teachers. *Journal of Educational Computing Research*, 37(1), 65–82.
- Steed, M., & Knight L. (2012). ICT as a catalyst of a change in pedagogy. *ISC Bulletin*, 29, 30–34.
- Stoffle, C. J., & Cuillier, C. (2010). Student-centred service and support: A case study of Arizona libraries information commons. *Journal of Library Administration*, 50, 117–134.
- Sujan, M., Rizzo, A., & Pasquini, A. (2002). Contradictions and critical issues during system evolution. *Proceedings of the 2002 ACM Symposium on Applied Computing (SAC), Madrid, Spain*.
- Sumner, M., & Hostetler, D. (1999). Factors influencing the adoption of technology in teaching. *Journal of Computer Information Systems*, 40(1), 81–87.
- Swan, K., Van Hoof, M., Kratcoski, A., & Unger, D. (2005). Uses and effects of mobile computing devices in K-8 classrooms. *Journal of Research on Technology in Education*, 38(1), 99–112.
- Säljö, R. (2001). *Oppimisen käytännöt. Sosiokulttuurinen näkökulma*. [Learning in practice. A socio cultural perspective] Juva: WS Bookwell Oy.
- Säljö, R. (2010). Digital tools and challenges to institutional traditions of learning: Technologies, social memory and the performative nature of learning. *Journal of Computer Assisted Learning* 26(1), 53–64.
- Ten Brummelhuis, A., & Kuiper, E. (2008). Driving forces for ICT in learning. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 97–111). New York: Springer.
- Teo, T. (2006). Attitudes toward computers: A study of post-secondary students in Singapore. *Interactive Learning Environments*, 14(1), 17–24.
- Tezci, E. (2011). Factors that influence preservice teachers' ICT usage in education. *European Journal of Teacher Education*, 34, 483–499.
- Thomson, P. (2010). *Whole school change: A literature review*, 2nd ed. Creativity, Culture and Education Series. Newcastle upon Tyne: Arts Council England.
- Tissari, V., Vahtivuori-Hänninen, S., Vaattovaara, V., Ruokamo, H., & Tella, S. (2005). Applying pedagogical models in network-based education: Research findings from the Finnish HelLa project case studies. In P. Kommers & G. Richards (Eds.), *Proceedings of ED-MEDIA 2005* (pp. 656–663). Chesapeake, VA: AACE.
- Tondeur, J., van Braak, J., & Valcke, M. (2006). Curricula and the use of ICT in education: Two worlds apart? *British Journal of Educational Technology*, 38(6) 962–976.
- Tondeur, J., Roblin, N. P., van Braak, J., Fisser, P., & Voogt, J. (2012). Technological pedagogical content knowledge in teacher education: in search of a new curriculum. *Journal of Educational Studies*, 38(4), 1–5.
- Trilling, B., & Fadel, H. (2009) *21st Century Skills: Learning for life in our times*. Jossey-Bass, a Wiley Imprint.
- Tsai, Y.-M., Kunter, M., Ludtke, O., Trautwein, U., & Ryan, R. M. (2008). What makes lessons interesting? The role of situational and individual factors in three school subjects. *Journal of Educational Psychology*, 100(2), 460–472.
- Tyack, D. B., & Cuban, L. (1995). *Tinkering toward utopia: A century of public school reform*. Cambridge, MA: Harvard University Press.

- Ubiquitous Information Society Advisory Board (2010). National Plan for Educational Use of Information and Communications Technology report. Retrieved February 21, 2013, from http://www.edu.fi/download/135308_TVT_opetuskayton_suunnitelma_Eng.pdf
- Uljens, M. (1997). *School didactics and learning: A school didactic model framing an analysis of pedagogical implications of learning theory*. Hove: Psychology Press.
- Uzunboylu, H., Bicen, H., & Cavus, N. (2011). The efficient virtual learning environment: A case study of web 2.0 tools and windows live spaces. *Computers and Education*, 56(3), 720–726.
- van Braak, J., Tondeur, J., & Valcke, M. (2004). Explaining different types of computer use among primary school teachers. *European Journal of Psychology of Education*, 14, 407–422.
- van Deursen, A. J. A. M. (2010). Internet skills. Vital assets in an information society. University of Twente. Retrieved March 21st, 2013, from <http://doc.utwente.nl/75133/>
- Vannatta, R., & Fordham, N. (2004). Teacher dispositions as predictors of classroom technology use. *Journal of Research on Technology in Education*, 36(3), 253–271.
- Venkatesh V., Morris, G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478.
- Voogt, J. (2008). IT and curriculum processes: Dilemmas and challenges. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 117–132). New York: Springer.
- Voogt, J., & Knezek, G. (2008). IT in primary and secondary education: Emerging issues. In G. Knezek & J. Voogt (Eds.), *International Handbook of Information Technology in Primary and Secondary Education* (Preface). New York: Springer.
- Watson, G. (2006). Technology professional development: Long-term effects on teacher self-efficacy. *Journal of Technology and Teacher Education*, 14(1), 151–166.
- Wong, E. M. L., & Li, S. C. (2008). Framing ICT implementation in a context of educational change: a multilevel analysis. *School Effectiveness and School Improvement*, 19(1), 99–120.
- Wozney, L., Venkatesh, V., & Abrami, P. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education*, 14(1), 173–207.
- Yang, H. (2012). ICT in English schools: Transforming education? *Technology, Pedagogy and Education*, 21(1), 101–118.
- Yelland, N. (2007). *Shift to the future: Rethinking learning with new technologies*. New York, London: Routledge.
- Yildirim, S. (2007). Current utilisation of ICT in Turkish basic education schools: A review of teachers' ICT use and barriers to integration. *International Journal of Instructional Media*, 34(2), 171–86.
- Yukselturk, E., & Bulut, S. (2009). Gender differences in self-regulated online learning environment. *Journal of Educational Technology & Society*, 1(3), 12–22.
- Zanting, A., Verloop, N., & Vermunt, J. D. (2003). How do student teachers elicit their mentor teachers' practical knowledge. *Teachers and Teaching: Theory and Practice*, 9(3), 197–211.

Appendices

Study I

Sipilä, K. (2009). Students' attitudes toward ICT and VLE in basic education. In G. Siemens & C. Fulford (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications* (pp. 2304–2311). Chesapeake, VA: AACE.

Students' Attitudes toward ICT and VLE in Basic Education

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Abstract: The use of ICT has been increasing in Finnish primary and secondary schools over the last decade, but the possibilities of new technology are still not being used in favor of pedagogical changes. One of the key factors in implementing new technology in schools is how motivated students are in using it: do they see the benefits of new tools in promoting their learning? The aim of this study was to investigate how students in Finnish basic education see the use of ICT and the virtual learning environment (VLE) in terms of their learning and motivation. The data was collected by an online questionnaire, to which 758 students responded. The analysis of the data revealed that successful and more motivated students were more positive in their attitudes toward ICT and the use of VLE. Older students' attitudes toward ICT and VLE were less positive, as was their motivation to study.

Introduction

Networked information and communication technology (ICT) has arrived at schools alongside the redefined Finnish curriculum, which is currently emphasizing the importance of using modern teaching methods and modern technology in teaching, studying and learning. With these guidelines, the curriculum is fostering transformational thought in the classroom, making way for ICT to be used in classrooms with its full potential. Global mega-trends, ICT being one of them, are having an effect on society that schools cannot afford to ignore. Educational institutions play a vital role in teaching the adults of the future the skills, capacities and knowledge needed for their future working lives. In Finland, the first six years of basic education are provided by the class teacher, who teaches all or most subjects. During the last three years, separate subjects are usually taught by different subject teachers. The first years of education are vital in the role of defining how students will start to experience what formal teaching and institutional learning is like. Research evidence suggests that ICT can have a positive impact both on student learning outcomes (BECTA, 2001, 2002; Cox & Abbott, 2004) as well as increasing motivation (BECTA, 2003). Cox and Abbott (2004) conclude that the impact of ICT is 'positive' in many areas. The motivational role of ICT is 'significant' (McFarlane and Sakellariou, 2002). Most students are in favor of using computers in the classroom (Cox, 1997). The potential for ICT to influence students' attitudes toward learning should be taken into account when the curriculum is carried out in schools. If it is, students can enjoy new opportunities for learning in school settings by using new technology.

The use of modern technology, networks and computers has increased in Finnish schools over the last decade. Yet it seems that the issue here is not necessarily *how much* ICT is used in teaching, studying and learning; rather, the issue is *how* ICT is used. The possibilities of new technology are still not used in favor of pedagogical changes; pedagogical thinking in educational institutes has not advanced in parallel with technological advances. Tools provided by new technology are used mainly in order to carry out tasks from a pedagogical point of view that is not able to grasp how to utilize ICT in education to its full potential (Sipilä, 2008). Technologies should be used to enhance the abilities of the individual within the context of a school. Kim and Kim (2001) stated that the focus should not be on utilization of high-tech information devices or facilities but whether the user knows how to use ICT to improve the quality of his or her life. The schools' responsibility should lie in preparing students with both the technological skills and the abilities to learn how to accomplish personal objectives in efficient ways.

In recent years, most progress has been made in increasing teachers' positive attitude toward ICT by fostering an understanding of its value for learning through using and experiencing it more. Teachers are increasingly using ICT to prepare their work more efficiently and to save time. The ICT Impact Report benchmarking survey (2006) showed that 90% of teachers in Europe already use ICT to prepare their lessons. Recent studies also show the benefits of ICT in increasing motivation and developing skills in students. The report also revealed that a very high percentage (86%) of teachers in Europe state that students are more motivated and attentive when computers and the Internet are used in class. ICT has a strong motivational and positive effect on behavior, communication and processing skills. Multimedia and interactive content on interactive whiteboards is engaging and motivating, particularly for primary students, and students pay more attention during lessons.

The Virtual Learning Environment (VLE) is gradually becoming a more central part of the teaching and learning process in Finnish basic education schools. VLE is an online set of teaching and learning tools designed to enhance a student's learning experience by including computers and the Internet in the learning process. VLE is usually defined in terms of time, location and space. VLE can be defined as "computer-based environments that are relatively open systems, allowing interactions and encounters with other participants" (Wilson, 1996, p. 8). In Finland, one of the commercial VLE providers is an environment called Opit. Opit has been developed and hosted by Sanoma WSOY Education and Books, which is one of the leading educational publishers in Europe and the leading book publisher in Finland. Opit differs from other VLEs in a profound way as Opit is the only environment that, in addition to the typical tools of VLEs, offers vast learning material and resources for teachers and students to utilize in their teaching and learning. The data for this study was gathered from a questionnaire that was published in Opit in October 2008.

At the end of the 20th century, the focus in Finland was to provide educational institutions with an adequate technical infrastructure in order to successfully carry out what the national curriculum and the Ministry of Education had stipulated about how to continue promoting information development in Finland. This resulted in schools beginning to have networked computers, but how to integrate them into teaching effectively remained unclear. Ten years later, the focus has shifted. Today, as VLEs have changed the way networked computers can be used in teaching and learning and it is becoming clearer that learning is not so much about the outcome of studying as the process itself, it is necessary to study how students of primary and secondary schools in Finland react to these theoretical, pedagogical and technological innovations.

New technology opens up new possibilities for differentiated learning and a more student-centered approach to education. With virtual learning environments, the student can be given alternative routes to learning based on his or her personal needs. It also gives teachers more possibilities to modify their teaching and focus more on the learning process than the learning outcome. The question is whether or not educational institutions will learn to adapt these new tools into their framework in a way that enhances learning.

Theoretical background

The scientific conception of learning has changed. The focus has shifted from a teacher-centered to a learner-centered approach, from individual to collaborative learning, from teaching to guidance and from instantaneous absorption of knowledge to life-long learning. The purpose of education and learning is to provide the means for students to develop mental tools and learning strategies with which they can obtain the knowledge they need for the different aspects of life (Hakkarainen, 2000).

The theoretical framework of this study is based on a socio-constructivist learning theory. The evolution of the scientific concept of learning itself has been a long process. The conception of learning is based on a socio-constructivist approach that emphasizes the active construction of knowledge in a social context (Säljö, 2001). One of the main principles that socio-constructivist learning theory stresses is the promotion of conceptual changes in the learner's mind. When traditional cognitive learning research focused on studying individual problem-solving processes, principles of shared cognition stated that the necessary knowledge and expertise are seldom in the possession of one individual (Asanti, Lehtinen, & Palonen, 2002). Socio-constructivist learning theory suggests that learners construct knowledge. Constructivism is often associated with pedagogical approaches that promote active learning by doing. Social constructivism views learning as a process of enculturation brought about by social interaction; it extends constructivism into social settings, wherein groups construct knowledge for one another, collaboratively creating a small culture of shared artifacts with shared meanings. As more and more software is used online and tools in VLEs open possibilities of collaborative interaction, communication and working, it is important to acknowledge how students take these new technological tools into account as a part of their learning environment.

Motivation is about the reasons for behavior, why we do what we do; it concerns the psychological processes behind student behavior in learning situations. It is important to understand the difference between motivation and engagement; students can be motivated but disengaged (DEST, 2008). Russell, Mackay, and Jane (2003) found primary and secondary students to have high learning motivation, but with minimum levels of interest in their classroom work. Inner motivation to learn does not help if schoolwork is not stimulating. Motivation of students to learn regarding the use of ICT and VLE has been studied before. Grepperud (1999) noticed that many students from grades eight to ten tended to describe learning in school as monotonous and boring. Even though they all realized that it is wise to perform well in school to be able to succeed later, many students complained about the lack of stimulating activities and challenges that were integrated into the context of real life. Bovée, Voogt, and Meelissen (2007) found in their study that when computers are used more often in education, students enjoy school more. Swan, Van Hooft, Kratoski, and Unger (2005) reported that the use of mobile computing improved students' motivation to learn and engage in learning activities. Lim and Tay (2003) reported students' engagement to be on a greater level of higher-order thinking when they were using ICT tools.

Time is also a factor in how computers are used in schools. A Norwegian ITU monitor (2005) showed that students in Norwegian primary schools had little opportunity to acquire experience using computers and utilizing ICT in their studies. This was due to the limited amount of time that was spent at the computer during the course of a normal school week. Twenty percent of seventh- and ninth-grade students reported that they had no weekly use of computers in school, while 50% to 60% of the students said that they used computers less than one hour per week. If students use computers at school for a very limited period of time and if, for the most part, computers are used for the simplest of tasks such as the Internet and word processing, there really is a need for schools to develop the use of ICT in a way that will enhance learning.

Moore (1994) found a positive correlation between computer experience and attitude. Selwyn (1998) discovered that high school students who use a computer at home have a significantly more positive attitude toward the use of computers than students who do not use a computer at home. Computer use at home seemed to have a positive effect on the general performance of students in school. The impact of teachers' attitudes to computers can also be a significant factor (McIroy, Bunting, Tierney, & Gordon, 2001; Van Eck & Volman, 2001). If teachers are confident and relaxed with computers, the teachers are likely to be a positive influence on students.

We use different ways to communicate. Learning first evolves as a social process through communication, and later on, at an individual level (Vygotsky, 1978). The way we understand learning changes through time as part of a broader cultural change. Both rapidly evolving technology and reconstituted learning theories have brought us into a transitional phase that is, without doubt, having an effect on educational institutions, the school framework and the way students communicate and learn. The study presented in this paper looks at this phase from a student's point of view as the study focuses on student motivation, their attitudes toward studying with ICT and VLE regarding their age and self-evaluation of their success in school subjects.

Research Questions

The research questions of this study are as follows:

- Does motivation, age or self-estimated level of success in learning make a difference to students' attitudes toward VLE or ICT?
- Is there a difference in attitude toward VLE and ICT with students who like studying compared to those who do not?

Methods

The research data consists of 758 answers to an online questionnaire (N=758). The invitation to take part in this questionnaire was originally sent to basic education students in 13 municipalities in Finland that were using Opiit. The exact number of students who received the invitation to participate in the questionnaire is not known. The questionnaire had five background questions and 45 questions concerning motivation and the use of VLE and ICT in learning. The questions were Likert-type statements (*I always do my homework*) with four scale answering options (*strongly agree–strongly disagree*). Table 1 presents the class grade distribution of the participating students.

Grade	Frequency	Percent
1	1	.1
2	27	3.6
3	54	7.1
4	189	24.9
5	178	23.5
6	173	22.8
7	28	3.7
8	65	8.6
9	43	5.7
Total	758	100.0

Table 1: Class grade distribution of the respondents.

Twenty of the statements in the questionnaire were designed to measure students' attitudes toward using VLE. These were the basis for constructing a combined variable for continued analysis. Fifteen statements concerning motivation and 10 concerning ICT were used in a similar way to provide combined variables. Cronbach's alpha values and means for different scales are presented in Table 2. The table also contains numbers of items for each scale, skewness and kurtosis values.

Scale	Number of item	Cronbach's alpha	Item mean	Skewness	Kurtosis
VLE	20	0.946	2.950	-0.667	0.131
ICT	10	0.937	3.114	-0.848	0.421
Motivation	15	0.883	3.068	-1.079	1.746

Table 2: Reliability of the scales.

The reliability analysis revealed that the scales were satisfactory and provided a good basis for further analyses.

Results

At the beginning of the questionnaire, the students were asked to assess on a four-scale framework how much they liked studying. Of the 758 participants (N= 758) of the study, 9.6% did not like studying at all, 42.9% liked it to some extent, 38.1% liked studying quite a lot and 9.1% liked it very much. As one of the research questions of this study was to find out whether these differences had any relevance to students' attitudes toward the use of VLE, the variables were analyzed in relation to each other. The analysis of students' attitudes toward studying in relation to how they valued using VLE is shown in Fig. 1.

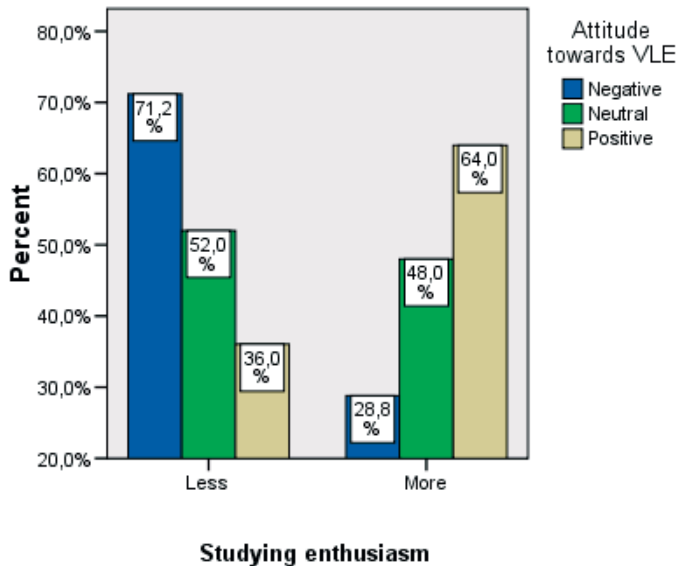


Figure 1: Students' attitudes toward studying compared to their attitudes toward VLE.

The analysis of the data showed that the students who were more positive about studying also regarded the use of VLE in school more positively on a statistically significant level ($p = 0.000$). The mean rank score for using VLE was 324.89 (SD = 0.66) in the group that valued studying less and 439.87 (SD = 0.57) in the group that liked studying more. The same tendency was present on a statistically significant level ($p = 0.008$) when attitudes toward studying and how students valued the use of ICT in their learning were compared.

With respect to the age of the participants, it became clear that the older the respondent, the more negative the response. Table 3 presents a summary of the respondents' scores when divided into two groups based on their age and then compared with values for motivation and the use of ICT and VLE.

	2-scale school grade division	N	Mean	Std. Deviation	Std. Error Mean
Motivation	Younger	449	2.11	.618	.029
	Older	309	1.85	.672	.038
VLE	Younger	449	2.17	.692	.033
	Older	309	1.80	.678	.039
ICT	Younger	449	2.08	.693	.033
	Older	309	1.96	.724	.041

Table 3: The difference between younger and older students in their scores for motivation, VLE and ICT.

Independent samples (t-test) gave similar results as can be seen in Table 3, indicating that older students' motivation decreased ($t(756) = 5.542, p = 0.000$), their opinions about VLE grew less positive ($t(756) = 7.249, p = 0.000$) and their enthusiasm about ICT sank ($t(756) = 2.195, p = 0.028$). When looking at the data through a variable that measured how long the respondents had been using VLE, there was the same tendency with scores decreasing as the years of use increased. This question supported only the notion that the older students' scores decreased on all the scales measured.

The students were asked to give their own evaluation of how well they thought they had succeeded in studying and learning. Fig. 2 shows students' evaluation of their success in school compared with their motivation to study.

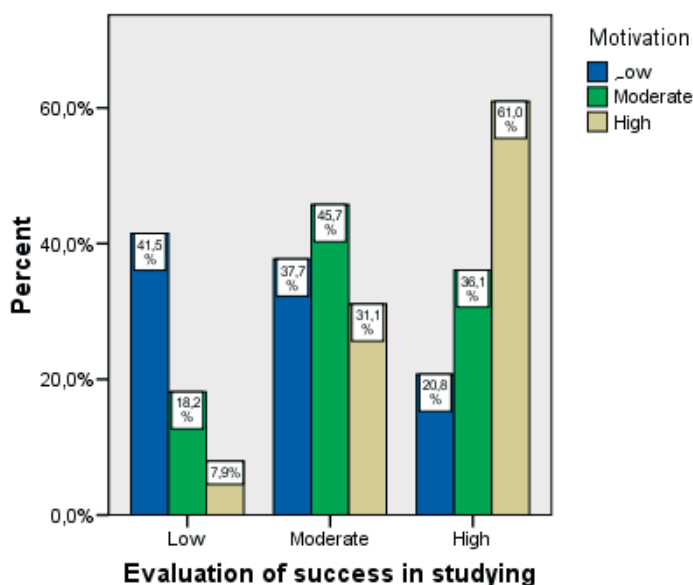


Figure 2: Students' evaluation of their own success compared with their motivation to study.

Of the respondents, 79.1% evaluated their success in school to be on a good level at the very least. While it is possible that their self-evaluation might have been based on overestimation of their personal abilities, when comparing students' evaluation of their success at studying with their motivation to study, the analysis revealed that students were quite honest in their responses, as Figure 2 shows. Of the students, 61.0% who evaluated their success at studying highly were also highly motivated to study. Students who evaluated themselves to be successful in their studies tended to give more positive feedback about statements concerning the use of ICT ($\chi^2(4) = 15.192; p = 0.000$).

The results showed that students liked working with computers. The statement 'I like it when ICT is used in learning and education' got the highest mean (3.27) from the 10 statements concerning ICT in the questionnaire. Students who evaluated their success at studying highly rated ICT in a more positive way on a statistically significant level ($\chi^2(4) = 15.192; p = 0.004$).

		Success in studying			Total
		1	2	3	
3 -scale level of ICT attitudes	1	51 28.5%	74 41.3%	54 30.2%	179 100.0%
	2	77 20.4%	158 41.8%	93 46.3%	378 100.0%
	3	30 14.9%	78 38.8%	93 46.3%	201 100.0%
Total		158 20.8%	310 40.9%	290 38.3%	758 100.0%

Table 4: Students' attitudes toward ICT compared to their self-evaluated success at studying.

Table 4 shows that 46.3% of students who evaluated their success at learning positively belonged to the group that were the most positive in their attitudes toward the use of ICT in learning. Only 14.9% of the same group was among those who evaluated their success at studying on the lowest level.

Discussion

It is believed that ICT motivates students in their learning. The results of this study show that this belief is not that straightforward. Students, who are not motivated to learn, or evaluate themselves to be less successful in their learning, do not seem to be as motivated by ICT or the use of VLE as those students who are motivated and who perceive themselves as successful. These students value the use of ICT and VLE. The simple explanation for this phenomenon could be that students regard the tools and methods used in school as a whole; even though students like using computers and software, the way they are used in schools do not motivate students to be active in higher-level learning. ICT in schools is used to teach various subjects; computers and software are often utilized in order to achieve low-level learning goals, applying teaching methods that do not give way to new pedagogical ideas or learning theories that could enhance learning and empower students to learn in new ways. If ICT or VLE is used mainly for controlling students, for drilling practice or for sharing basic learning material, the motivational effect of the new tools will soon fade away. An ICT-based virtual learning environment should be used for problem-based learning and collaborative work where students work together and share ideas, negotiate solutions, and construct knowledge. Their learning should involve challenging and authentic problems to solve. By providing a more personal learning path and an interactive learning process, it should be possible to make students more engaged and active, thus having a positive effect on their attitudes toward learning in general.

ICT alone is not enough to trigger the change for achieving better learning outcomes. Providing students with VLE will not make in-depth learning follow automatically (Earle, 2002). Technological tools must be profoundly integrated with the curriculum and pedagogically grounded in order to activate higher-order thinking in students. If a student lacks motivation to learn, drilling practices and tasks giving feedback automatically may result in student entering answers or values, waiting for negative feedback and then continuing with more guesswork. With ICT, it is possible to give students more autonomy in their learning, but at the same time, it is vital to provide scaffolding structures to contribute to the learning process. With orienting activities, it is possible to help students manage their learning with ICT and stay focused on the learning objectives, as Oliver and Hannafin (2000) concluded. According to Erstad (2003), it is a matter of finding a balance between setting the students free from the traditional restraints of the school system and at the same time giving them enough guidance and challenges in their quest for knowledge. Students of today are accustomed to the use of technological tools, software and social networks; they have gone through the process of enculturation with ICT. It is the school's responsibility to adjust to society. Transfer metaphor (teachers passing knowledge to students) should not be guiding schools in how to teach. Instead, schools should teach skills that help learning to learn and skills that empower lifelong learning.

Roschelle, Pea, Hoadley, Gordin, and Means (2000) stated that the education system is like a locked puzzle. If you want to move or change the place of one piece in the puzzle, you can do so only if the other surrounding pieces are evolving at the same time. The perception of educational institutions in society has evolved over a very long time span. This perception, what school is supposed to be like and how subjects should be taught, is easily transferred and adopted by students in primary school. Thus, even if we manage to bring ICT and VLE into classrooms and provide students with learning material and activities that we think are pedagogically modern and that encourage students to construct knowledge collaboratively, there can still be a piece missing from the puzzle. Students are used to carrying out tasks because the students are expected to do so, not because they want to. New technologies can motivate students for some time and be easy for them to use, but without proper motivation and pedagogically grounded learning strategies, students tend to use new tools for practicing a restricted form of information gathering rather than undertaking a more iterative and expansive process of knowledge building. When developing technological tools or pedagogical practices in order to enhance teaching and learning in educational institutions, it is always important to understand how students react to these changes.

References

- Asanti, R., Lehtinen, E., & Palonen, T. (2002). Changes in working life [Työelämän Muutokset ja Osaamisen Haasteet]. In E. Lehtinen & T. Hiltunen (Eds.), *Learning and teachership* [Oppiminen ja opettajuus](pp. 87–108). Turku, Finland: Turun opettajankoulutuslaitos.
- Australian Government Department of Education, Science and Training (DEST). (n.d.). *Schooling Issues Digest: Student motivation and engagement*. Retrieved November 23, 2008, from http://www.dest.gov.au/sectors/school_education/publications_resources/schooling_issues_digest/schooling_issues_digest_motivation_engagement.htm
- BECTA. (2001). *Primary schools of the future: Achieving today*. Coventry, England: Author.
- BECTA. (2002). *Impact 2: Final report*. Coventry, England: Author.
- BECTA. (2003). What the research says about virtual learning environments in teaching and learning. ICT Research. Coventry, England: Author.
- Bové, C., Voogt, J., & Meelissen, M. (2007). Computer attitudes of primary and secondary students in South Africa. *Computers in Human Behavior*, 23(4), 1762–1776.
- Cox, M., & Abbott, C. (2004). ICT and attainment—A review of the research literature. City: DfES/BECTA.
- Earle, R. S. (2002). The integration of instructional technology into public education: Promises and challenges. *Educational Technology*, 42(1), 5–13.
- Erstad, O. (2003). Electracy as empowerment: Student activities in learning environments using technology. *Young*, 11, 11–28.
- European Schoolnet. (2006). *The ICT impact report*. Retrieved September 20, 2008, from http://insight.eun.org/shared/data/pdf/impact_study_executive_summary.pdf
- Grepperud, G. (1999). The school owns half the day [Skolen Eier Halve Dagen]. In *Stemmeskifte – en rapport fra ordskiftet om ungdomsskolen* (pp. xx–xx). Oslo: Barneombudet.
- Hakkarainen, K. (Ed.). (2000). Foreword. In *How do we learn* [Miten opimme: aivot, mieli, kokemus ja koulu]. Helsinki: National Research Council, WSOY.
- ITU monitor. (2005). Retrieved October 7, 2008, from <http://www.itu.no/ituenglish/1093980667.4/1158725912.54>
- Kim, M. C., & Kim, J. K. (2001). Digital divide: Conceptual discussions and prospects. *Human society and the Internet. Proceedings (LNCS)*, 2105, 78–91.
- Lim, C., & Tay, L. (2003). Information and communication technologies (ICT) in an elementary school: Students' engagement in higher order thinking. *Journal of Educational Multimedia and Hypermedia*, 12(4), 425–451.
- McFarlane, A., & Sakellariou, A. (2002). The role of ICT in science education. *Cambridge Journal of Education*, 32(2), 219–232.
- McIlroy, D., Bunting, B., Tierney, K., & Gordon, M. (2001). The relation of gender and background experience to self-reported computing anxieties and cognitions. *Computers in Human Behavior*, 17, 21–33.
- Moore, C. (1994). Attitudes towards computers: The influence of sex stereotypes, experience, ownership and mathematics. *Unisa Psychologia*, 21(1), 20–27.
- Oliver, K., & Hannafin, M. (2000). Student management of web-based hypermedia resources during Open-ended Problem-solving. *The Journal of Educational Research*, 94(2), 75–92.
- Roschelle, J., Pea, R., Hoadley, C., Gordin, D., & Means, B. (2000). Changing how and what children learn in school with computer-based technologies. *The Future of Children. Children and Computer Technology*, 10(2), 76–101.

- Russell, J., Mackay, A., & Jane, G. (2003). *Messages from the myriad: Improving the middle years of schooling*. Melbourne, Australia: IARTV Jolimont.
- Säljö, R. (2001). *Learning in practice: A sociocultural perspective* [Oppimiskäytännöt, Sosiokulttuurinen näkökulma]. Helsinki: WSOY.
- Selwyn, N. (1998). The effect of using a home computer on students' educational use of IT. *Computers and Education*, 31, 211–227.
- Sipilä, K. (2008). Mobile technology and teachers' attitudes towards ICT in basic education. In: *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications* (pp. 3270–3278). Chesapeake, VA: AACE.
- Swan, K., Van Hooft, M., Kratcoski, A., & Unger, D. (2005). Uses and effects of mobile computing devices in K-8 classrooms. *Journal of Research on Technology in Education*, 38(1), 99–112.
- Van Eck, E., & Volman, M. (2001). Gender equity and information Technology in Education: the Second Decade. *Review of Educational Research*, 71(4), 613–634.
- Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wilson, B. G. (1996). *Constructivist learning environments: Case studies in instructional design*. Englewood Cliffs, NJ: Educational Technology.

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The impact of laptop provision on teacher attitudes towards ICT

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The impact of laptop provision on teacher attitudes towards ICT

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The use of information and communication technologies (ICTs) in Finnish primary and secondary schools has been increasing for the last decade, but the full potential of the new technology has not been achieved; pedagogical thinking in educational institutes has not advanced in parallel with technological advances. Teachers' attitudes towards the use of ICTs in schools are significant factors in determining how technology is used in schools. The aim of this study is to investigate if there is a difference in attitudes towards ICTs by teachers who have a personal laptop computer (provided by the employer) compared to teachers who have not. The data were collected by means of an online questionnaire, to which 69 teachers out of 196 (31%) from four schools replied. Analysis of the data reveals that teachers who used personal laptops in their work regarded the use of ICTs, both in teaching and in general, more positively than teachers who did not.

Keywords: attitudes; teachers; mobility; technology; pedagogy

Introduction

Information and communication technologies (ICTs) have rapidly changed our society, whether we look at it from a global, national, or local perspective, and it is important to foresee these changes and to react and adapt to them in a timely manner. The technological revolution is a major challenge for teachers' professional development, as the knowledge society challenges them to adopt new pedagogical practices in order to facilitate higher level knowledge acquisition skills the learners need to empower lifelong learning (Hakkarainen et al., 2001). The development of teaching and learning by investing in providing ICTs resources to schools has proven to be worthwhile. Evidence in the research literature shows that ICTs have a positive effect on pupils' attainment in almost all the National Curriculum subjects (Cox & Abbott, 2004). Rogers and Finlayson (2004) concluded that ICT made subject knowledge more accessible, stimulated thought, and improved learning. Educational institutions play vital roles in helping children to acquire the capacity to learn and the knowledge they will need in their future years.

In Finland, the first six years of basic education are provided by the class teacher, who teaches all, or most, subjects. During the last three years, subjects are usually taught by different (specialised) subject teachers. The *Development Plan for Education and Research 2003–2008* (Ministry of Education of Finland, 2004a) is based on a vision developed by the Finnish government regarding how to continue to promote the development of an information society in Finland. The programme states that care will be taken during the programme period to ensure that all students have opportunities

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to gain the knowledge and skills they need to operate in an information society. The vision of inclusion in an information society requires that all citizens have access to technical devices and skills in their use. The vision, and the plans for its development, have greatly affected the newly reformed Finnish National Core Curriculum (Finnish National Board of Education, 2004), which is the foundation of education, teaching, and learning. Both the national and the municipal curricula currently emphasise the importance of using modern teaching methods and modern information technologies. With these guidelines, the curricula foster transformational thought in the classroom, making way for ICTs to be used to their full potential in classrooms. To realise the vision, the teaching framework in schools will need to change. The *Information Society Programme for Education, Training and Research* (Ministry of Education of Finland, 2004b) identifies major priorities and actions for boosting the information society development in education, training and research. The programme aimed to improve the training of teaching personnel, to produce high-quality, pedagogically sound educational material, and to make sure that appropriate use of ICTs in learning and in teaching is part of everyday school life.

Global megatrends, ICTs being one of them, are also having an effect on schools. The use of modern technology, networks, and computers has been increasing in Finnish schools for the last decade. In the 1990s, the focus was on providing teachers with the necessary technical skills and support structures that they needed to integrate ICTs into their classrooms. At the beginning of the twenty-first century, this focus shifted to thinking about how to bring ICTs into schools in a pedagogically appropriate manner. It seems that the issue is not necessarily how much ICTs are used in teaching-studying-learning processes, but rather how they are used. The opportunities that new technology can provide are still not recognised in relation to pedagogical changes; pedagogical thinking in educational institutes has not advanced in parallel with technological advances. Tools provided by new technologies are mainly used to carry out tasks that have been set up based on a pedagogical approach that is unable to grasp how to utilise ICTs to their full potential in a learning environment; nevertheless, it is generally considered that the use of ICTs in education adds value to teaching and learning (Kansanen et al., 2000) if they are used in a pedagogically meaningful way.

The perspectives on the state of utilising ICTs in schools mentioned above are fairly common conceptions; it is not the purpose of this study to try to challenge those beliefs.

In order to increase and deepen the level of learning with the use of ICTs, most ICT-based tools have in general been fully merged with the social practices of teachers and students; only then are their intellectual resources genuinely augmented and learning achievements correspondingly facilitated (Hakkarainen, 2009). Until these changes are implemented, the inconsistent use of new technologies in schools and the slow speed at which ICTs are integrated into teaching and learning will remain. This slow integration of ICTs can be explained from a historical perspective: schools have typically adopted changes very slowly, and these changes will eventually gather momentum. This perspective is anchored in the belief that technological change is inevitable; however, it is not an entirely valid explanation, because technology itself does not necessarily trigger change. Another historical point of view relates to teacher-centred teaching practices; a teacher has to have the knowledge to utilise ICTs in a pedagogically grounded manner in teaching. Therefore, in order to change teaching methods, the advantages of using new technologies should be clear to the teachers;

otherwise, they will not be motivated to change. Defects in equipment can also explain the problems mentioned above. If technical glitches occur, whether weekly or a few times a month, then confidence in the technology's worth is undermined and contributes to sustaining current teaching practices (Cuban, Kirkpatrick, & Peck, 2001).

There are numerous factors that can affect a teacher's readiness to bring ICTs into a classroom. Wozney, Venkatesh, and Abrami (2006) conclude that teaching styles, frequency of computer use outside of teaching activities, amount of technology-related training, and accessibility of resources within the school all had a significant effect on how much technology was used. Hallam (2008) presents evidence that differences between teachers with and without computer anxiety appear to be related to differences in social resources within the sociocultural environment of computing. It is clear that simply providing a technological tool for a teacher does not solve all the problems regarding ICTs in schools. However, providing laptop computers for teachers is a recent phenomenon; the motivation of this study is to see how this personal, mobile medium is adopted as a teaching and learning tool.

Learning today is seen as a process during which we adapt and absorb parts of a culture. Learning occurs by means of the conditions and mediating tools provided by the culture. In addition to learning skills and knowledge in schools, we socialise in a culture-specific way and engage in a culture's activities. As society and the concept of learning are evolving, the schools' framework will also gradually change. The focus of this study is on finding out whether mobile technologies will have an effect on teachers' attitudes towards ICTs. Are these technological advances having an effect on how we teach and learn in schools?

Lieto, a small municipality in south-western Finland, near Turku, has developed a long-term development strategy to bring technology into teaching and learning. All schools are equipped with modern ICT classrooms, and wireless local area network connections are available; commercial e-learning platforms with ready-made content are widely utilised. ICT support is adequate and professional, pedagogical training and support are available. As part of the latest ICT education strategy, Lieto decided to make an effort to provide a personal mobile laptop computer to every teacher. During 2006, teachers in four of the nine basic education establishments were provided with laptops. This paper presents the results from research which was conducted to determine whether there was a difference in attitudes towards ICTs by those teachers who had personal laptop computers, compared to the teachers who had not.

Theoretical background

The theoretical framework of this study is based on Bandura's efficacy theory, also known as the social learning theory. Bandura's (2001) theory provides a theoretical context which helps us to understand how technology impacts teachers. This theory proposes that an individual creates a database on how certain actions will drive certain outcomes. This database then becomes a resource that helps the individual determine what outcome can be expected from different circumstances, and also to determine how he or she should behave in order to produce a specific desired outcome. Teachers' actions are based upon their belief systems. The key to change is in their belief that they have the power to produce change with their actions. Further, in order to achieve certain outcomes, teachers need a strong sense of self-efficacy. Their perceived self-efficacy is a crucial link to the decisions that they make, which in turn establish their teaching methods. Teachers must have an understanding of the change process before

they are able to lead complex behavioural changes, such as using computers in the classroom. Fullan (2001) notes that there are no shortcuts for leading complex change. It is also clear that self-efficacy is not the only factor that has an effect on changing teaching and learning. The role of leadership, experience and knowledge of computers, and attitudes towards computers are vital to the successful implementation of change (Piper, 2000).

The scientific concept of learning has changed. The focus has shifted from a teacher-centred approach to a learner-centred approach; from individual learning to collaborative learning; from teaching to guidance; and from instantaneous absorption of knowledge to life-long learning. The purpose of education and learning is to help students to develop the mental tools and learning strategies with which to acquire knowledge and which will enable them to consider different aspects of life (Hakkarainen, 2000). Scardamalia and Bereiter (2003) describe the 'knowledge age' as the era in which the ability to innovate is decisive in relation to the health and wealth of society. Further, Bielaczyc (2006) states that the central challenge in implementing knowledge-building pedagogy in schools lies in creating the appropriate social infrastructure around the implementation of technology, specifically in the classroom practices and online activities involving the use of the technological environment, so that the old 'transfer metaphor' model of education (where knowledge is passively received) is rejected. As Ilomäki (2007) states, schools that successfully adopt ICTs into teaching and learning can have a positive impact on adjusting both teaching and learning methods to meet the demands of the curriculum and modern learning theories. When one is immersed in a culture like this, one learns how to be a part of that culture, on many levels. Can similar enculturation be detected in the attitudes of teachers who took part in this study?

Haaparanta (2007) found that pedagogical problems increase as the technical infrastructure in schools improves and as ICTs are used more frequently. According to previous research, adding technology to the learning environment cannot cause significant changes to the teaching-studying-learning processes by itself; changes in schools' frameworks and procedures are also required (Lehtonen, 2003). To utilise technology in a pedagogically meaningful way, reorganisations in the three processes mentioned above (teaching, studying and learning) as well as in individual actions, attitudes, and pedagogical models are required (Enkenberg, 2003). Wentworth and Popham (2005) found that giving mobile technology and laptop computers to teachers encouraged them to develop inquiry-based lesson plans and to use technology innovatively in order to enhance learning. With the aid of technology, Carroll (2000) proposed that the teacher becomes an expert learner, organising and leading others in networked learning communities.

Teachers are inclined to use their own experiences and practical, commonplace knowledge as a basis for their decision-making in teaching, rather than adopting ideas and guidelines stated in theoretical, science-based knowledge or the curriculum. It is generally accepted that, as teachers gain experience with computer technology, the use of computers in the classroom evolves into using more computer applications, more often, and more flexibly. But even if the large majority of teachers have sufficient skills for everyday and routine working practices, many of them still have difficulties in finding a meaningful pedagogical use for technology (Ilomäki, 2008). Attitudes towards ICTs can also be barriers; gaining the experience and an understanding of how to use ICTs is time-consuming and requires commitment. Attitudes toward ICTs bear a significant relationship with, and also predict, competence (Jegede, Dibu-Ojerinde,

& Ilori, 2007). The importance of previous computer experience is widely recognised (Snoeyink & Ertmer, 2001), even though attitudes partly depend on personality (Guha, 2000). Perceptions of the ease of use and relevance of ICT can be affected by negative experiences, making teachers less confident and more anxious.

Teachers' attitudes toward ICTs have been studied previously. Albirini's (2006) findings suggest that teachers have positive attitudes toward ICTs in education. The results point to the importance of teachers' concept of technology itself, their experiences with it, and the cultural conditions that surround its introduction into schools, in shaping their attitudes toward technology and its subsequent diffusion in their educational practice. Bullock (2004) found that teachers' attitudes are a major factor in enabling/disabling the adoption of technology. Meelissen and Drent (2008) stated that female teachers assess their knowledge and skills in ICT considerably less positively than male teachers do. Shapka and Ferrari (2003) suggest that female teachers are less likely to apply computers for various teaching and learning purposes. Some researchers (King, Bond, & Blandford, 2002; North & Noyes, 2002) have pointed out that gender should not be an issue with regards to basic ICTs skills. However, other studies have provided evidence that gender inequalities now emerge in new areas of ICTs use. Males tend to be more intensive users of the Internet, enjoy more competitive forms of e-learning, and encounter different problems while using ICTs (Colley, 2003). A study by Anyan, Owens, and Magoun (2000) (which studied teacher attitudes towards ICTs and considered the teachers' gender, teaching experience, and teaching levels) concluded that female teachers had a better attitude towards technology than their male colleagues. Anyan et al. also found a dependency (although weak) on the teaching level: elementary school teachers were less positive in their attitudes than their middle or high school colleagues. Piper and Austin (2004) conclude that the teacher's attitude towards working with the computer, and his or her perception of leadership and professional development, have an impact on his or her beliefs about using the computer in an instructional setting.

A team assigned by the Finnish National Board of Education to make development plans for education and research has recommended that the changes and influences on a teacher's work when using ICT in education should be studied and analysed. The study presented in this article addresses this issue from a local municipal level by presenting a comparison group of teachers to whom mobile, personal laptop computers are provided by the employer. Piper (2000) showed that, despite extensive professional development opportunities, if the teachers ultimately have a negative attitude about the use of computers in the classroom or feel the leadership isn't supportive of the initiative or the teacher, then it is likely that the teacher's self-efficacy in using the computer in the classroom will be negatively influenced. Providing teachers with mobile laptop computers, however, adds a new dimension to the framework of teachers, ICTs, and learning. Mobile technology gives teachers new possibilities to prepare, plan, and carry out their teaching. The possibility of using these laptops at home as well, and in their spare time, is also proposed to have an effect on the way the teachers utilise ICTs. A personal laptop would provide a teacher with the opportunity to practise ICT skills, to test new tools and methods, and to raise their professional status with regard to the use of technology. Mobile technology could be a key factor in influencing their attitudes towards the innovation and thus having an effect on their self-efficacy of using computers in the classroom. If this proves to be the case, it would be vital for educational institutions to look into their policies and practices for investing in utilising ICTs in schools.

Research questions

The research questions addressed in this study are:

- Do teachers who have a personal laptop computer have different attitudes towards ICTs compared with teachers who have not?
- Does gender have an effect on the attitudes of the teachers within the comparison groups?
- Does teaching experience have an effect on the attitudes of the teachers within the comparison groups?
- Does being a classroom teacher (one who teaches many subjects) or a subject-specific teacher make a difference in attitudes towards ICTs?

Methods and data collection

The research data consist of 69 participants' answers to an online questionnaire (N = 69). An invitation to take part in this questionnaire was originally sent to 196 teachers, which was the number of basic education teachers in Lieto at the time. The response rate was 31%. The basis of the questionnaire was the Survey of Teachers' Attitudes toward Information Technology Questionnaire (TAT v.3.2a) which was developed by IITTL (the Institute for the Integration of Technology into Teaching and Learning). The original questions were first translated into Finnish and then edited to suit the needs of the study. The final questionnaire had 168 questions that were divided into 12 different sections, which were Likert questions (for example: 'To me multimedia is important – not important') and statement sentences (for example: 'I want to learn a lot about computers') with answering options on a scale from one to five (*strongly agree* – *strongly disagree*). Both positive and negative types of questions were used randomly throughout the questionnaire. After preliminary reliability and validity checks, the questions were organised according to the following subscales:

- enthusiasm;
- anxiety;
- productivity;
- semantic perception of computers;
- developing teaching methods and professional skills with ICTs;
- utilising ICTs in teaching-studying-learning processes;
- e-learning platforms and communication technologies;
- email, multimedia, Internet.

The analysis of the research data was performed statistically with *SPSS*, a computer statistics program. Negatively oriented belief statements were reverse coded after data collection to facilitate their interpretation. Missing data were replaced with the variable response mean. The consistency of the data was assured by looking at descriptive statistics, correlation coefficients and other statistical methods. Concept validity and the structure of the scale were assessed by using factor analysis.

Results

Of the 69 participants (N = 69) in the study, 62.3% were female and 37.7% were male. Almost half of the participants (49.7%) had had teaching experience of more than

15 years, and 76.8% of the participants had a computer in the classroom. A projector was available in the classroom for 27.5% of the respondents.

Attitudes and laptops

The main research question of this study was: Do teachers who have a personal laptop computer have different attitudes towards ICTs compared with teachers who have not? Because it is not customary for teachers in Finland to utilise expensive personal equipment in teaching, all of the teachers in the four schools concerned were given the possibility to receive a laptop provided by their employer, which they accepted. After the provision of laptops, the teachers were given some technical support in order to make sure that all of them knew for instance how to connect the laptop to a data projector, to an external sound amplifier, and so on. They did not receive any extra pedagogical support. This was to minimise the possibility of affecting their attitudes before the questionnaire; the data for this research were gathered within six months after the provision of laptops. The invitation to reply to the questionnaire used for gathering data for this research was sent to all teachers in Lieto; the fact that almost half of the participants were those who did receive laptops was purely coincidental. The division between those participants who had a laptop provided by the employer and those who had not can be seen in Table 1.

The differences in respondents' views about utilising ICTs in teaching and learning are presented in Figure 1.

The variables that measured teachers' negative, neutral or positive attitudes towards utilising ICTs in the teaching-studying-learning processes revealed that there was a slight ($p = 0.023$) correlation between having a laptop for use and the teacher having a positive attitude. When the respondents' means in this subscale were compared with a T-test, the results were statistically significant ($p = 0.009$). As can be seen from Figure 1, 57.6% of the teachers who had laptop computers for their use had a positive attitude towards the subscale. Only 25% of the teachers who did not have a laptop computer for their use had a positive attitude towards this subscale. Respondents with laptops had more positive attitudes towards utilising ICTs in teaching and learning. Respondents' answers for each of the two comparison groups are presented in Figure 2.

The same tendency was also present when analysing respondents' attitudes towards email, the Internet, multimedia, use of ICTs in developing teaching methods, improving the development of professional skills, and use of ICTs in teaching. Teachers who had the use of a laptop gave, on average, higher values to all of the six subscales presented in Figure 2. The biggest difference with the two comparison groups was in their attitudes towards developing teaching methods using ICTs. However, developing professional skills with ICTs and utilising ICTs in education also received higher values from teachers with a laptop to use. The differences,

Table 1. Has your employer provided you with a personal laptop computer?

	Frequency	Percent
Yes	33	47.8
No	36	52.2
Total	69	100.0

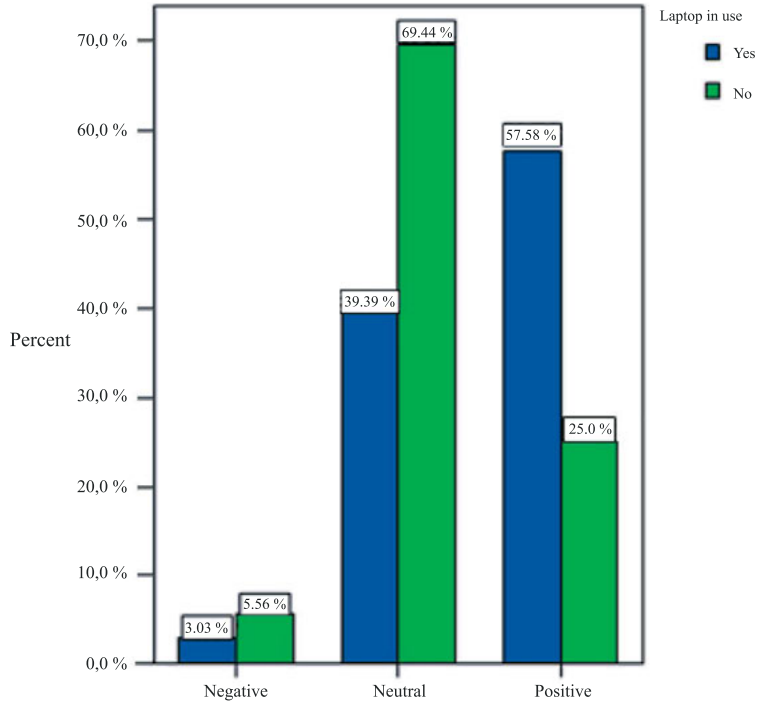


Figure 1. Respondents' views about utilising ICTs in teaching and learning.

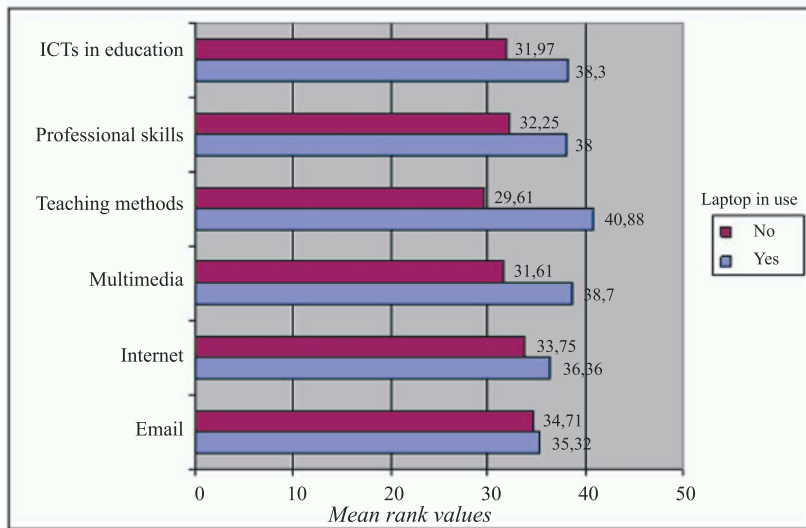


Figure 2. Divisions of respondents' answers in six subscales presented with mean rank values.

however, were not statistically significant. It was interesting to discover that concepts which are abstract in nature are seen more positively by teachers who had laptops, yet more concrete concepts, such as the Internet and email, differ less when the two groups are compared. It was also interesting to see that teachers who were using personal laptop computers in their work evaluated all of the 12 subscales more positively than teachers without a laptop. Since these teachers' attitudes towards ICTs were unavailable for the period of time before the personal laptop computers were provided, it is not possible to state that having a laptop for personal use is the only factor that explains this ranking; however, it does indicate that the factor is relevant to the topic under discussion.

Attitudes and gender

The second question evaluated by this study was whether the gender of the teachers within the comparison groups affects attitudes towards ICTs. Table 2 presents the results of how female and male teachers differed in their attitudes towards ICTs in general.

The analysis of the data revealed that a greater number of teachers who had positive attitudes towards ICTs were, in fact, female (64.9%). Female teachers also viewed the Internet, email, and utilising ICTs in teaching and learning more positively. On the other hand, male teachers' attitudes towards developing teaching methods with ICTs were more positive in a statistically significant way ($p = 0.01$), when compared to those of female teachers. Male teachers were also more positive towards multimedia, developing professional skills with ICTs ($\chi^2(2) = 7.964$; $p = 0.019$), and increasing productivity. Analysis of the data revealed that gender did make a difference, but only partly and variably, and only one subscale revealed statistically significant differences. These results are in line with earlier studies; the traditional belief that men are more positive in their technological attitudes than women could not be confirmed.

Attitudes and teaching experience

The third question of this study was to evaluate whether teaching experience had relevance to teachers' attitudes towards ICTs. In general, it is believed that younger teachers are more accustomed to the technological advances in society and therefore would adopt and deploy the use of technology in classrooms in a more flexible way. In analysing the data of this study, we divided the respondents into two groups, based on their teaching experience: one group of teachers, with fewer than 10 years of teaching experience, and another with over 10 years. According to the analysis of the results, the

Table 2. Cross-tabulation of female and male teachers' attitudes towards ICTs in general.

			Female	Male	Total
ICTs in general	negative	Count	19	13	32
		% within	59.4%	40.6%	100.0%
	positive	Count	24	13	37
		% within	64.9%	35.1%	100.0%
Total	Count	43	26	69	
	% within	62.3%	37.7%	100.0%	

less experienced teachers were more positive in their responses to most of the questions. The greatest differences between the two comparison groups were seen in their attitudes towards utilising ICTs in teaching and learning, and in developing teaching methods with ICTs. However, even in these two subscales, the differences were not statistically significant. Teachers with more than 10 years of teaching experience viewed email, e-learning platforms, communication technology, and general ICT questions more positively. Therefore, according to the results of this study, the general belief that younger teachers are more sympathetic towards ICTs must be questioned. There are differences in the emphasis of the younger teachers, but their attitudes did not differ significantly and the results were not consistent. The results of this study are consistent with earlier studies about computer attitudes and teacher experience; attitudes towards computers are not solely dependent on the length of teachers' teaching experience.

Attitudes and teacher type

Finally, this study investigated whether being a class teacher or subject teacher would make a difference in teachers' attitudes towards ICTs. Analysis of the results revealed that these two sample groups were very much alike in their views. Class teachers' answers were more positive, on a statistically significant level, when it came to questions concerning developing teaching methods with ICTs; on all of the other subscales, however, the attitudes of class teachers and subject teachers were very similar.

Discussion

The aim of this study was to investigate how the ICT-related attitudes of teachers using personal laptop computers differ from teachers without laptops. The results revealed that those teachers who had a personal laptop computer for their use were more positive in their attitudes towards ICTs in education and towards ICTs in general. Teachers with laptops had a much stronger belief in the value of utilising ICTs in teaching and learning, developing teaching methods, and developing their own professional skills with the use of ICTs. Their attitudes were more positive in all of the subscales. Other research variables, such as gender, teaching experience or class teacher and subject teacher division, did not have a statistically significant effect on the attitudes of teachers in any of the subscales and did not have a coherent influence on the research group. Coupled with the results of a previous study by Cuban et al. (2001), which also found that teachers' age, experience, and gender were not significant factors in explaining the differences in teachers' use of ICTs, the findings of this paper's study indicate that providing mobile technology to teachers can have an effect on their attitudes towards ICTs.

Since the number of participating teachers was rather small, and the study was limited to teachers in the municipality of Lieto, this study will not draw conclusions about teachers' attitudes in a wider or general sense, but will instead focus on teachers' attitudes in the municipality of Lieto and draw conclusions as to whether providing teachers with laptops would have a positive effect on this specific group. However, if one of the goals of an educational system is to have an influence on how ICTs are used in schools, the step taken in Lieto is only a part of the solution, although it seems to be a step in the right direction. As Roschelle, Pea, Hoadley, Gordin, and Means (2000) state, an education system is like a locked puzzle: if you want to move

or change the place of one piece in the puzzle, it is only possible if other surrounding pieces are evolving at the same time. If we want to develop the use of ICTs in teaching and learning, it is necessary to develop teacher training, curriculum, evaluation, pedagogical support, and school infrastructures simultaneously with technological advances. ICTs are already very much present in schools, and their use will increase even more in the future. Providing teachers with an opportunity to use technology, not only while at work but also in their spare time, seems to be a good way to increase their technological experience.

Teachers' beliefs about the relevance of ICT to their subject can impact on their attitudes towards utilising ICTs in education. Unfortunately, it is not easy to demonstrate the immediate benefits of using ICTs in education, particularly since they will be perceived differently depending on the teacher's subject area. For example, a domestic science teacher would perceive the benefits of ICT use differently from a physical education teacher. This might explain why the results of this study gave the notion that class teachers were slightly more positive in their attitudes towards ICTs. Teacher training is one way of changing the attitudes of teachers, but the problem with training is that it often is irrelevant to teachers' specific needs (Cuban et al., 2001). Although this type of training is necessary for computer novices, the training needs to be extended to also help teachers learn and prepare to integrate ICTs into their pedagogy. According to Espinosa and Chen (2001), all teachers can become technologically literate, and most can learn constructivist teaching practices. The challenge is how to combine these two domains. Specific, targeted assistance is necessary for teachers to be able to understand and integrate technology into their teaching and at the same time apply constructivist teaching principles.

Implications

Many of the traditionally manual activities in today's schools have already been automated, using software-based or Internet-based applications. In the municipality of Lieto, communication between the parties in the school – teachers, headmaster and parents – is carried out through an online communication system. Leave of absence and student evaluation are accomplished with online student administrative software, and schools have their own intranet systems online. In addition, many teachers are administrating and updating their classroom systems to facilitate cooperation between home and school: for example, teachers are using online calendar software to inform everyone about school activities. In order to ensure these tools are used, it is vital that teachers always have the possibility of using an online computer. Therefore, the availability of mobile, personal laptop computers and wireless local area networks is critical. Teachers must be able to go online, whether in a classroom, staff room, or the school library. Mobility gives teachers the opportunity to choose the time and place for their research, communication, and planning activities. The expectation that teachers utilise ICTs in schools is reasonable only when the technical infrastructure, equipment, and support are available and sufficient.

Making pedagogical decisions about how to teach is not purely routine thinking; pedagogical thinking guides the decision-making process when a teacher is choosing from different options in order to achieve certain goals. If a teacher has the ability, means, and skills to easily adopt technology in teaching and learning, ICTs will be increasingly used in schools. Providing teachers with laptop computers and with technical and pedagogical support will affect a teacher's readiness and willingness to

bring ICT to students; in order to achieve this, it is necessary to provide ICTs as part of the infrastructure of a school. Cuban et al. (2001) argued that, without these support structures, only modest, peripheral modifications will occur in teaching and learning. In other words, without these support structures, teachers will adapt innovations to the constraints of the self-contained classroom, using new technologies to sustain old practices.

Conclusion

Technology implementation is a diverse process mediated by teacher characteristics, technological framework, and conditions within the school. According to this research, providing teachers with laptops can be seen as a factor to influence teachers in how they utilise mobile technology at work and also in their spare time. This is consistent with other findings. Wozney et al. (2006) found that personal use of computers outside of teaching activities was the most significant predictor of teacher use of technology in the classroom. When the use of modern technology is not tied to a specific time or a place, teachers will have more time to use and evaluate the possibilities provided by the technology. If teachers make lesson plans using a computer, and then use this computer later in the classroom, the threshold for utilising the tool and its software in planning and teaching will be lower.

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References

- Albirini, A. (2006). Teachers' attitudes toward information and communication technologies: The case of Syrian EFL teachers. *Computers and Education*, 47(4), 373–398.
- Anyan, J., Owens, C., & Magoun, D. (2000). The effects of technology on the attitudes of classroom teachers (E-TACT). In D. Willis, J. Price & J. Willis (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2000* (pp. 1528–1533). Chesapeake, VA: Association for the Advancement of Computing in Education.
- Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, 52, 1–26.
- Bielaczyc, K. (2006). Designing social infrastructure: Critical issues in creating learning environments with technology. *Journal of the Learning Sciences*, 15, 301–329.
- Bullock, D. (2004). Moving from theory to practice: An examination of the factors that preservice teachers encounter as they attempt to gain experience teaching with technology during field placement experiences. *Journal of Technology and Teacher Education*, 12(2), 211–237.

- Carroll, T. (2000). If we didn't have the schools we have today, would we create the schools we have today? *Contemporary Issues in Technology and Teacher Education*, 1(1), 117–140.
- Colley, A.M. (2003). Gender differences in adolescents' perceptions of the best and worst aspects of computing at school. *Computers in Human Behavior*, 19, 673–682.
- Cox, M., & Abbott, C. (2004). *ICT and attainment – A review of the research literature*. Department for Education and Skills/British Educational Communications and Technology Agency.
- Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal*, 38(4), 813–834.
- Enkenberg, J. (2003). Kestävään tieto- ja viestintätekniikan opetuskäyttöön [Using ICTs in education effectively]. In J. Enkenberg & M.B. Kentz (Eds.), *Kasvatuksen maiseimista* [From landscapes of education], (pp. 133–145). Joensuu: Joensuun yliopistopaino.
- Espinosa, L., & Chen, W. (2001). The role of technology in supporting multi-age classroom practices. *Information Technology in Childhood Education Annual*, 1, 5–31.
- Finnish National Board of Education. (2004). *Finnish national core curriculum*. Vammala: Vammalan kirjapaino OY.
- Fullan, M. (2001). *Leading in a culture of change*. San Francisco: Jossey-Bass.
- Guha, S. (2000, November). *Are we all technically prepared? Teachers' perspective on the causes of comfort or discomfort in using computers at elementary grade teaching*. Paper presented at the Annual Meeting of the National Association for the Education of Young Children, Atlanta, GA.
- Haaparanta, H. (2007). *Tietokoneistako virtaa perusopetuksen opettajille? Raportti opettajista ja teknologian käytöstä nyt ja tulevaisuudessa* [Effects of new technology on primary school teachers' work: How technologies can support teachers' basic tasks]. Pori: Tampereen teknillinen yliopisto, Porin yksikkö.
- Hakkarainen, K. (2000). How people learn: Brain, mind, experience, and school. Foreword, in J.D. Bransford, A.L. Brown, & R.R. Cocking (Eds.), *National Research Council*. Washington, DC: National Academy Press.
- Hakkarainen, K. (2009). A knowledge-practice perspective on technology-mediated learning. *Computer-Supported Collaborative Learning*, 4, 213–231.
- Hakkarainen, K., Muukonen, H., Lipponen, L., Ilomäki, L., Rahikainen, M., & Lehtinen, E. (2001). Teachers' information and communication technology (ICT) skills and practices of using ICT. *Journal of Technology and Teacher Education*, 9(2), 181–197.
- Hallam, T. (2008). *Sociocultural influences on computer anxiety among preservice teachers: An exploratory study* (Doctoral dissertation). The Graduate Faculty of The University of Akron, Ohio.
- Ilomäki, L. (2007). School in front of challenges of knowledge society, again and again. Eden conference. Retrieved October 15, 2008, from <http://www.slideshare.net/mkfc/liisa-ilomaki>.
- Ilomäki, L. (2008). *The effects of ICT on school: Teachers' and students' perspectives* (Doctoral dissertation). Annales Universitatis Turkuensis B 314. Department of Teacher Education, University of Turku.
- Jegede, P., Dibu-Ojerinde, O., & Ilori, M. (2007). Relationships between ICT competence and attitude among some Nigerian tertiary institution lecturers. *Educational Research and Review*, 2(7), 172–175.
- Kansanen, P., Tirri, K., Meri, M., Krokfors, L., Husu, J., & Jyrhämä, R. (2000). *Teachers' pedagogical thinking. Theoretical landscapes, practical challenges*. New York: Peter Lang Publishing.
- King, J., Bond, T., & Blandford, S. (2002). An investigation of computer anxiety by gender and grade. *Computers in Human Behavior*, 18, 69–84.
- Lehtonen, M. (2003). Simulations as mental tools for network-based group learning. In B. Thompson & P. Nicholson (Eds.), *E-training practices for professional organizations: IFIP Open Working Conference*. New York: Kluwer Academic Publishers.
- Meelissen, M.R., & Drent, M. (2008). Gender differences in computer attitudes: Does the school matter? *Computers in Human Behaviour*, 24(3), 969–985.
- Ministry of Education of Finland. (2004a). *Development plan for education and research 2003–2008*. Helsinki: Helsinki University Press.

- Ministry of Education of Finland. (2004b). *Information society programme for education, training and research 2004–2006*. Helsinki: Helsinki University Press.
- North, A.S., & Noyes, J.M. (2002). Gender influences on children's computer attitudes and cognitions. *Computers in Human Behavior, 18*, 135–150.
- Piper, D. (2000). *Facilitating change: Factors influencing teachers' practices of using computers in the classroom*. Ann Arbor, MI: UMI Dissertation Services.
- Piper, D., & Austin, D. (2004). The relationship of leadership, experience and computer attitudes on teachers' self-efficacies of computer technology use in the classrooms. In R. Ferdig & C. Crawford (Eds.), *Proceedings of the Society for Information Technology and Teacher Education International Conference 2004* (pp. 1635–1642). Chesapeake, VA: Association for the Advancement of Computing in Education.
- Rogers, L., & Finlayson, H. (2004). Developing successful pedagogy with information and communications technology: How are science teachers meeting the challenge? *Technology, Pedagogy and Education, 13*(3), 287–306.
- Roschelle, J., Pea, R., Hoadley, C., Gordin, D., & Means, B. (2000). Changing how and what children learn in school with computer-based technologies. *The Future of Children. Children and Computer Technology, 10*(2), 76–101.
- Scardamalia, M., & Bereiter, C. (2003). Knowledge building. In J. W. Guthrie (Ed.), *Encyclopedia of education* (2nd ed.), pp. 1370–1373. New York: Macmillan Reference.
- Shapka, J.D., & Ferrari, M. (2003). Computer-related attitudes and actions of teacher candidates. *Computers in Human Behaviour, 19*(3), 319–334.
- Snoeyink, R., & Ertmer, P. (2001). Thrust into technology: How veteran teachers respond. *Journal of Educational Technology Systems, 30*(1), 85–111.
- Wentworth, N., & Popham, A. (2005). Changing learning environments with mobile technology. In C. Crawford, R. Carlson, I. Gibson, K. McFerrin, J. Price, R. Weber & D.A. Willis (Eds.), *Proceedings of the Society for Information Technology and Teacher Education International Conference 2005* (pp. 1071–1076). Chesapeake, VA: Association for the Advancement of Computing in Education.
- Wozney, L., Venkatesh, V., & Abrami, P. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education, 14*(1), 173–207.

Study III

Sipilä, K. (2011). No pain, no gain? Teachers implementing ICT in instruction. *Interactive Technology and Smart Education*, 8(1), 39–51.



No pain, no gain? Teachers' implementing ICT in instruction

No pain, no gain?

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Abstract

Purpose – The purpose of this paper is to investigate the differences between 99 Finnish primary and secondary teachers in their frequency and nature of information and communication technology (ICT) use, levels of ICT implementation, functional uses and perceived values about educational use of ICT.

Design/methodology/approach – The data were collected with an online questionnaire and analyzed with expectancy-value theory as a theoretical background.

Findings – Teachers use ICT mostly for administrative tasks. Teachers' methods of utilizing student-centred approaches in their teaching, proficiency levels in relation to ICT, and their self-reported stage of ICT integration into teaching strongly depend on how much ICT teachers use in their teaching activities. Primary teachers value utilizing ICT in teaching more positively than secondary teachers even though secondary teachers reported being more active in the use of ICT in various functional uses. Pedagogical thinking in educational institutes has not advanced in parallel with technological advances; teachers in basic education are still using ICT mainly for informational, organizational, evaluative, and lesson-planning activities instead of communicative, activating, creative, and expressive purposes.

Originality/value – This study was able to produce further evidence to support the claim that providing teachers with computer technology will lead them to integrate computers into teaching activities, which in turn will give them more support in their perceived proficiency at computer use and help them to advance in the stage of computer integration.

Keywords Teachers, Education, Information technology, Communication technologies, Finland

Paper type Research paper

1. Introduction

The introduction of information and communication technology (ICT) has had an effect on instructional activities in the teaching process, changed the way students learn and had an impact on school as a physical learning environment. The educational use of ICT is generally seen to be beneficial to learning (Somekh *et al.*, 2006). This conception is also strong with teachers who have long experience in utilizing ICT in education (Hicks, 2006), and it has been proved that, with the aid of ICT, students are more engaged with learning (Schrum *et al.*, 2007). As part of long-term development program in technical infrastructure and strong efforts to make all citizens ICT literate, Finnish schools have been equipped with networks and computer technology. The Finnish National Board of Education organized a vast in-service teacher-training program in order to raise teachers' level of ICT knowledge. These actions combined with the twenty-first century web 2.0 phenomenon and the expansion of web technology in society as a whole have made a difference in teachers as well; a large majority of teachers in Finland are beginning to have sufficient skills for everyday and routine ICT-working practices. Still, many have difficulties in finding a meaningful pedagogical use for technology (Ilomäki, 2008). Utilizing educational technology imposes challenges in



teaching praxis and requires complex, situated, and multidimensional knowledge (Lambert and Sanchez, 2007) from teachers.

In addition to technological revolution, the introduction of constructivist-learning theories (Piaget, 1976; Vygotsky, 1978) has brought significant changes and challenges to educational institutes. These theories implemented the conception of student-centered approaches to teaching and learning an approach that strives to break a long tradition of teacher-centered approach and knowledge transfer metaphor; the idea that teachers are transferring knowledge to students who are passively absorbing it. The socio-constructivist approach, which has been a cornerstone in Finnish pedagogical reforms, emphasizes the active construction of knowledge in a social context (Säljö, 2001). This approach extends constructivism into social settings, wherein groups construct knowledge for one another, collaboratively creating a small culture of shared artifacts with shared meanings. This aspect of learning was introduced in Finnish curriculum in the 1990s, but it was not until the dawn of the web 2.0 era in the new millennium with its social media tools, e-learning platforms, and web-based collaboration that finally the necessary tools were available for schools to integrate technology into teaching and learning in a way that would promote learning according to socio-constructivist learning theory principles.

In order to increase and deepen the level of learning with the use of ICTs, most ICT-based tools should be fully merged with the social practices of teachers and students; only then are their intellectual resources genuinely augmented and learning achievements correspondingly facilitated (Hakkarainen, 2009). Teachers are the key players in this process, so it is important to understand how they are managing to adapt to the technological and pedagogical reform requirements presented by the curricula and educational theorists. Presently, it seems that theory and practice do not always meet; studies show discrepancy between the ideal and the reality (Mooij and Smeet, 2001). Haaparanta (2008) found that teachers do not have enough knowledge about using technology in instruction in a pedagogically grounded manner. The use of ICT in Finnish schools tends to focus mainly on basic work (e.g. word processing) and communication (e-mail) tools (Walls-Carpelan, 2005). But is this picture of discrepancy and manner of ICT use true both in primary and secondary schools?

Finnish basic education encompasses nine years and caters for all those between seven and 16 years. The first six years of basic education is provided by the class teacher, who teaches all, or most, subjects. During the last three years, subjects are usually taught by different (specialized) subject teachers. The learning outcomes of Finnish comprehensive schools have been found to be excellent in all three international comparisons in the Programme for International Students Assessment studies carried out by OECD member states in 2000, 2003, and 2006. Teachers working at all levels of education in Finland are well trained and strongly committed to their work, as the teaching profession is respected and popular. Organization of schoolwork and teaching is guided by a conception of learning where students' own active involvement and interaction with teachers, fellow students, and the learning environment are important. Students process and interpret the information that they absorb based on their prior knowledge structures.

Teachers working in Grades 1-6 (primary school) spend most of their day teaching various school subjects to their own group of students, whereas in Grades 7-9 (secondary school), teachers focus on their specific subject and usually have one

45-minute lesson at a time for one group of students. Is this division of practice having an effect on how technology is implemented in teaching? No pain, no gain?

The purpose of this study is to investigate differences between primary and secondary teachers in their levels of ICT implementation, their values toward ICT, and the manner of the teachers' technology use in instruction and teaching practices. Expectancy-value theory will be applied as a framework when the results are analyzed in order to discover possible differences between these two groups of teachers: how do they perceive the value of ICT in teaching, what is the expectancy of success when utilizing ICT, and do the possible benefits outweigh the perceived costs of ICT implementation?

2. Theoretical background and literature review

The theoretical framework of this study is based on expectancy-value theory (Fishbein and Ajzen, 1975). According to expectancy-value theory, behavior is guided by function of the expectancies a person has and by the self-perceived value of the goal that a person is trying to achieve. If there is more than one behavior to choose from, the behavior chosen will be the one that has the largest combination of expected success and value. Expectancy-value theories think of people as goal-oriented beings. According to this model, a person is more likely to adopt innovations if the perceived value of the innovation and the expectancy of success are high and if these values are perceived to give more than the perceived costs of implementation are likely to be. ICT as an innovation can be seen as a major disturbance that has shaken the order and brought about significant, unpredictable changes (Kompf, 2005). If expectancy-value theory is used when looking at teachers' decisions to implement computer technology in instruction, then the decision will be based on how high the teachers value the innovation and how much they will expect the costs of this implementation to be. Venkatesh *et al.* (2003) list four predictors that have meaning when teachers make decisions about utilizing ICT in education: performance expectancy, effort expectancy, social influence, and facilitating conditions. The present study will focus on the first two predictors with the form of the teachers' values and perceived costs of using ICT. Value items used in this study will evaluate how worthwhile teachers perceive the innovation or its associated outcomes. These include benefits to the teacher (e.g. career advancement) and to the students (e.g. increased achievement). Cost items evaluate the perceived demands of implementing ICT (e.g. preparation time, effort, etc.) (Wozney *et al.*, 2006). These items combined with questions about the functional use of ICT in education, frequency, and level of ICT implementation and teachers' proficiency levels are used to explore possible differences between primary and secondary teachers in their ICT implementation.

The attitudes of teachers and their willingness to embrace the technology have significant impact on the success of student learning with computer technology (Huang and Liaw, 2005; Teo, 2006). ICT attitudes have a significant relationship with and predict competence (Jegade *et al.*, 2007). Piper and Austin (2004) conclude that the teachers' attitude towards working with the computer and his or her perception of leadership and professional development have an impact on his or her beliefs about using the computer in an instructional setting. According to Haaparanta (2008), teachers' future use of computers is predicted far more strongly by the teachers' perceived usefulness of computers than with the teachers' perceived ease of

computer use. Previous researchers have suggested that there are differences in how teachers in different school levels regard ICT implementation in teaching. Anyan *et al.* (2000) found a dependency (although weak) on the teaching level: elementary school teachers were less positive in their attitudes toward ICT than their middle or high-school colleagues. Walls-Carpelan (2005) found that primary school teachers regarded themselves to be less ICT-skilled and to be using ICT in all major areas least frequently. Haaparanta (2008) concluded that Finnish teachers as a whole had relatively positive attitudes toward ICT, but also that there were teachers who perceived the use of ICT in teaching negatively and that these teachers also had the worst experiences with the usefulness of ICT.

3. Research questions and method

Based on the theoretical review, the research questions addressed in this study are as follows:

- RQ1.* What is the frequency and manner of teachers' ICT implementation in Finnish basic education schools?
- RQ2.* Does the frequency of ICT use have an effect on teachers' teaching style?
- RQ3.* In what stage of ICT integration do teachers perceive themselves to be?
- RQ4.* What kind of differences are there in functional use of ICT and the proficiency levels of ICT use between primary and secondary teachers?
- RQ5.* What kind of differences are there in how primary and secondary teachers perceive the values and cost of ICT use in teaching?

In order to ensure objectivity, generalizability, and reliability of the study, the quantitative paradigm was chosen as a basis for the present study. An online questionnaire as the data-gathering method was chosen to produce quantifiable, reliable data that would be usually generalizable to some larger population. This line of action allows the researcher to be considered external to the actual research so that results to be expected would be replicable no matter who conducts the research. The data gathering was conducted on two separate occasions, in April and September 2009, as part of a larger research program. The invitation link to participate in answering the questionnaire was distributed to teachers in five Finnish municipalities by e-mail in spring and autumn 2009 as part of a larger study.

3.1 Questionnaire

The questionnaire used to collect data for this study was constructed based on a Technology Implementation Questionnaire (TIQ) developed by Wozney *et al.* (2006). The original questionnaire was translated to Finnish and then modified to suit the needs of the present study. The final version's first section had background questions and questions about the school's technical resources. Section II focused on teachers' frequency, manner, and proficiency in implementing ICT into teaching. Section III had 19 belief items (values and costs) about the use of computer technology in the classroom. The data were collected with an online questionnaire, to which 99 teachers from five different municipalities in Finland replied. Descriptive statistics, frequency

distribution, cross-tabulation, *t*-test, Mann-Whitney test, χ^2 test, and one-way ANOVA tests were used to analyze data. No pain, no gain?

4. Results

4.1 *Sample descriptions and computer resources*

Of the 99 respondents, 63 percent were female, and 37 percent male; 47 percent of the respondents were class teachers, 39 percent subject teachers, and 14 percent special education teachers. Teaching experience varied from 0 to 38 years; 14 percent had been teaching for 20 years. About 55 percent of the respondents reported student access to computer resources as good or excellent, 54 percent stated technological support at the school to be on a good or excellent level, and 78 percent of the respondents had access to computer resources whenever they needed; only 16 percent stated that they did not have a data projector available at all. The amount of inservice training that teachers had received on using computer technologies varied evenly between three options; one to three days, three to six days, and more than six days all had 25 percent of the respondents.

4.2 *The frequency and manner of teachers' ICT use*

The *RQ1* of this study was, what is the frequency and manner of teachers' ICT implementation in Finnish basic education schools? About 45 point 5 percent of the respondents reported to use ICTs in teaching "often," "almost all the time," or "all the time" while 51.5 percent utilized ICTs "rarely" or "sometimes." About 64 percent of the respondents used computers in their spare time for more than 3 hours a week and 17 percent more than 10 hours. About 37 point 4 percent of the respondents stated that ICT was integrated into their teaching activities "often" and 11.1 percent "almost always" or "all the time." About 51 point 5 percent reported they integrated ICT into teaching "rarely" or "occasionally." Three items in the questionnaire addressed the issue of how often teachers utilized free internet-based learning material, virtual learning environment, and CD-ROM-based learning material: 46.5 percent of the respondents used free internet-based learning material "fairly often," "very often," or "almost always," and 47.4 percent answered similarly when asked about the use of virtual learning environment. CD-ROM-based learning material was not used at all by 25 percent of the respondents.

4.3 *Teachers' teaching styles and levels of ICT integration*

The first sub-question of *RQ1* was:

RQ1a. Does the frequency of ICT use have an effect on teachers' teaching style?

The respondents were asked to choose their preferred teaching style from five different options. The responses are reported in Table I.

None of the teachers (0 percent) preferred the "largely student-centered" option, and only 6.1 percent preferred to teach with a "more student centered than teacher directed" teaching style. Analysis with the Pearson χ^2 test revealed that teachers who preferred student-centered styles of teaching reported using computers more frequently in their teaching with borderline statistical significance ($\chi^2(1) = 6.076; p = 0.014$) and regarded themselves to be at a higher stage in the process of integrating ICTs into teaching in a highly significant manner ($\chi^2(5) = 35.29; p < 0.001$).

The second sub-question of *RQ1* was:

RQ1b. In what stage of ICT integration do teachers perceive themselves to be?

Teachers were asked to choose one of six stages that best described their personal process of integrating ICTs into teaching. Table II shows the distribution of the teachers' responses.

Of the respondents, 35.4 percent viewed themselves as being in the "adaptation" stage; they see computers as instructional tools; the teachers are no longer concerned about computers as technology and can use various computer applications. Teachers who reported using ICT in teaching more were likely to choose "Familiarity," "Adaptation," or "Creative application" on a statistically significant level, when analyzed with the Pearson Chi-square test ($\chi^2(5) = 16.651; p = 0.005$).

4.4 Functional use and proficiency levels of using ICT in teaching activities

The *RQ2* of the study was, what kind of differences are there in functional use of ICT and the proficiency levels of ICT use between primary and secondary teachers? Ten items of the questionnaire addressed the issue of how often teachers utilized computers for various functional uses. The Cronbach's alpha value of 0.79 for teacher's responses to these items indicated about high-internal consistency. The division of responses based on the frequency of use can be seen in Figure 1.

Two computer functions reported to be most frequently integrated into teaching were "informative" (71 percent) and "organizational" (70 percent) purposes with "recreational" (69 percent) and "lesson planning" (68 percent) coming close. Integrating ICTs into teaching for "creative" (18 percent) and "communicative" (16 percent) purposes was done by surprisingly few teachers.

One-way analyses of variances with ten functional use categories of ICT were carried out. Table III shows the mean values, standard deviation values, and *p*-values of the categories that revealed statistical significance.

Teaching style	Frequency	%
Largely teacher directed	8	8.1
More teacher directed than student centered	49	49.5
Even balance	36	36.3
More student centered than teacher directed	6	6.1
Total	99	100.0

Table I.
The division of respondents' views about their preferred teaching styles

Self-reported stages of integration	Frequency	%
Awareness	1	1.0
Learning	14	14.1
Understanding	17	17.2
Familiarity	20	20.2
Adaptation	35	35.4
Creative application	12	12.1
Total	99	100.0

Table II.
Teachers' self-reported stages of ICT integration

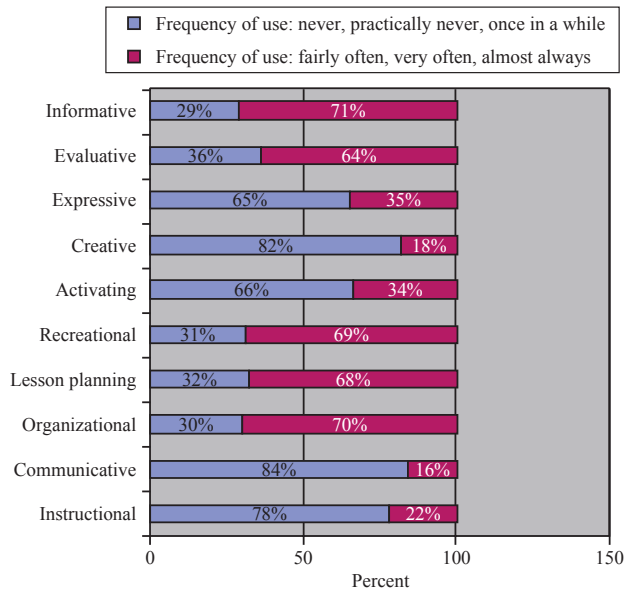


Figure 1. Frequency of functional uses of ICT in teaching

Functional use	Teaching level	Mean	SD	<i>p</i>
Lesson planning	Elementary	3.85	1.25	0.036
	Secondary	4.44	1.21	
Evaluative	Elementary	4.33	1.52	0.008
	Secondary	4.08	1.72	

Table III. Mean values, standard deviation values and *p*-values of the categories that revealed statistical significance in functional use of ICT

The analysis revealed that secondary teachers responded that they spent more time in seven categories (instructional, organizational, lesson planning, recreational, activating, creative, and informational), one category was even (communicative), and in two categories, the elementary teachers responded that they used more time (expansive and evaluative). Though only two categories revealed statistical significance, secondary teachers in general perceived themselves to utilize ICT more in functional uses of ICT.

Teacher’s proficiency levels in relation to computer technologies were also measured: 26 percent of the teachers described themselves as being at an “advanced” or “expert” level, and 64 percent of the teachers reported themselves as “average.” When teachers were divided into two groups with the use of ICT in teaching as the dividing factor, teachers who reported using ICTs more were more likely to be on an “expert” level ($\chi^2(2) = 6.324; p = 0.042$) on a statistically significant level.

4.5 Teachers' values and perceived costs toward integrating ICT into teaching

The RQ3 of the study was, what kind of differences are there in how primary and secondary teachers perceive the values and cost of ICT use in teaching? About 12 items of the questionnaire assessed teachers' values and seven their perceived cost associated with integrating ICTs into teaching. Teachers' value items scored a Cronbach's alpha value of 0.88, and their cost items scored a value of 0.68. Figure 2 shows the division of the responses with value and cost items when cross-tabulated with the amount of ICT use by the teachers.

Figure 2 shows that teachers who reported using ICT more were likely to respond more positively to value items ($\chi^2(2) = 18.23; p < 0.001$) as well as cost items ($\chi^2(2) = 14.76; p < 0.001$); teachers who responded they used ICT in teaching more frequently were more positive in their perceptions about the usefulness of it and valued the output of using ICT to be greater than what the cost of it was. The statistical significance was confirmed with an independent samples *t*-test ($t(97) = -4.406; p < 0.001$).

One-way analyses of variances were produced in order to analyze quantitative dependent variables (value items and cost items) by a single factor (teaching level). Table IV presents the differences between elementary teachers (class teachers), secondary teachers (subject teachers), and other teachers (special education teachers) about their responses to value items. Value items and cost items were first recoded to three category variables (1 – negative, 2 – neutral, 3 – positive).

When the value items were compared with teaching level using one-way analyses of variances, secondary school teachers gave significantly more negative responses ($M = 1.74; SD = 0.637$) than elementary school teachers ($M = 2.24; SD = 0.705$) or other teachers ($M = 2.21; SD = 0.699; F(2, 96) = 6.169; p < 0.01$); 39.1 percent of the

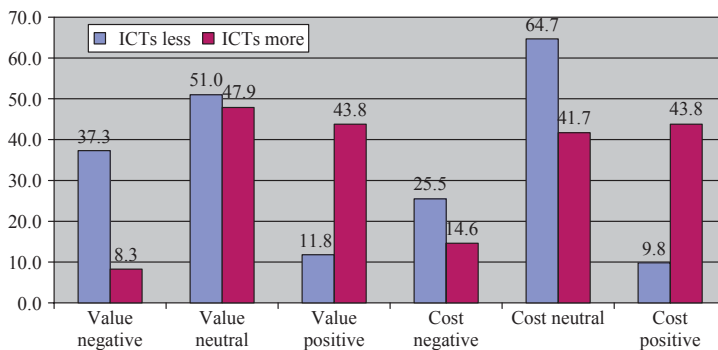


Figure 2. The division of teachers' responses to value and cost items when cross-tabulated with the amount of ICT use

Teaching level	<i>n</i>	Mean	SD	SE
Elementary	46	2.24	0.705	0.104
Secondary	39	1.74	0.637	0.102
Other	14	2.21	0.699	0.187
Total	99	2.06	0.680	0.131

Table IV. Differences among elementary, secondary, and others in their responses to value items

elementary teachers gave positive responses to value items while the percentage in secondary teachers' group was only 10.3 percent, when analyzed with the Chi-square test ($\chi^2(4) = 11.61; p = 0.02$). The same tendency of elementary teachers to be more positive than secondary teachers was also present when the cost items were analyzed, but the difference was not statistically significant.

About 19 value and cost items were assessed to see whether elementary and secondary teachers would differ in their responses to these belief items. Table V presents these items, their category, mean values of elementary and secondary teachers, and standard deviation values.

Belief items (response scale: 1 – strongly disagree through 6 – strongly agree)	Category	Mean	SD
1. Increases academic achievement	Value	Elementary 3.85 Secondary 3.46	0.998
2. Promotes student collaboration	Value	Elementary 3.54 Secondary 3.33	1.110
3. Makes classroom management easier	Cost	Elementary 3.50 Secondary 3.21	1.327
4. Promotes the development of communication skills	Value	Elementary 4.28 Secondary 3.74	1.078
5. Is a valuable instruction tool	Value	Elementary 4.80 Secondary 4.38	1.003
6. Is not too costly in terms of resources, time, and effort	Cost	Elementary 4.26 Secondary 3.77	1.202
7. Makes teachers feel more competent as educators	Value	Elementary 3.33 Secondary 2.87	1.303
8. Gives teachers the opportunity to be learning facilitators instead of information providers	Value	Elementary 4.67 Secondary 4.03	1.021
9. Does not demand that too much time be spent on technical problems	Cost	Elementary 3.54 Secondary 3.49	1.224
10. Is an effective tool for students of all abilities	Value	Elementary 4.87 Secondary 4.49	0.959
11. Enhances my professional development	Value	Elementary 4.72 Secondary 4.33	0.940
12. Makes it easier for me to teach	Value	Elementary 4.67 Secondary 4.31	0.973
13. Helps accommodate students' personal learning styles	Value	Elementary 4.37 Secondary 3.79	1.109
14. Motivates students	Value	Elementary 5.11 Secondary 4.41	0.889
15. Does not limit my choices of instructional materials	Cost	Elementary 5.02 Secondary 4.41	0.956
16. Does not require software skills training that is too time consuming	Cost	Elementary 4.17 Secondary 4.03	1.109
17. Promotes the development of students' interpersonal skills	Value	Elementary 3.41 Secondary 3.13	1.056
18. Will not increase the amount of stress and anxiety of students' experiences	Cost	Elementary 4.37 Secondary 3.62	1.106
19. Improves student learning	Value	Elementary 4.35 Secondary 3.82	0.850

Table V.
Technology
implementation
questionnaire: belief items

As Table V reveals, elementary teachers gave more positive responses to all of the cost and value items. One-way analyses of variance were used to study the differences further. Statements where the difference was statistically significant were the following: ICT gives teachers the opportunity to be learning facilitators instead of information providers ($F(2, 96) = 5.347; p < 0.01$), ICT motivates students ($F(2, 96) = 8.639; p < 0.001$), ICT does not limit my choices of instructional materials ($F(2, 96) = 4.906; p = 0.009$), ICT will not increase the amount of stress and anxiety students experience ($F(2, 96) = 7.731; p = 0.001$), and ICT improves student learning ($F(2, 96) = 5.373; p = 0.006$).

Teachers' self-reported frequency of integration of computers in teaching activities, self-reported proficiency at computer use, and self-reported stage of computer integration presented a clear view about how much teachers use ICT and perceive its use in school. Frequency and proficiency ($r = +0.588, p = 0.000$), frequency and stage ($r = +0.343, p = 0.001$), and proficiency and stage ($r = +0.422, p = 0.001$) correlated positively so combining scores from these three statements into one new composite variable (teacher level) for each respondent was done in order to further study teachers' perceptions in this respect. When this new composite variable was regressed with teachers' opinions about value and cost items, their opinions about ICT values were able to explain 45 percent of the variance in the degree of teacher level variable ($R^2 = 0.45, F(4, 891) = 3.948, p = 0.000$) and their opinions about cost items 38 percent of the variance ($R^2 = 0.38, F(9, 559) = 5.591, p = 0.000$).

5. Conclusion

The aim of this study was to investigate the differences between 99 Finnish primary and secondary teachers in their frequency and nature of ICT use, levels of ICT implementation, functional uses, and perceived values about educational use of ICT. The analysis of the data revealed that even though the technological framework in schools is beginning to be on a fairly good level, pedagogical thinking in educational institutes has not advanced in parallel with technological advances; teachers in basic education are still using ICT mainly for informational, organizational, evaluative, and lesson planning activities instead of communicative, activating, creative, and expressive purposes. This is in line with other studies; teachers most commonly use ICTs for administrative tasks (Walls-Carpelan, 2005) and to support existing pedagogies (Somekh *et al.*, 2006).

In order to utilize ICT in teaching in a way that is pedagogically supported by the modern conception of learning as a socio-constructivist activity, teachers should use a student-centered approach in their teaching. The results of this study show that only a fraction of the respondents have adopted new ways of teaching, and the teachers who reported using computers more frequently in their teaching who were inclined to use a more student-centered approach in their teaching. If teachers' pedagogical reasoning is still based on the idea of transmitting knowledge, it is reasonable to expect that ICT in teaching is being used only to maintain existing instructional practices, as Cuban (2001) claimed.

This study was able to produce further evidence to support the claim that providing teachers with computer technology will lead them to integrate computers into teaching activities, which in turn will give them more support in their perceived proficiency at computer use and help them to advance in the stage of computer integration. According to the results of this study, teachers' manner of utilizing student-centered approaches in their teaching, proficiency levels in relation to ICT, and their self-reported stage of ICT

integration into teaching strongly depend on how much ICT teachers use in their teaching activities. These findings are in line with other research; Wozney *et al.* (2006) also found these factors to be strongly linked together. As these factors also influence teachers' values about implementing ICT into teaching, it can be said that if the purpose is to increase pedagogically sound use of ICT in teaching, teachers need to be experienced enough with computers in order to start adapting new teaching methods and using new technologies in class. In order to get teachers familiarized with ICT, they need to have regular access to ICT equipment. However, it is also important to bear in mind that introducing technology alone will not change the teaching process (Trucano, 2005).

The study found that primary and secondary teachers differed drastically in their views about the expectancy of cost and perceived value in implementing ICT in teaching. Primary teachers gave more positive responses to all of the 19 value and cost statements, but at the same time, it was the secondary teachers who answered to utilize computers more overall in various functional uses. Walls-Carpelan (2005) also found Finnish secondary teachers to use ICT more frequently than primary teachers. According to the present study, secondary teachers' value-cost ratio is not as value orientated as primary teachers; secondary teachers do not expect to gain as much from ICT as primary teachers. Studies indicate (Franssila and Pehkonen, 2004) that secondary teachers do not believe in the possibilities of ICT in empowering students' learning process. Another explanation for secondary teachers utilizing ICT more in their teaching activities but being less positive in their values about ICT might be that secondary teachers in Finland generally are one-subject teachers and thus have a stricter curriculum to follow. They do not have the possibility of being flexible in their lesson planning in order to implement ICT; they usually have only one lesson per day for each of their groups. Primary teachers can more easily use project or problem-based teaching methods and change their lesson plans according to their needs in order to use ICT, which often requires extra time or making reservations for ICT equipment. This discrepancy between primary and secondary teachers' ICT values and the amount of ICT use should be focused on in future research.

5.1 Reliability, limitations and future directions

The questionnaire used in the present study was based on a TIQ developed by Wozney *et al.* (2006). Even though the reliability of the original questionnaire was thoroughly tested by its developers, translating it to Finnish and modifying it to suit the needs of this study could have had an effect to the reliability of the findings of this study. In addition, using self-reported measures of computer use, proficiency levels, and stages of integration leads to the fact that the data collected is not objective information, thus affecting the reliability of analysis. Finally, the relatively small sample size ($n = 99$) does not encourage to make generalizations of too wide a perspective; this was a clear setback as the sample size was originally expected to be substantially larger than what the outcome finally was. The original idea to use five municipalities in question to collect data was because the schools of these municipalities were in different stages of using virtual learning environment, and this would have offered another interesting factor to analyze the results. As the sample size collected did not meet expectations, this aspect of the study had to be rejected.

With teachers' opinions about value and cost statements, this study was able to explain a relatively significant part of the variance of the ICT use of teachers. For future research, there are still factors that need explaining, requiring objective research data about how primary and secondary teachers actually differ in their manner of ICT use. Future research could focus on a follow-up or case study where a group of teachers would be monitored as they use ICT in instruction and interviewed about their views before providing them with tailored and pedagogically orientated ICT training that would also guide them to use a more student-centered approach in their teaching. We know that the frequency of ICT use has an effect on teachers' perceptions about it, but the point is not "how much" ICT is used; the question is "how" it is used. Would the change in teaching style make way for more constructivist use of ICT in education?

References

- Anyan, J., Owens, C. and Magoun, D. (2000), "The effects of technology on the attitudes of classroom teachers (E-TACT)", in Willis, D. and Price, J. (Eds), *Proceedings of Society for Information Technology and Teacher Education International Conference 2000, San Diego, CA, USA*, pp. 1528-33.
- Cuban, L. (2001), *Oversold and Underused: Computers in the Classroom*, Harvard University Press, Cambridge, p. 134.
- Fishbein, M. and Ajzen, I. (1975), *Belief, Attitude, Intention, and Behaviour: An Introduction to Theory and Research*, Addison-Wesley, Reading, MA.
- Franssila, H. and Pehkonen, M. (2004), "Tieto- ja viestintäteknikka peruskoulun ja lukion opettajien työssä, Tapaustutkimus Tampereelta" [*ICT in basic and upper secondary school teachers' work, case study from Tampere*], Hypermedia Laboratory Net Series 7, Tampere University Press, Tampere.
- Haaparanta, H. (2008), *Computers in Primary School Teachers' Everyday Life: Teachers' Well Being, Burnout, School Information Strategy and Technology Acceptance*, Tampere University of Technology, Tampere (Publication 761).
- Hakkarainen, K. (2009), "A knowledge-practice perspective on technology-mediated learning", *Computer-Supported Collaborative Learning*, Vol. 4, pp. 213-31.
- Hicks, T. (2006), "Expanding the conversation: a commentary toward revision of Swenson, Rozema, Young, McGrail, and Whitin", *Contemporary Issues in Technology and Teacher Education*, Vol. 6 No. 1, pp. 46-55.
- Huang, H.M. and Liaw, S.S. (2005), "Exploring user's attitudes and intentions toward the web as a survey tool", *Computers in Human Behavior*, Vol. 21 No. 5, pp. 729-43.
- Ilomäki, L. (2008), "The effects of ICT on school: teachers' and students' perspectives", *Annales Universitatis Turkuensis B 314*, Doctoral Dissertation, Department of Teacher Education, University of Turku, Turku.
- Jegede, P., Dibu-Ojerinde, O. and Ilori, M. (2007), "Relationships between ICT competence and attitude among some Nigerian tertiary institution lecturers", *Educational Research and Review*, Vol. 2 No. 7, pp. 172-5.
- Kompf, M. (2005), "Information communication and technology and the seduction of knowledge, teaching and learning, what lies ahead for education", *Curriculum Enquiry*, Vol. 5 No. 2, p. 213.
- Lambert, J. and Sanchez, T. (2007), "Integration of cultural diversity and technology: learning by design. Meridian Middle School", *Computer Technologies Journal*, Vol. 10 No. 1, available at: www.ncsu.edu/meridian/win2007/pinballs/index.htm (accessed 12 January 2010).

- Mooij, T. and Smeets, E. (2001), "Modeling and supporting ICT implementation in secondary schools", *Computers & Education*, Vol. 36 No. 3, pp. 265-81.
- Piaget, J. (1976), *To Understand is to Invent: The Future of the Education*, Penguin, New York, NY.
- Piper, D. and Austin, D. (2004), "The relationship of leadership, experience and computer attitudes on teachers' self-efficacies of computer technology use in the classrooms", in Ferdig, R. and Crawford, C. (Eds), *Proceedings of Society for Information Technology and Teacher Education International Conference 2004, Atlanta, GA, USA*, pp. 1635-42.
- Säljö, R. (2001), *Learning in Practice: A Sociocultural Perspective [Oppimiskäytännöt, Sosiokulttuurinen näkökulma]*, WSOY, Helsinki.
- Schrum, L., Thompson, A., Maddux, C., Sprague, D., Bull, G. and Bell, L. (2007), "Editorial: research on the effectiveness of technology in schools: the roles of pedagogy and content", *Contemporary Issues in Technology and Teacher Education*, Vol. 7 No. 1, pp. 456-60.
- Somekh, B., Underwood, J., Convery, A., Dillon, G., Lewin, C., Mavers, D., Saxon, D., Woodrow, D., British Educational Communications and Technology Agency (2006), *Evaluation of the ICT Test Bed Project, Annual Report*, available at: www.evaluation.icctestbed.org.uk/reports (accessed 22 January 2010).
- Teo, T. (2006), "Attitudes toward computers: a study of post-secondary students in Singapore", *Interactive Learning Environments*, Vol. 14 No. 1, pp. 17-24.
- Trucano, M. (2005), *Knowledge Maps: ICTs in Education*, InfoDev/The World Bank, Washington, DC.
- Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D. (2003), "User acceptance of information technology: toward a unified view", *MIS Quarterly*, Vol. 27 No. 3, pp. 425-78.
- Vygotsky, L.S. (1978), *Mind in Society*, Harvard University Press, Cambridge, MA.
- Walls-Carpelan, M. (2005), "E-teaching & e-stress? On the use of ICT among the Finnish teachers and its impact on teachers' psychosocial work environment", in Crawford, C. (Ed.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2005, Phoenix, AZ, USA*, pp. 1059-62.
- Wozney, L., Venkatesh, V. and Abrami, P.C. (2006), "Implementing computer technologies: teachers' perceptions and practices", *Journal of Technology and Teacher Education*, Vol. 14 No. 1, pp. 73-207.

Further reading

- Kim, J. (2005), "The effects of a constructivist teaching approach on student academic achievement, self-concept, and learning strategies", *Asia Pacific Education Review*, Vol. 6 No. 1, pp. 7-19.

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Study IV

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Concept Mapping in Visual Arts Lessons

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Educational institutes need pedagogically grounded methods to properly integrate Information and Communication Technologies (ICT) into learning processes. Concept mapping software can provide this and more, because it is based on learning through conceptual changes and offers the possibility of collaborative knowledge construction. The powers of the concept mapping method and software are yet to be implemented in the Finnish education system. The study presented in this paper is about a case study where 11 Finnish secondary school students were introduced to utilizing concept mapping software as a tool in their visual arts lessons about National Romantic style. Each student's ability to construct maps was evaluated. The possible correlation between reading skills and the ability to construct maps were studied as well as students' perception about using the software. The results show that secondary school students are able to construct well designed concept maps, found the software to be user friendly, and perceived the method of concept mapping to be useful in promoting their learning.

Keywords: concept map, e-learning, software, school, student

1 Introduction

The learning outcomes of Finnish comprehensive schools were found to be excellent in PISA's (Programme for International Students Assessment) international comparison studies carried out by OECD (Organisation for Economic Co-operation and Development) member states. Organization of schoolwork and teaching in Finland is guided by a pupil's own active involvement and interaction with teachers, fellow pupils, and the learning environment. Pupils process and interpret the information that they absorb based on their prior knowledge structures. The national core curriculum of Finland (2004) has been formulated on the basis of learning as an individual and community process to build knowledge and skills. The theoretical framework of the national core curriculum is based on social constructivist learning theories. The theoretical framework that supports the use of concept mapping is consistent with constructivist epistemology. Concept maps are graphical tools for organizing and representing knowledge (Novak & Cañas, 2008). Novak and Gowin (1984) developed the idea of using hierarchical concept maps as a tool for evaluating the development of concepts in a learning experience. Concept mapping can be seen as a method of visualizing the structure of knowledge, sometimes compared to the structure of long-term memory (Asan, 2007).

With the rapid development of Information and Communication Technologies (ICT), a number of computer-assisted concept mapping systems have been introduced, finally making it possible to work with concept maps fluently both individually and collaboratively, with the latter creating new possibilities for knowledge construction within a group of experts. In Finland, however, the development of utilizing ICT in teaching, studying, and learning processes in a pedagogically grounded manner has not advanced alongside technological advances; teachers most commonly use ICT for administrative tasks (Sipilä, 2010). In order to use ICT in formal teaching through the modern conception of learning as a social constructivist activity, teachers should use student-centered approaches in their teaching. This is where concept maps would have an important role; it is imperative to obtain more knowledge about how students react when their traditional learning styles are influenced by introducing a new way of conceptualizing and constructing knowledge.

The following research provides an insightful look at the learning experience of a group of secondary school students (N=11) as they were taught to use the Institute of Human and Machine Cognition (IHMC) Concept Map (Cmap) software and guided in utilizing the software in their visual arts studies. These students were chosen based on voluntary participation in a visual arts course as a part of their 9th grade studies. The teacher of the course was acquainted with the concept mapping method and was able to use concept mapping software in her teaching. IHMC Cmap Tools-software is developed by the Florida Institute of Human and Machine

Cognition. The software is designed to build any type of relational charts, concept maps and other types of diagrams. It can be used free of charge and is localized to several languages, including Finnish. Students were instructed to construct a concept map individually based on selected reading material. Another assignment was to build a concept map based on lecturing, text, and a game on the Internet. Their success in constructing maps was evaluated by comparing their results to their score in a reading comprehension exercise, and by comparing their individual maps to an expert map constructed by their teacher. Finally students' reactions and thoughts about the use of concept mapping in their learning were gathered in an online questionnaire.

2 Theoretical background of concept mapping in knowledge construction

The idea of mind mapping has been present in basic Finnish education for a long time. However, mind mapping and concept mapping differ in their use and usefulness for learning. The former is based on radial hierarchies and tree structures denoting relationships with a central governing concept, whereas concept maps are based on connections between concepts in more diverse patterns. Mind mapping can be taken into teaching and learning more flexibly, whereas concept mapping needs more input from the teacher and learner in order to get the most out of using concept mapping.

Novak and Cañas (2008) define concepts as a perceived regularity (or pattern) in events or objects, or records of events or objects, designated by a label. Competence in a domain of knowledge is defined by knowledge that has a highly integrated structure around central concepts (Glaser & Bassok, 1989). Martins (1994) defines concept mapping as two-dimensional representations of cognitive structures showing the hierarchies and interconnections of concepts involved in a discipline or sub discipline. Concept mapping was originally based on Ausubel's theory of meaningful learning. Ausubel worked on how one learns large amounts of useful information from textual and verbal inputs. Ausubel's subsumption theory is based on the premise that the acquisition of new knowledge is dependent on what is already known (Ausubel, 1968).

Externalization of knowledge supports information processing because the externalized model can be used as external memory and as an additional source for information processing (Hanke, 2006). Concept mapping has been found to be a supportive learning method that promotes thinking processes, problem solving, and information recall (Nesbit & Adesope, 2005; O'Donnell, Dansereau & Hall, 2002). MacKinnon (2009) found concept mapping to have great potential for stimulating critical thinking and conceptual change, and that the pedagogical context in which it is used has great importance on its success. Concept maps promote students' understanding and have a positive effect on their thinking skills as it makes the knowledge construction process visible (Ligorio, 2001). Presseisen (2001) lists five basic skills in enhancing complex thinking: qualifying or identifying basic units and facts, classifying, finding relationships, transforming the known to a unique metaphor or analogy, and drawing conclusions such as causes and effects. These underlying skills are applied to higher-level thinking processes such as problem solving, decision making, and critical and creative thinking (Oliver, 2007). Highly structured maps may only require students to identify existing knowledge, maps with pre-selected terms may lead students to build on existing knowledge with new relationships and structures, and open-ended maps may lead students to generate new knowledge (Tergan, 2006).

The theoretical framework of this study is based on Gadamer's (1979) conception of understanding to be a process of the 'fusion of horizons', which involves the formation of a new context of meaning that enables integration of what is otherwise unfamiliar. Understanding and interpretation always occurs from within a certain 'horizon' which is determined by our historically-determined situation (Malpas, 2009). In Gadamer's view, understanding is essentially a matter of conceptual articulation where the primacy is given to language and conceptuality. Language is about communication. It is about transferring, aggregating and processing information. The ability of language to perform these functions depends on the skill with which its users understand each other in any particular case. The study presented here will mainly focus on investigating the ability of secondary school students to adopt new information into their personal 'horizon' by reading text – based material and from given lectures from a topic that is already familiar to them in general (National Romantic style) but containing quite a lot of in depth new information about it. Transforming what students learn during the process into a form of a concept map that can be edited and extended, the students should be able to better recognize sequences, classify terms, and externalize their new ideas and thoughts based on their existing knowledge.

3 Research questions

The research questions of the study are as follows:

- How well do students succeed in constructing concept maps from written material and lectures and how do their maps differ from a map constructed by an expert?
- How does a student's ability to understand reading material affect their ability to construct concept maps?
- How do students perceive and experience the use of the concept mapping method in their learning?

4. Method

The research presented in this paper is based on the mixed method research model. The intent is to create and then evaluate changes in the way technology is used and how the use of concept mapping in learning is regarded by students. Observation of students, analyses of personal documents, and semi-structured interviews were chosen from the ethnographic research strategy.

The subjects of this research consist of a group of 11 9th grade secondary school students; age 15, who had all chosen a course in visual arts as one of their voluntary courses. None of the students had prior experience with the software used or had been instructed in how to construct concept maps. The idea of mind mapping was familiar to them. The group's visual arts teacher had participated in a course about concept maps and knew how to use CmapTools—software in teaching.

The qualitative part of the case study was employed during a one month time period, over which the students learned to use the software. Through the teacher's eight lessons, they came to understand the basics of concept mapping by constructing a map with some super ordinate terms from a given topic and studying the given assignments. The researcher's role was that of an on-site participant-observer during those lessons.

The reading material that was used in the first assignment, where students were told to construct a concept map based on the text, was edited from a text excerpt taken from a schoolbook about folk art. In this exercise, students were given a map template with some preselected terms already inserted. Their assignment was to continue constructing the map; a scaffolding method to help them get started. The main subject, National Romantic style, was covered during the lessons when their teacher first taught students about the subject, then guided them to play through an edutainment game on the Internet about the subject and given extra reading material about the subject from a certain web address. In the final lesson, students were asked to complete a reading comprehension exercise. The subject of the text in the exercise was not related to the actual topic of National Romantic style. Their last assignment was to take part in an online questionnaire, where they were asked about their opinions concerning utilizing concept mapping technology as a means of learning.

5 Analysis

The content analysis of the students' concept maps was executed by comparing their individual maps with an expert map conceived by the visual arts teacher. As the subject being learned covered four different main topics with several subtopics, these were color-coded with four different colors by the teacher when found. In the second phase the teacher looked at the maps more carefully, identifying to what extent the student had managed to cover the topics and whether the student had managed to discover and link the main topic with the subtopics. In the last phase of analyzing student maps, the teacher concentrated on finding cause and effect relationships between different concepts. After the analysis, the teacher graded the maps on the four to ten scale normally used when grading tests in the Finnish education system.

Map grades were compared to the student's score on the reading comprehension test in order to discover whether their reading comprehension ability was in any way connected to their ability to construct concept maps. All the student data was handled anonymously. Students were identified only by a code in order to make the necessary connections between the reading comprehension test and the individual concept map. In the last

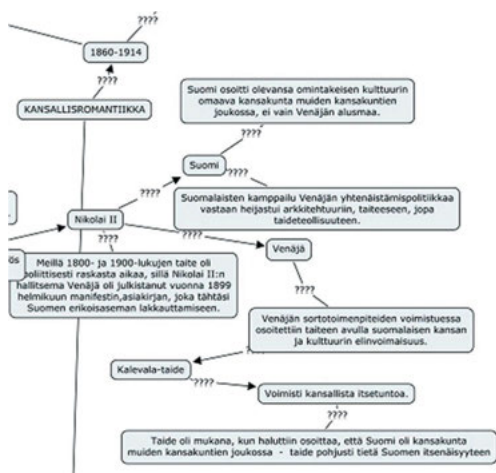


Figure 3. Poorly constructed map.

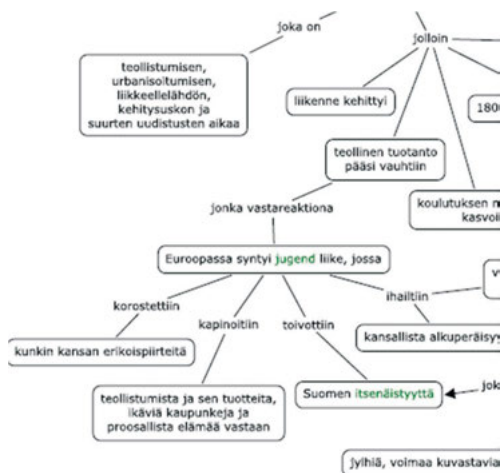


Figure 4. Well designed map.

Figure 3 shows a part of the map where the student has not managed to produce linking words between concepts and has copied sentences from the source material into the boxes. This map as a whole was not logically constructed or organized. This student did not perform well in the reading comprehension test. Figure 4 part of the map of a student who understood how to use linking words between concepts, create a map that is logical in its structure, and is easy to comprehend. This particular student performed well also in the reading comprehension test.

The results of the analysis indicate that secondary school students are able to construct well designed, logically constructed concept maps with topic interrelations. Utilizing concept mapping software makes constructing maps with superordinate/subordinate terms and linking words easy; but also emphasizes the fact that students need to work on the subject and understand it thoroughly in order to succeed in constructing a good concept map.

The second research question of this study asked how a student’s ability to understand reading material affected his/her ability to construct concept maps. Table 1 below lists individual student scores from the reading comprehension test and from the concept map assignment, as well as mean values.

Table 1. Individual student scores from reading comprehension and concept map with mean values.

ID	Reading comprehension 1-10p.	Concept map 4-10p.
01	7	6
02	4	5
03	6	8
04	4	7
05	3	7
06	2	8
07	4	6
08	7	10
09	7	10

10	6	9
11		7
Mean	5.00	7.55

When all of the ten participants in both columns above were categorized into two groups based on their performance, performing well on the reading comprehension test correlated with succeeding in concept mapping at a rate of .56. This would indicate that reading skills are related to one’s ability to construct concept maps, but the small sample size does not permit generalizations and was not the intention of this study.

The third research question of this study asked how students perceived and experienced the use of the concept mapping method in their learning. One of the respondents was not present during the lesson when the students took part in the online questionnaire, but the remaining ten respondents found using concept mapping as a learning method to be a positive experience.

Table 2 below shows the mean value of respondents to eight statements. the students were asked to reply by choosing the option that best suited their opinion (1= totally disagree, 4= totally agree).

Table 2. Mean values on a scale of 1-4 of students’ (N= 10) replies to eight statements about the experience of concept mapping.

	Mean
It was helpful for me to use concept mapping to study National Romantic style.	2.70
It was fun to use concept mapping software.	2.50
It was useful to study with the help of concept mapping software.	2.60
It was easy to construct concept maps.	3.60
Concept mapping helped me to understand the subject in its entirety.	2.90
It was easy to build superordinate term - proposition- subordinate term paths.	2.90
We had adequate time to become familiar with the software.	3.50
Visualizing ideas and concept relations was helpful for me.	2.67
Overall mean	2.92

Overall, the students felt that the use of concept mapping software was easy and that it did not require much time to get acquainted with it. They found the process of concept mapping itself to be easy to adopt and perceived it to be useful in their learning. Of the respondents, 60% said that they would benefit from using concept mapping in other disciplines and 40 % stated that they would rather use concept mapping technique when taking notes in lessons instead of writing notes with pen and paper.

Students were also asked to broadly describe their experiences and ideas about concept mapping. The attitude was positive overall, with most comments stating concept maps helped memorization and improved learning.

Student 11: “I think I would learn even better if I was to do the map with pen and paper, but either way I would memorize more about the subject than by just reading.”

Student 09: “Various topics were more easily memorized than with writing notes on my worksheet”.

None of the respondents stated that concept mapping would have been an undesirable way to learn. The few negative comments were about having to deal with a difficult or uninteresting topic, or that working with a computer was tiring. It is interesting to notice that even in the positive comments above the students are writing about memorization, not about learning or understanding. Is school a place for learning or a place to memorize things for tests to come? The answer might be different, depending on whether you asked a student or teacher.

7 Conclusions

The small group of students who took part in this study found it easy, favorable, and useful to use concept mapping techniques and software as a means of learning. This is consistent with other studies. Asan (2007) found 5th grade students perceived concept mapping in a positive manner with regard to both the software and helping them understand the material. Of Oliver's (2007) 6th grade student respondents, 65% loved or liked using concept mapping and were even more positive about it in conjunction with readings. The results of this study showed moderate correlation between having better reading skills and performing better in constructing concept maps more accurately. Oliver did not find reading skills to be related to a student's ability to construct average rated maps.

The study presented in this paper was designed to provide data about introducing concept mapping technology and software to students. The results were encouraging and further support the idea that concept mapping, with the aid of computer software, could be one of the first "killer applications" that can unite computer technology seamlessly into the learning process, bring pedagogically grounded Information and Communication Technologies (ICT) into classrooms, and promote learning through conceptual changes, as learning in the Finnish National Core Curriculum today is regarded to happen in an active process, where students process and interpret the material to be learned on the basis of existing structure of knowledge. With concept mapping, students are able to view, refine, edit and share their knowledge 'horizon' in a way that has not been possible before. Future research will target one basic education school with a large sample group of students and teachers as a framework, and concentrate on collaborative knowledge building with concept maps. The effect of learning with concept mapping will also be studied with control groups and pre-post testing

References

- Asan, A. (2007). Concept Mapping in Science Class: A Case Study of fifth grade students. *Educational Technology & Society*, 10 (1), 186–195.
- Finnish National Board of Education 2004. National Core Curriculum of Basic Education 2004. Vammala. Vammalan kirjapaino OY.
- Gadamer, H. (1979). *Truth and Method*. London: Sheed and Ward.
- Glaser, R. & Bassok, M. (1989). Learning theory and the study of instruction. *Annual Review of Psychology*, 40, 631–666.
- Hanke, U. (2006). Externale Modellbildung als Hilfe bei der Informationsverarbeitung und beim Lernen. Freiburg i. Br. Univ., Diss., <http://www.freidok.uni-freiburg.de/volltexte/2495/>.
- Ligorio, M.B. (2001). Integrating communication formats: synchronous versus asynchronous and text-based versus visual. *Computers and Education*. 37 (2), 103–125.
- MacKinnon, G. (2009). Electronic Concept Mapping in A Laptop University: A Cross-Curricular Study. In I. Gibson et al. (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2009* (pp. 1016-1022). Chesapeake, VA: AACE.
- Malpas, J. (2009). "Hans-Georg Gadamer", *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.), <http://plato.stanford.edu/archives/sum2009/entries/gadamer>.
- Nesbit, J.C., & Adesope, O.O. (2005). *Learning with concept and knowledge maps: A meta-analysis*. Annual Conference of the American Educational Research Association, Montreal, Canada.

Novak, J.D. & A.J. Cañas, (2008). The Theory Underlying Concept Maps and How to Construct and Use Them. Technical Report IHMC CmapTools. Florida Institute for Human and Machine Cognition. Available at:

<http://cmap.ihmc.us/Publications/ResearchPapers/TheoryUnderlyingConceptMaps.pdf>

Novak, J.D. & Gowin, D.B. (1984). *Learning how to learn*. New York, NY: Cambridge University Press.

O'Donnell, A.M., Dansereau, D.F. & Hall, R.H. (2002). Knowledge Maps as Scaffolds for Cognitive Processing. *Educational Psychology Review*, 14(1), 71–86.

Oliver, K. (2007). An Investigation of Student Thinking from Concept Mapping of Reading Material. In C. Montgomerie & J. Seale (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007* (pp. 2593-2602). Chesapeake, VA: AACE.

Presseisen, B.Z. (2001). Thinking skills: Meanings and models revisited. In A.L. Costa (Ed.), *Developing Minds: A Resource Book for Teaching Thinking* (3rd ed., pp. 47–53). Alexandria, VA: ASCD.

Sipilä, K. (2010). Teachers' manners, proficiency levels and perceived values in implementing ICT in instruction. *IADIS International Conference e-Learning 2010, Vol.1*, 209–217.

Tergan, S.O. (2006). Mapping and managing knowledge and information in resource-based learning. *Innovations in Education and Teaching International*, 43(4), 327–336.

Study V

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Educational use of information and communications technology: teachers' perspective

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Educational use of information and communications technology: teachers' perspective

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This study investigated teachers' perceptions about how information and communications technology (ICT) is being incorporated into teaching and learning, the level of teachers' digital competence and what factors, in their opinions, might be hindering the use of ICT in schools. A total of 292 Finnish teachers took part in the survey. Activity Theory was chosen for a pedagogical framework. Descriptive statistics, frequency distribution, cross-tabulation and thematic analysis were used to analyse the data statistically. Conclusions include that teachers who have advanced ICT competence use ICT frequently in education. The majority of teachers do not have the means or knowledge to fully use ICT in promoting learning. There still are contradictions between the formal structures of educational institutions and daily classroom practices.

Keywords: teacher; digital competence; basic education; ICT

Introduction

Information and communications technology (ICT) plays an ever-greater role in the everyday life of citizens, communities, educational institutions and businesses. Society is being transformed into an information or knowledge society (e.g. Anderson, 2008). At the same time the concept of knowledge has evolved. Knowledge is seen as being a dynamic concept, involving both information acquisition and competence in thinking and learning. Schools should emphasise the skills required of citizens: thinking skills, work and interaction skills, manual and expression skills, participation and influencing skills, self-knowledge and responsibility skills and information, media and technology skills. The rapid transformation of society implies that students need to be prepared for jobs that might not yet even exist. Being able to use IT is one of the core skills for the twenty-first century.

Finland started to develop an information society very rapidly in the 1990s and was at the forefront of development in international comparisons (e.g. Kankaanranta, Puhakka, & Linnakylä, 2000; Pelgrum & Anderson, 1999). Considerable financial resources were allocated to development of the information society in terms of education.

At present, Finland is at about the European average and the last of the Nordic countries in terms of educational use of ICT (e.g. CICERO, 2008). The international SITES 2006 study indicated that the use of ICT in education was no

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longer at the level made possible by new operating methods (Kankaanranta & Puhakka, 2008). Pedagogically innovative ways of using ICT have declined. In addition, the study revealed a certain lack of trust in the role of ICT in promotion of learning.

The Finnish National Plan for Educational Use of Information and Communications Technology (Ubiquitous Information Society, 2010) laid out the strategic policies and actions formulated as a result of the ICT at School's Everyday Life Project. The object of the project is to promote innovative and creative ICT models and practices for wide dissemination to all Finnish schools. The National Plan (2010) captured obstacles to establishing educational use of ICT. In addition to inadequate technological infrastructure, support structure and the question of e-learning materials, the main obstacles viewed from a systemic point of view were 'low usage of pedagogical models and practices geared toward supporting learners' active involvement and collaborative learning, challenges for the school's operational culture, development of school management practices and change management and bringing teacher training up-to-date'. The National Plan responds to these obstacles by introducing policies and proposals for action that cover 'systemic change, pedagogical models and practices, teacher identity, teachers' pedagogical expertise and operational culture and leaderships at school'.

Policies, proposals and action plans can without a doubt have an effect on pupils' learning, but only indirectly; it is the teacher who decides which methods, pedagogical models and practices, and tools and materials are chosen. Although the use of educational technology in Finnish schools has increased over the years, teachers' ICT competence is, generally speaking, not at a sufficient level. Student teachers fail to obtain sufficient competence in educational use of ICT during their studies (Meisalo, Lavonen, Sormunen, & Vesisenaho, 2010). Teachers already working at schools require continuous and diverse training (Shear, Novais, & Moorthy, 2010). Pedagogical thinking in educational institutions has not advanced in parallel with technological advances (Sipilä, 2011).

National strategies and action play a very important role in making systemic changes in education, but are those strategies in line with views of the individual teacher, who is an integral and sensitive part of sociocultural settings at school, striving to educate pupils but, on the other hand, according to the national curriculum, also influenced by his/her internal motivation, abilities and areas of interest? Integration of ICT into teaching, studying and learning processes is a complex and multi-dimensional task including many dynamics such as ICT tools, teachers, students, school administration, educational programmes and school culture (Sutherland, 2004). With Activity Theory – which will be explained in the next section – as a pedagogical framework, this paper addresses the issue of using ICT in education by:

- Identifying factors seen by teachers as affecting the development of ICT competence and its integration in teaching and learning.
- Finding out specific details about how well teachers see the overall process of integrating ICT into education in their school being handled and what in their opinion are the obstacles hindering the process.
- Determining teachers' levels of ICT implementation and the manner of teachers' technology use in instruction and teaching practices.

Theoretical framework

Activity Theory

Engeström (1987) reformulated Activity Theory (AT), which was originally presented by Soviet Union-era researchers. He presented a model for conceptualising all purposeful human activity as the interaction of these elements: subject, object, tools, community, rules, and division of labour. Kuutti (1995) defines AT as a general framework for studying human activity in different forms as development processes. Kuutti continues to broadly describe AT as a philosophical and multi-disciplinary framework for studying different forms of human practices as development processes, both individual and systemic levels interlinked at the same time.

The main focus in the framework of AT is in manufacturing or processing an object, which is transformed into an outcome. The process needs a subject, which can be either a person or a group of persons who are tied to a certain activity. The object (or objective) is the target of the activity within the system. External mediating artefacts are the tools, which help to achieve the outcomes of the activity. The community consists of one or more persons who share the objective with the subject. Rules can be seen as the explicit and implicit regulations, norms and conventions that constrain actions and interactions within the activity system. The division of labour defines how tasks are divided between members of the community as well as how power and status are divided (Centre for Activity Theory and Developmental Work Research, 2003). AT provides a sociocultural perspective that supports the idea that ICT must be studied within the learning environment and the broader context in which it is situated.

Educational institutions are complex systems, organisational entities. The activity-theoretic concept offers a framework that appears to be particularly useful for describing and explaining human behaviour in complex, dynamic systems (Sujan, Rizzo, & Pasquini, 2002). The interaction of humans in schools has been present from the beginning of educational institutions, but ICT is shaping the development of that interaction in numerous ways. The activities, rules, actions and interactions in schools have evolved and adapted over a long period of time, undergoing an adaptation process that is continuous. The introduction of ICT into the activity systems of schools is likely to bring about contradictions. Contradictions within activity systems are both catalysts and opportunities for systemic change (Sujan et al., 2002).

Kuutti (1995) defines activities as longer-term formations that consist of several steps or phases. He continues by breaking activities into shorter-term processes: activities consist of actions or chains of actions, which in turn consist of operations. Considering this framework in educational surroundings is clarified by the following example: activity (teaching) → action (teaching how to write an essay) → operation (selecting appropriate wording). Activities are always changing and developing. ICT can provide support throughout all of these steps and can work as a catalyst of change.

Demiraslan and Usluel (2008) have adopted the basic structure of activity elements to analyse ICT integration in schools as follows:

- *Subject*: Teacher (teaching experience, teaching approach, the personal, administrative and instructional use of ICT, the place of ICT in daily life, the necessity of knowledge and competence related to ICT).

- *Object*: The goals of using ICT in the teaching-learning process (knowledge and competence acquisition and problem solving).
- *Tools*: ICT and other ICT tools, methods used and problems encountered.
- *Rules*: The evaluation criteria, expectations of the teacher and rules of the school.
- *Community*: Students, teachers, school administration and ICT co-ordinator.
- *Division of labour*: The roles and responsibilities of students and teachers, co-operation among teachers and the support of administration.
- *Outcome*: The reflection of the use of ICT in the teaching-learning process on the learning of students and instruction.

Overall definitions of learning environment and school operational culture

The teacher plays an active and vital part in the learning environment. The term ‘learning environment’ covers a broader concept than just the physical one. It consists of people (teachers and students), technology, materials, classroom layout (or the virtual classroom) and the environment (Lai, 2008). Manninen et al. (2007) present five approaches to *learning environment* that can be seen as overlapping or supplementing: physical, social, technological, local and didactic. According to Manninen et al., the concept of learning environment can be understood as a pedagogical model that guides the planning of education, as a way of thinking or as a fashionable term (for instance to replace education development with learning environment development). The Finnish National Core Curriculum for Basic Education defines learning environment as the entirety of the learning-related physical environment, psychological factors and social relationships. The physical learning environment consists of the facilities, the instructional and working tools, and the learning materials, library services, computers, media technology and data networks. Cognitive and emotional factors together with interaction and human relations affect the physical and social learning environment (Finnish National Board of Education, 2004). Ten Brummelhuis and Kuiper (2008) distinguish four key elements that affect learning processes directly: the learner, the teacher, the curriculum and the infrastructure. These inner elements are surrounded by school environment and then by the society.

Digital competence is the most recent concept describing technology-related skills (Ilomäki, Kantosalo, & Lakkala, 2011). Ilomäki, Kantosalo, and Lakkala continue to state that the term ‘competence’ is more used than ‘skills’, reflecting the need for a wider and more profound content of the concepts. Digital competence is not only digital skills; it is also about social and emotional aspects of using and understanding a digital device.

Dimensions that create the *school culture* are teachers, students, classroom, learning materials, teaching methods, the nature of inquiry, and the attitude of the principal (Limberg, 2002). The National Core Curriculum for Basic Education, by the Finnish National Board of Education (2004), has a wider definition: it defines *school’s operational culture* as the operational culture that embraces all the school’s official and unofficial rules and operational and behavioural models, as well as the values, principles and criteria on which the quality of the schoolwork is founded.

The *hidden curriculum* mixes the formal structures (laws, regulations and budgets) and daily classroom practices guided by curricula, textbooks and study materials. The hidden curriculum is about unnoticeable, repeated aspects of schooling, which usually

are not questioned; for example, the use of time, textbooks and physical space, and the interaction among teachers as well as between teachers and parents (Engeström, 2008).

The integration of ICT into education can be seen either as a catalyst for change (educational push) or as a set of tools that are used to follow educational needs (educational pull) (Ten Brummelhuis & Kuiper, 2008). It is challenging to conclude decisively from a research point of view which paradigm would be the correct conclusion as there are a number of factors that can potentially affect the use of ICT in schools: organisational factors, support factors and environmental factors (Sumner & Hostetler, 1999). Leskes, Grogan, Canham, and O'Brien (2008) argue that the right combination of vision, compromise and commitment of administrators and teachers is crucial in making fundamental and sustainable change possible. According to Grunwald Associates LLC (2010), the more teachers use technology, the more they recognise and value its strong positive effects on student learning and engagement and its connection to twenty-first-century competence. They further conclude that frequent technology users see more effect on behaviours associated with twenty-first-century competence than infrequent users do.

Research questions

Based on the theoretical review, the research questions addressed in this study are as follows:

- (1) How do teachers perceive the systemic support for using ICT in education as being organised?
 - (a). According to teachers, what are students' awareness of and possibilities for using ICT in studying and learning?
- (2) At what level are teachers' ICT competence, frequency and functional use of ICT?
 - (a). Does teaching experience, teaching level or gender of teachers have an effect on the previous factors?
- (3) From the teachers' perspective, are there factors causing contradictions or hindering the expansion of ICT use in teaching?

Method

The data were gathered with a questionnaire directed to teachers in five Finnish municipalities. Thematic analysis is used for analysing open-ended questions in the questionnaire. This is done by representing a view of reality via systematically working through text from open-ended questions to identify topics that are then progressively integrated into higher-order themes via processes of de-contextualisation and re-contextualisation. Quantitative and qualitative analysis is used to explore teachers' perspectives and perceptions about using ICT more widely in education.

Thematic analysis is used for identifying, analysing and reporting patterns (themes) within data. With thematic analysis, the researcher is able to organise and describe the data set in detail and interpret various aspects of the research topic

(Braun & Clarke, 2006). The text-based data acquired by the questionnaire's open-ended questions is analysed based on principals of thematic analysis, but it is also interpreted to suit the structure of AT.

Data collection

The quantitative paradigm was chosen as a basis for the present study and an online questionnaire as the data-gathering method. Data gathering was conducted on three occasions during 2011. The invitation link to participate was distributed to the heads of education departments in 10 municipalities located in southwestern Finland. The heads of education departments were asked to forward the questionnaire to teachers in their municipalities. Teachers from five municipalities took part in the questionnaire. Since the actual invitation message was not sent to teachers in the municipalities in question straight from the researcher, it is not known how many teachers actually received the email.

Questionnaire

The questionnaire used to collect data for this study had five background questions (municipality, gender, teaching experience, school and teaching level). Fourteen Likert-type questions on a scale of 1–5 concerned overall systemic support, practices and goals of using ICT, and students' possibilities of and knowledge in using ICT in studying and learning. Twenty-seven questions were introduced in order to investigate how the respondents assessed themselves as ICT users and whether they hoped to have training in these particular types of competencies. One question was asked about the functional use of ICT. Many of the Likert-type questions had an open text field attached to them labelled 'Improvement necessity/contradictions'. Additionally, there were two open-ended questions asking respondents to describe things that would require improvement in technical and pedagogical support, e-learning material, in-service training and equipment/infrastructure. Respondents were also asked to define ICT factors that would need improvement from the school subject point of view. Finally, the respondents were asked to evaluate how often they had the possibility to provide students with computers.

Data analysis

Descriptive statistics, frequency distribution, cross-tabulation and thematic analysis were used to analyse the data statistically. The data collected with open-ended questions were transcribed, combined and catalogued to themes and sub-themes if needed in order to see whether there were patterns emerging. Themes and sub-themes were then analysed in terms of AT categories: subject, object, tools, rules, community, division of labour and outcome. The teacher's perspective was chosen as the subject in the analysis.

Results

Of the 292 respondents ($N = 292$), 67% were female and 33% male; 38% of respondents were working in primary schools, 34% in secondary schools and 22% in upper secondary schools; 24% were class teachers, 55% subject teachers, 10%

special education teachers, 6% headmasters and 5% special needs assistants or guidance counsellors. Teaching experience varied evenly: 12% stated their teaching experience was less than six years, while 10% had been teaching for more than 30 years. The largest group – 20% of respondents – stated their teaching experience was between 11 and 15 years.

Systemic support, students' awareness and possibilities

Table 1 presents mean and standard deviation values of respondents when asked to evaluate on a scale of 1–5 how they see the overall systemic support, practices and goals of using ICT in their work community being handled.

Mean values presented in Table 1 show that in general the respondents had more than average perceptions about how ICT is used, supported and developed in their school (mean = 3.1). Evaluation of the effect of ICT use in education does not seem to be on an adequate level and social media tools have not found their way into teachers' use in planning teaching together.

The Cronbach's alpha value of 0.88 for teachers' responses to nine items presented in Table 1 indicated high internal consistency, so scores from these items were combined into one new composite variable (systemic support). Values were then recoded into two categories, more negative and more positive. These categories were then cross-tabulated according to whether the respondents are primary school teachers, subject teachers in secondary school or subject teachers in upper secondary school. Table 2 presents the differences.

The results show that primary school teachers are more positive in their perceptions than secondary or upper secondary teachers. Of primary school teachers, 44.3% gave more positive values to the statements in question, whereas less than 30% of secondary and upper secondary teachers gave more positive values. The difference shows borderline statistical significance ($\chi^2(1) = 8.849; p = 0.012$) when analysed with the Pearson chi-square test.

The questionnaire also included five questions asking respondents their perceptions on a scale of 1–5 about students' possibilities of and knowledge in using ICT

Table 1. Respondents' mean and standard deviation values on statements about the development of ICT use in school on a systemic level ($N = 292$).

Statement	Mean	SD
There is a shared volition in the school to develop the use of ICT in education.	3.5068	0.91379
There are shared goals set for developing the use of ICT in the school.	3.4089	0.89737
Teachers' professional ICT competencies are systematically developed in the work community.	3.1034	0.97898
The curriculum supports the use of ICT in education.	3.4417	0.79903
ICT is being used on a daily basis as part of teaching practices in different subjects.	3.4256	0.82623
The staff use ICT as part of student-centred and modern teaching methods.	3.1557	0.84949
The use of ICT in education and its effect on learning is evaluated.	2.4877	0.93648
The school actively supports the development of students' ICT competence.	3.3945	0.81022
The staff use social media tools as a shared means of planning teaching together.	2.5833	1.00855

Table 2. Respondents' perceptions about how the use of ICT is supported on a systemic level based on their teaching level ($N = 292$).

		Teaching level			Total	
		Primary	Secondary	Upper secondary		
Systemic support	More negative	Count	36	53	36	125
		%	28.8	42.4	28.8	100.0
	More positive	Count	74	47	46	167
		%	44.3	28.1	27.5	100.0
Total		Count	110	100	82	292
		%	37.7	34.2	28.1	100.0

in studying and learning. Table 3 presents mean and standard deviation values of the responses in those five statements.

According to teachers' opinions, students have a good possibility of and knowledge about how to use ICT in studying and learning. Teachers also regarded information literacy and information management to be taught to students. The idea of providing personal learning paths in studying and learning processes is less familiar to teachers.

Internal consistency of the five statements presented in Table 3 was high (Cronbach's alpha value 0.82). These statements were combined into a new composite variable called Students' Possibilities and cross-tabulated with respondents' teaching level. Analysis revealed that primary teachers again were more positive in their perceptions of students' possibilities and awareness of using ICT, but in this case the difference was not statistically significant.

ICT competence and frequency of ICT use

Twenty-seven questions were introduced to investigate how the respondents assessed themselves as ICT users and whether they hoped to have training in these particular types of competencies. The first 16 questions surveyed respondents' perceptions about their own basic ICT competence, e.g. office software use, clipboard, images, email, etc. The respondents perceived themselves to be at a very good level in word processing (mean = 4.5 on a scale of 1–5), inserting images or objects into text and using computer accessories (mean = 4.3), as well as using email comprehensively (mean = 4.4). They were the least confident in producing or editing web

Table 3. Respondents' mean and standard deviation values on statements about students' possibilities of and knowledge about using ICT in learning ($N = 292$).

Statement	Mean	SD
Pupils/students have the possibility to use ICT in studying and learning.	3.5483	0.82450
Students are aware of how to enhance their learning with ICT.	3.1525	0.77867
Students can use platforms or software that encourage them to produce material about their learning and share it with others.	3.1573	0.94145
Information literacy and information management competence are taught.	3.5069	0.86649
Students are able to use platforms or software that support the idea of personal learning paths.	2.9333	0.87291

pages (mean = 2.6), using an electronic calendar (mean = 2.9) and recording or playing sounds with a computer (mean = 3.0). Internal consistency of responses to these 16 questions was 0.92.

The analysis revealed that male teachers considered themselves more likely to master basic ICT competence; 84.5% of male teachers ($N = 97$) responded as being on a good or excellent level, whereas 68.2% of female teachers ($N = 195$) chose the same option. The difference was statistically significant ($\chi^2(1) = 8.898$; $p = 0.003$). Gender had statistical significance ($p = 0.002$) also when the frequency of ICT use was explored; the female to male percentage ratio in using ICT only a little was 80:20, whereas in the group that described itself as good or excellent the ratio was 51:49.

Thirty-five per cent of respondents stated that they are using ICT in education either all the time or almost always, 37.7% frequently; 47.9% regarded themselves as average users of ICT and 51.7% perceived themselves to be on an adaptive or creative level in integrating ICT into their teaching.

Ten questions in the questionnaire covered respondents' information-management competence and ability to use social media and e-learning platforms (advanced ICT competencies). Statements, along with their mean and standard deviation values, are presented in Table 4.

The mean values presented in Table 4 are significantly lower than values taken from basic ICT competence. Teachers perceive themselves to be less confident about their professional competence in using ICT in ways that require advanced and more in-depth knowledge. Internal consistency of these 10 questions was 0.87. Table 5 presents whether having good or excellent competence in basic ICT results in possession of advanced ICT competence as well.

Correlation between the two skill levels presented in Table 5 showed on a statistically significant level ($\chi^2(1) = 69,482$; $p = 0.000$) when analysed with the Pearson chi-square test. The analysis also revealed that male teachers considered themselves more likely to possess advanced ICT competence; 64.9% of male teachers ($N = 97$) responded as being on a good or excellent level, whereas 46.2% of female teachers ($N = 195$) chose the same option. The difference was statistically significant ($\chi^2(1) = 9174$; $p = 0.002$). Of teachers who stated that they possessed advanced ICT competence, 64.7% also responded that they used ICT considerably. Of teachers who perceived themselves as having only moderate skill at best, only 35.7% answered that they use ICT considerably. The difference was statistically significant ($p = 0.000$).

Functional use of ICT in education

Respondents were asked to evaluate the functional use of ICT in their educational activities by stating the frequency of use on a scale of 1–6 (1 = never, 6 = almost always) in 11 categories. Figure 1 presents the categories and respondents' mean values.

According to the results shown in Figure 1, teachers are using ICT in their work mainly for information retrieval, administrative or evaluative tasks, and for planning lessons. The main focus on how to incorporate ICT into students' use is by using computers for information retrieval. Communicative, collaborative or creative use of ICT is not favoured. Internal consistency of responses to these 11 questions was 0.88. There was a gender correlation on what kind of values respondents gave to questions concerning functional use of ICT. Male teachers gave bigger values on a statistically significant scale ($\chi^2(1) = 9.178$; $p = 0.001$). Also, frequency of ICT use had an effect; the more the respondents stated they used ICT in education, the

Table 4. Respondents' mean and standard deviation values on statements about their information-management competence and ability to use social media and e-learning platforms ($N = 292$).

Statement	Mean	SD
Ability to plan information retrieval process.	3.2143	1.49356
Ability to use networks independently and comprehensively in information retrieval.	3.7378	1.32298
Awareness of source criticism and copyright issues.	3.7797	1.26969
Ability to use social media tools.	3.1734	1.46535
Ability to use instant messaging services fluently.	2.8127	1.46978
Ability to use discussion boards and other interactive web-based tools.	2.3220	1.28383
Ability to support students' collaborative learning.	2.3071	1.32650
Ability to receive assignments and give feedback with tools on e-learning platforms.	2.8487	1.44878
Ability to use e-learning materials in a way that adds pedagogical value to learning.	3.4307	1.47742
Ability to teach on an e-learning platform.	2.8915	1.46313

Table 5. Respondents' perceptions about their ICT competence at basic and advanced levels cross-tabulated ($N = 292$).

			Advanced ICT competence		Total
			Moderate at best	Good or excellent	
Basic ICT competence	Moderate at best	Count	68	9	77
		%	88.3	11.7	100.0
	Good or excellent	Count	71	144	215
		%	33.0	67.0	100.0
Total	Count	139	153	292	
	%	47.6	52.4	100.0	

bigger were the values given in categories concerning functional use of ICT ($\chi^2(1) = 73.571$; $p = 0.000$).

Factors hindering the use of ICT or causing contradictions

Text data from the questionnaire's open-ended questions were categorised thematically according to AT's basic structure. Throughout the questionnaire, respondents were asked to write opinions about factors that should be developed or that were not adequate concerning educational use of ICT. At the end of the questionnaire, respondents were specifically asked to write three to five factors that should be developed in order to have a positive effect on educational use of ICT generally as well as from the point of view of the subject that they teach. The following factors or contradictions that arose from the data are presented below as categorised by the basic structure of activity elements and are explained with actual text excerpts taken from responses. The contradictions seen from teachers' points of view are labelled **A** to **F** and presented in Figure 2, where they are implemented in the basic structure of activity:

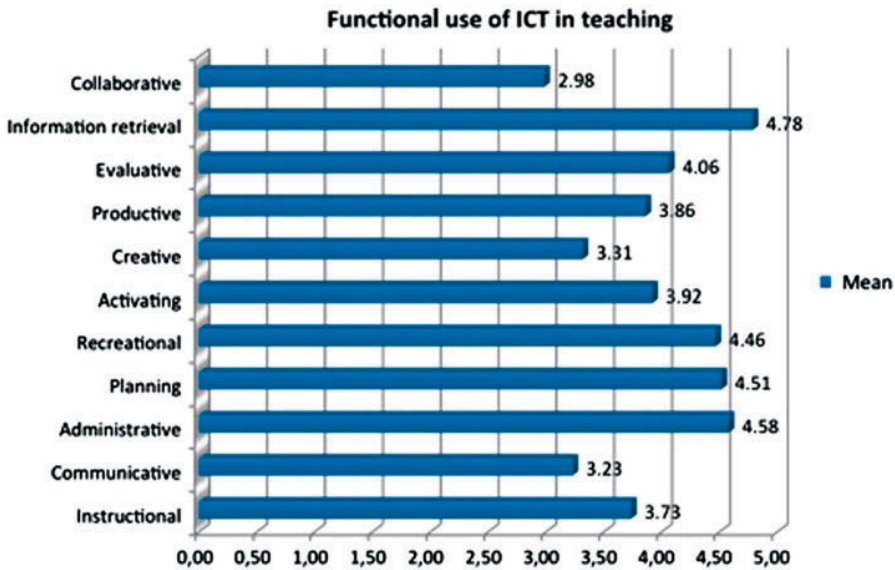


Figure 1. Respondents' mean values of functional use of ICT in education ($N = 292$).

- Subject (teacher)
- Teachers did not see their own professional development to be on a level adequate to use ICT in way that would promote learning in a pedagogically grounded manner. Teachers struggle to meet demands set in the curriculum; they do not have time to focus on technology or new teaching methods. The attitudes toward ICT are varied.

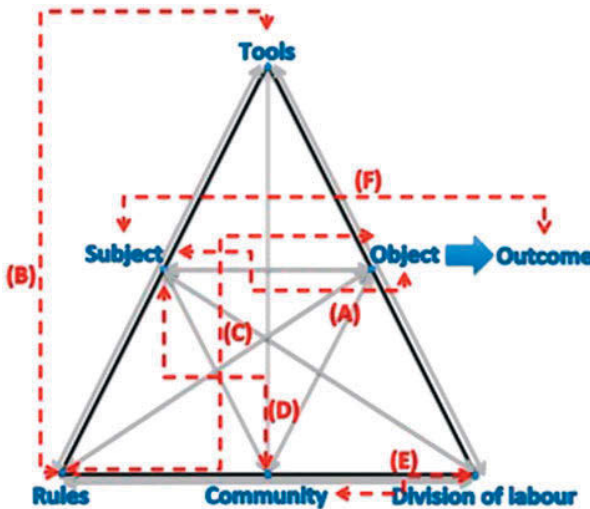


Figure 2. Contradictions stated by the respondents seen from the Activity Theory perspective ($N = 292$).

- Respondent 22: ‘Not all teachers understand that ICT is an essential part of everyday life outside school and that it should be that way also at school.’
 - Respondent 271: ‘Teachers’ knowledge about how to use ICT in education is not sufficient.’
 - (A) Object (the goals of using ICT in the teaching-learning process)
 - Schools lack systematic goals for ICT use. The vision about ICT as a mediating tool in learning is not shared by all teachers. It is hard to show if ICT has a positive effect on learning.
 - Respondent 123: ‘Only a small group of teachers is responsible for the planning of ICT use; goals are not shared among the majority.’
- Respondent 128: ‘Schools are not able to meet the demands set in the national curriculum.’
 - (B) Tools (technological framework, pedagogical methods and learning material)
 - Teachers perceive the lack of computers and equipment to be the greatest obstacle to further advancement in implementing ICT into education. Students do not have enough equipment. Learning methods with which to integrate ICT into education effectively are not familiar to teachers. Schools need more professional e-learning materials.
 - Respondent 217: ‘There are too few computers per student in order to use them properly.’
 - Respondent 160: ‘The lack of in-service training is the greatest obstacle.’
 - (C) Rules (the evaluation criteria, expectations of the teacher and rules of the school)
 - The curriculum does not offer concrete advice or means for how to implement ICT into teaching. There is a lack of joint effort at school and uncertainty about what the correct methods are. School leadership lacks vision. The impact of using ICT at school is not evaluated.
 - Respondent 292: ‘Using ICT in teaching effectively requires new pedagogical methods. Educational tools have improved; teaching has to improve as well.’
- (D) Community (students, teachers, school administration and the ICT co-ordinator)
 - Co-ordinated, concrete hands-on plans are missing. Technology in itself does not guarantee progress. There should be possibilities for promoting experimentation to explore the abilities of ICT tools to improve practice and develop methods.
 - Respondent 268: ‘There is a need for a guide that gives concrete and consistent advice on how to implement technology into education in different grades.’
- (E) Division of labour (roles, co-operation and support)

- Pedagogical support is missing. IT departments can be restrictive. Teachers do not plan teaching collaboratively or share their ideas for ICT use. In-service training should be possible during working hours.
 - Respondent 292: ‘Co-operation between colleagues is needed, for instance in trying out certain software.’
 - Respondent 73: ‘Technical support should take care of all the technical equipment in the classroom.’
- (F) Outcome (the goals that are sought)
 - ICT is often seen as an extra-curricular event that does not help meet demands. National plans to improve the use of ICT in education are considered to be unrealistic.
 - Respondent 182: ‘Strategies and reality do not meet.’
 - Respondent 290: ‘To evolve the goals into practices requires joint planning and training.’

Figure 2 illustrates the contradictions or problems that teachers responding to the questionnaire saw as hindering the development of ICT use in education.

Figure 2 illustrates that there are several contradictions still prevalent among different components laid out according to AT. It seems to be unclear to teachers what is being sought after by integrating technology into classrooms (**A**: Subject–Object). Nor is it clear what the final outcome should be (**F**: Subject–Outcome). According to analysis of data gathered from the open-ended questions, teachers seem to think that increasing the amount of technological equipment in classrooms and increasing training for teachers would solve the issues currently at hand (**B**: Rules–Tools). On the other hand, teachers do realise that technology alone does not trigger change in the operational culture of educational institutions; there is a need for new kinds of pedagogical methods as well (**C**: Rules–Object; **D**: Subject–Community). Schools are in need of joint efforts, collaborative knowledge-building and shared experiences in order to focus as a community on how to further develop the use of ICT at school to foster learning (**E**: Community–Division of labour).

Conclusion and discussion

The Finnish National Plan for Educational Use of Information and Communications Technology (Ubiquitous Information Society, 2010) lays out strategic policies and proposals in order to promote meaningful and collaborative learning and to develop learning-to-learn and other competencies required in the twenty-first century. This study gives indications that half of teachers consider themselves to be both unqualified and unprepared to use ICT in education in a way that would add value to teaching and learning.

This study presented evidence that teachers who have advanced ICT competence use ICT frequently in education. This is supported by other research. The Department of Education and Training Western Australia (2006) found a very strong relationship (0.38) between the extent to which ICT is integrated into the classroom to achieve learning outcomes and the ICT competence and knowledge of the teacher. The same study also provided evidence in line with that found in this study: male

teachers are more likely to perceive themselves as having higher levels of ICT competence. Educational technology has the tendency to attract male teachers in general. This phenomenon is on the brink of changing as tools used within social media are increasingly implemented into platforms used at school. The emphasis is shifting from a technological point of view (using discrete software tools) to a more social one (using familiar social media tools for producing material collaboratively and sharing it easily over the web). This progress is making the use of ICT more appealing to teachers not technically oriented.

The study presented in this article found several factors that need to be addressed before the implementation of ICT into teaching will be possible as it should be. The findings indicate that at the moment teachers do not have the means or knowledge to fully use ICT in promoting learning. Technological issues are still to be solved. It is unclear in what direction the school should go as an organisational entity. Hands-on guides about what to do with ICT in specific subjects are needed. ICT should be seen as a mediating tool instead of an extra-curricular subject.

It must also be remembered that it is the learner who should be everyone's main concern. Every change that we make in the context of learning should be made so that learning is promoted, both at individual and at systemic levels. ICT in education is not ultimately about what kind of technology is provided to teachers, it is about having the right kind of equipment on hand for the learner and providing him or her with pedagogically grounded learning methods and tools.

The systemic support, technical framework and basic ICT competence of teachers have clearly taken steps forward, but the large-scale leap forward in learning ignited by technology is yet to come. After almost two decades of ICT implementation in schools, there are still contradictions between the formal structure of educational institutions (national development processes, curriculum, teacher training) and daily classroom practices (teaching, studying, learning). Theory and practice need to come closer to each other.

The national curriculum and plan for educational use of ICT provide general guidelines as to the ultimate goals, but if the need is to have an impact on the activities and interactions happening in schools, then providing support only for the activity level is not enough: there is need for support for the action and operation level as well. As long as the curriculum does not tie the use of ICT concretely to school subjects being taught, it is in the teacher's hands to decide whether to turn on the devices or to carry on as usual. If there are glitches in equipment on hand, lack of knowledge of how to use it or uncertainty whether it is promoting learning, the devices will be left untouched.

New technologies require new teacher roles, new pedagogies and new approaches to teacher training (Makrakis, 2005). If the goal is for teachers to use the learning environment in non-traditional ways, to join new technology with new pedagogy or to develop collaborative knowledge building, reaching the goal requires twenty-first-century competence to be developed in the teacher. Educational technology will have to be used as the catalyst for change – to push educational change further. With the help of Web 2.0 tools, the possibility to evolve education is now possible. Grosseck (2009) defines Web 2.0 as 'the social use of the Web which allows people to collaborate, to get actively involved in creating content, to generate knowledge and to share information online'. Web 2.0 is transforming the way in which people learn. Current views of learning regard the notion of a teacher-dominated classroom and curriculum as obsolete and embrace learning

environments and approaches where students take control of their own learning, make connections with peers, and produce new insights and ideas through inquiry (McLoughlin & Lee, 2007). In order to keep pace with the content creation processes enabled by Web 2.0 and social software, it appears to be necessary to go beyond the acquisition and participation dichotomy; Paavola and Hakkarainen (2005) propose the knowledge creation metaphor of learning.

The Finnish national core curriculum is currently undergoing a renewal process with the goal of being in use in two to three years. Because the core curriculum includes the objectives and core contents of different subjects, the principles of a good learning environment, working approaches and the concept of learning, it has a crucial effect on our school's operational culture. On a local level, education providers (municipalities) and schools are renewing their educational technology strategies in order to meet the requirements set in a national strategy and plan. If the National Plan and core curriculum do not provide technological standards, pedagogical guidance, financial support and teacher training programmes at sufficient levels nationally, it will be up to individual municipalities' priorities and funds to support the integration of ICT into education. Leaving development to individual municipalities would only lead to increased inequality in education, as opposed to the aim of the Basic Education Act: the aim of education shall further be to secure adequate equity in education throughout the country.

Reliability, limitations and future directions

A part of the questionnaire used in this study consisted of questions in which the participants were asked to assess their own personal ICT competence, their level of ICT integration, etc. When analysing this kind of self-reported material, it is vital to acknowledge that the data gathered are not objective, but subjective. The final number of respondents to the questionnaire proved not to be as large as expected. This, too, should give us pause before making generalisations.

The next phase is a research project that provides teachers with adequate in-service training, pedagogical support, time for planning and modern equipment for students.

Notes on contributor

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References

- Anderson, R. (2008). Implications of the information and knowledge society for education. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 5–22). New York, NY: Springer.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, 77–101.
- Centre for Activity Theory and Developmental Work Research. (2003). *The activity system*. Retrieved from <http://www.edu.helsinki.fi/activity/pages/chatanddwr/activitysystem>
- CICERO. 2008. *Tieto- ja viestintäteknikan hyödyntäminen opetuksessa ja opiskelussa* [Information and communications technology in teaching and learning at Finnish comprehensive schools]. Retrieved from http://www.cicero.fi/sivut2/documents/CICERO_TVT-selvitysraportti.pdf [English summary available from <http://www.cicero.fi/sivut2/documents/CICERO%20report%20on%20ICT%20in%20teaching%20and%20learning.pdf>]

- Demiraslan, Y., & Usluel, Y. K. (2008). ICT integration processes in Turkish schools: Using activity theory to study issues and contradictions. *Australasian Journal of Educational Technology*, 24, 458–474. Retrieved from <http://www.library.dcu.ie/Eresources/databases-az.htm>
- Department of Education and Training Western Australia. (2006). *Teacher ICT competence. Evaluation of the information and communication technology (ICT) knowledge and skill levels of Western Australian government school teachers*. Retrieved from <https://www.det.nsw.edu.au/proflearn/der/docs/wherenow/teachict.pdf>
- Engeström, Y. (1987). *Learning by expanding*. Helsinki: Orienta-konsultit.
- Engeström, Y. (2008). *From teams to knots: Activity-theoretical studies of collaboration and learning at work (learning in doing: social, cognitive and computational perspectives)*. New York, NY: Cambridge University Press.
- Finnish National Board of Education. (2004). *National core curriculum for basic education*. Retrieved from http://www.opf.fi/ops/english/POPS_net_new_1.pdf
- Grosseck, G. (2009) To use or not to use web 2.0 in higher education? *Procedia – Social and Behavioral Sciences*, 1, 478–482.
- Grunwald Associates LLC. (2010). *Educators, technology and 21st-century competence: Dispelling five myths*. Minneapolis, MN: Walden University, Richard W. Riley College of Education. Retrieved from <http://www.WaldenU.edu/fivemyths>
- Ilomäki, L., Kantosalo, A., & Lakkala, M. (2011). *What is digital competence? In linked portal*. Brussels: European Schoolnet.
- Kankaanranta, M., & Puhakka, E. 2008. *Kohti innovatiivista tietotekniikan opetuskäyttöä. Kansainvälisen SITES 2006 -tutkimuksen tuloksia. Jyväskylän yliopisto. Koulutuksen tutkimuslaitos* [Towards innovative use of information technology in education. Results of the international SITES 2006 Study]. Jyväskylä, Finland: University of Jyväskylä, Finnish Institute for Educational Research [Executive summary of the SITES 2006 international report available in English from <http://www.sites2006.net>].
- Kankaanranta, M., Puhakka, E., & Linnakylä, P. (2000). *Tietotekniikka koulussa. Kansainvälisen arvioinnin tuloksia. Jyväskylän yliopisto. Koulutuksen tutkimuslaitos* [IT at school. Findings of an international assessment]. Jyväskylä, Finland: University of Jyväskylä, Finnish Institute for Educational Research.
- Kuutti, K. (1995). Activity theory as a potential framework for human–computer interaction research. In B. A. Nardi (Ed.), *Context and consciousness: Activity theory and human–computer interaction* (pp. 17–44). Cambridge, MA: MIT Press.
- Lai, K.-W. (2008). ICT supporting the learning process: The premise, reality and promise. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 215–230). New York, NY: Springer.
- Leskes, A., Grogan, W. R., Canham, R. P., & O'Brien, J. (2003). Designing institutional change. *Liberal Education*, 89, 32–41.
- Limberg, L. (2002). *The school library's pedagogical role – A literature review*. Stockholm: Skolverket.
- Makrakis, V. (2005). Training teachers for new roles in the new era: Experiences from the United Arab Emirates ICT program. In Th. Tzimoyiannis (Ed.), *Proceedings of the 3rd Pan-Hellenic Congress on Didactics of Information and Communication Technologies (ICT)*. University of Peloponnesus: Korinthos, 2005 (1–6).
- Manninen, J., Burman, A., Koivunen, A., Kuittinen, E., Luukannel, S., Passi, S., et al. (2007). *Environments that support learning. Introduction to the learning environments approach*. Helsinki: Finnish National Board of Education.
- McLoughlin, C., & Lee, M. J. W. (2007). Social software and participatory learning: Pedagogical choices with technology affordances in the Web 2.0 era. In Atkinson, R. J., McBeath, C., Soong, S. K. A., & Cheers, C. (Eds.), *ICT: Providing choices for learners and learning. Proceedings ascilite Singapore 2007*. Centre for Educational Development, Nanyang Technological University.
- Meisalo, V., Lavonen, J., Sormunen, K., & Vesisenaho, M. (2010). *ICT in initial teacher training. Finland. Country report. OEDC CERI, New Millennium Learners*. Helsinki: Department of Teacher Education, University of Helsinki and School of Applied Education and Teacher Education, University of Eastern Finland.
- Paavola, S., & Hakkarainen, K. (2005). The knowledge creation metaphor – An emergent epistemological approach to learning. *Science and Education*, 14, 535–557.

- Pelgrum, W. J., & Anderson, R. E. (Eds.). (1999). *ICT and the emerging paradigm for life long learning: A worldwide educational assessment of infrastructure, goals and practices*. Enschede, The Netherlands: IEA.
- Shear, L., Novais, G., & Moorthy, S. (2010). *ITL research. Executive summary of pilot year findings*. SRI International. Retrieved from <http://www.elb2011.org/docs/ITL%20Research%20Executive%20Summary.pdf>
- Sipilä, K. (2011). No pain, no gain? Teachers implementing ICT in instruction. *Interactive Technology and Smart Education*, 8, 39–51.
- Sujan, M., Rizzo, A., & Pasquini, A. (2002). Contradictions and critical issues during system evolution. In P. Prajendra (Ed.), *Proceedings of the 2002 ACM Symposium on Applied Computing (SAC), Madrid, Spain* (pp. 715–715). New York, NY: ACM.
- Sumner, M., & Hostetler, D. (1999). Factors influencing the adoption of technology in teaching. *Journal of Computer Information Systems*, 40, 81–87.
- Sutherland, R. (2004). Designs for learning: ICT and knowledge in the classroom. *Computers & Education*, 43, 5–16.
- Ten Brummelhuis, A., & Kuiper, E. (2008). Driving forces for ICT in learning. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 97–111). New York, NY: Springer.
- Ubiquitous Information Society. (2010). *National plan for educational use of information and communications technology*. Retrieved from [http://www.arjentietoyhteiskunta.fi/files/313/TVT_opetus kayton_sunnitelma_011210_\(2\).pdf](http://www.arjentietoyhteiskunta.fi/files/313/TVT_opetus kayton_sunnitelma_011210_(2).pdf)