Hanna Vuojärvi

Conceptualising Personal and Mobile Learning Environments in Higher Education

Focus on Students' Perspective

ACADEMIC DISSERTATION
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ABSTRACT

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This study investigated how the concept of personal and mobile learning environments (PMLEs) can be conceptualised, and how their creation could best be supported in higher education, according to university students. The six empirical studies comprising this thesis were conducted at the University of Lapland, where a large-scale mobile technology initiative was carried out between 2004 and 2009.

The particular focus was on university students, their experiences, perceptions and development ideas. The first study sought to discern students' expectations concerning data security, mobility and collaborative learning processes on a wireless campus, while the second aimed to reveal the domestication process that students go through when putting their laptops to use at the beginning of their studies. In addition, the means by which students integrated the laptop into their personal learning processes, the kinds of procedures that rendered the laptop useful and meaningful, and how gender and IT proficiency influenced these processes, were also examined. The third study was a design-based research (DBR) process, in which a computer-supported collaborative learning (CSCL) course on the data security of wireless learning environments was designed and implemented. The fourth study deliberated on the students' perceptions of the added pedagogical value that laptops and wireless networks bring to CSCL processes.

The fifth and sixth studies concentrated particularly on the views of non-traditional students who have extra life commitments along with their studies, such as taking care of children or term-time employment. The results of these two studies revealed that students with children especially benefited from the support the laptops and networks provided, and the mobility and flexibility that they afforded.

Multiple methodologies were employed in order to answer varying and multidimensional research questions within the six empirical studies. The studies used

approaches including statistical methodologies, grounded theory (GT), DBR, and mixed methods. Both qualitative and quantitative data were collected.

The results of the individual empirical studies are considered through activity theory, which is a socio-culturally driven, general framework for describing human activity as development processes in different forms. This study strengthens the view of PMLEs as conceptual tools, moving away from a device- or system-oriented understanding of learning environments. For universities as administrative organisations, the concept of a PMLE can serve as a strategic tool that can be used when developing strategies for ICTs' pedagogical use and when designing possible future ICT initiatives. For university instructors, this research offers insights into students' perceptions of using mobile ICTs in learning, and a starting point when developing their own professional skills and knowledge. It encourages students to consider the best ways to use mobile ICTs in their personal lives, of which higher education studies form a part. For researchers, the conceptual understanding of a PMLE offers a multitude of research tasks for future completion.

KEYWORDS Personal and mobile learning environment (PMLE), mobile learning, information and communication technologies (ICTs), higher education, activity theory

TIIVISTELMÄ

Vuojärvi Hanna
Henkilökohtaisten ja mobiilien oppimisympäristöjen käsitteellistäminen korkeakoulutuksessa—Tarkastelussa opiskelijoiden näkökulma
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Tämän väitöskirjan tavoitteena oli tutkia yliopisto-opiskelijoiden näkökulmasta, miten henkilökohtaisen ja mobiilin oppimisympäristön käsite voidaan määritellä. Väitöskirja koostuu kuudesta osatutkimuksesta, jotka toteutettiin Lapin yliopistossa, missä vuosien 2004 ja 2009 välisenä aikana kaikille opintonsa aloittaville opiskelijoille tarjottiin mahdollisuus hankkia käyttöönsä kannettava tietokone yliopiston osaksi kustantamana.

Tutkimuksen keskiössä ovat yliopisto-opiskelijat, heidän kokemuksensa ja näkemyksensä sekä kehitysideansa. Ensimmäisessä osatutkimuksessa kartoitettiin opiskelijoiden tietoturvaan, opiskelun mobiiliuteen sekä tietokoneilla tuettuun yhteisölliseen opiskeluun liittyviä odotuksia. Toisessa osatutkimuksessa selvitettiin, millaisen kotouttamisprosessin opiskelijat käyvät läpi ottaessaan kannettavaa tietokonetta käyttöönsä. Tutkimuksessa tarkasteltiin myös sitä, miten opiskelijat integroivat kannettavan tietokoneen oppimisprosessiinsa, millaisten kokemusten kautta kannettavasta tuli merkityksellinen sekä sitä, miten sukupuoli tai tietotekniset taidot vaikuttivat tähän prosessiin. Kolmas osatutkimus rakentui design-perustaisen tutkimuksen periaatteille ja sen aikana suunniteltiin ja toteutettiin langattomien kampusten tietoturvaa käsittelevä opintojakso. Neljännessä osatutkimuksessa selvitettiin, mitä pedagogista lisäarvoa kannettavat tietokoneet opiskelijoiden mielestä tuovat tietokoneella tuettuihin yhteisöllisen oppimisen prosesseihin.

Viidennessä ja kuudennessa osatutkimuksessa keskityttiin erityisesti lapsiperheellisten ja lukukausien aikana työskentelevien opiskelijoiden kokemuksiin. Tulosten perusteella voidaan sanoa, että erityisesti lapsiperheelliset opiskelijat hyötyivät kannettavien tietokoneiden ja langattomien tietoverkkojen mahdollistamasta mobiiliudesta ja joustavuudesta.

Osatutkimusten tutkimustehtäviä ja -kysymyksiä lähestyttiin useista metodologisista lähtökohdista käsin. Tutkimuksissa hyödynnettiin tilastollista lähestymistapaa, grounded-teoriaa, design-tutkimusta sekä erilaisten tutkimusmenetelmien yhdistelmiä (mixed methods). Tutkimuksissa kerättiin sekä laadullista että määrällistä aineistoa.

Osatutkimuksissa saatuja tuloksia tarkastellaan toiminnan teorian (activity theory) kautta. Toiminnan teoria on sosio-kulttuurisesti orientoitunut viitekehys, joka käsittelee ihmisen toimintaa eri muodoissaan kehitysprosesseina. Tutkimus vahvistaa käsitystä oppimisympäristöistä käsitteellisinä, ei niinkään laitteisto- tai järjestelmävetoisina työvälineinä. Tässä tutkimuksessa esiteltävä käsitteellinen tarkastelu tarjoaa yliopistoille strategisen työvälineen, jota voidaan hyödyntää mobiilin tieto- ja viestintätekniikan (TVT) pedagogisen hyödyntämisen sekä tulevien TVT-hankkeiden suunnittelussa. Opettajille tutkimus valottaa opiskelijoiden näkemyksiä mobiilin TVT:n hyödyntämisestä opiskeluprosesseissa sekä lähtökohdan omien pedagogisten ja ammatillisten tietojen ja taitojen kehittämiseen. Tutkimusten valossa opiskelijat voivat pohtia, miten he voivat parhaalla tavalla hyödyntää mobiilia TVT:aa osana omaa arkeaan, johon yliopisto-opinnot kuuluvat. Tutkijoille tämä väitöskirja tarjoaa useita jatkotutkimustehtäviä, joiden kautta tässä kehitettyä käsitettä voidaan edelleen kehittää ja tarkentaa.

AVAINSANAT henkilökohtaiset ja mobiilit oppimisympäristöt, tieto- ja viestintätekniikka, mobiiliopiskelu, korkeakoulutus, toiminnan teoria

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When I started my PhD studies in spring 2004, I had only a vague idea of what it meant to work as a researcher or to compile a PhD thesis. Luckily, I have had the pleasure of working with gifted and hardworking people who have guided and supported me, and contributed to my work and the evolution of this thesis. To all, I owe my deepest gratitude.

First, I am deeply grateful to Professor Heli Ruokamo, director of the Centre for Media Pedagogy (CMP) at the University of Lapland, for giving me the chance to work at CMP for almost 7 years now, and to be a member of a team of researchers in both the MobIT and TravEd projects. I sincerely appreciate her supervision and encouragement, reflected in the comments on the articles and the manuscript of this thesis. Her support has been something that I have been able to count on in my academic work. I also highly value and appreciate the fact that I have been capable of flexibly combining my professional and family lives while working at CMP.

I thank Research Director, Adjunct Professor Hannakaisa Isomäki for introducing me to Heli and guiding me in combining two research fields that are both present in this study: education and applied information technology. Her support was critical when I first started my PhD studies, and our collaboration has yielded interesting research themes, through which I have learned to think outside my 'educational box.'

Reviewers of this thesis, Professor Päivi Häkkinen from the University of Jyväskylä, Finland, and Professor Norbert Pachler from the University of London, UK, offered priceless help, via their thorough work of reading the manuscript and providing feedback of the calibre I could only have hoped for. I will also value their observations and comments in my future research.

My sincerest gratitude goes to Miikka Eriksson, with whom I had the joy of working in both the MobIT and TravEd projects. Collaboration with him has offered me irreplaceable knowledge, with regard to conducting statistical research and the courage to cross methodological borders. His expertise is also visible in two research articles in this thesis. In addition, I thank Miikka for encouraging and advising me in my PhD studies; I think he was the one who suggested that I should take a closer look at personal learning environments as a research area to find out what possibilities it would offer for my thesis.

I warmly thank Miika Lehtonen and Deirdre Hynes, both of whom co-authored a research article in this thesis with me, and Professor Raimo Rajala,

who reviewed the manuscript and offered valuable comments in the PhD seminar of the Faculty of Education.

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I am privileged to have friends in my life with whom to share my everyday joys and sorrows. Maria and Toni, Päivi and Mika, Anne and Petri, and the entire Puutteenperän painijaosto gang: thank you for your friendship, support and unforgettable moments!

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grandmothers and grandfathers have given us much-needed help with our children, for which I am very grateful.

Working as a researcher has been challenging, enriching, inspiring and fun. I am thankful for the 9 years that it took me to compile this thesis, and at the same time hope that this is just the beginning of an adventure that will last for years to come.

Rovaniemi, October 2013

Hanna Vuojärvi

LIST OF ARTICLES

Study I

Räisänen, H. (2007). Students' expectations of data security, mobility and computer-supported collaborative learning on a wireless campus. In H. Ruokamo, M. Kangas, M. Lehtonen & K. Kumpulainen (Eds.), *Proceedings of the 2nd International NBE 2007 conference* (pp. 217–226). Rovaniemi: Lapland University Press.

Study II

Vuojärvi, H., Isomäki, H., & Hynes, D. (2010). Domestication of a laptop on a wireless campus. *Australasian Journal of Educational Technology*, *26*(2), 250–267.

Study III

Vuojärvi, H., & Isomäki, H. (2012). Designing and implementing a CSCL-based course on the data security of a wireless learning environment. *Online Journal of Media and Communication Technologies, 2*(2), 57–78.

Study IV

Vuojärvi, H., Lehtonen, M., & Ruokamo, H. (2008). The added pedagogical value of laptop computers in computer-supported collaborative learning on a wireless campus. In *Proceedings of the ED-MEDIA 2008 conference* (pp. 2760–2768). Chesapeake, VA: AACE.

Study V

Eriksson, M. J., Vuojärvi, H., & Ruokamo, H. (2009). Laptop computers and wireless university campus networks: Is flexibility and effectiveness improved? *Australasian Journal of Educational Technology, 25*(3), 322–335.

Study VI

Eriksson, M. J., & Vuojärvi, H. (accepted). Different backgrounds—different priorities? Perceptions of a laptop initiative. *Higher Education Research and Development*.

CONTENTS

1 INTRODUCTION

1.1 Mobile Information and Communication Technologies in Higher Education

In many ways, learning is currently on the move. The use of mobile information and communication technologies (ICTs) in education has been increasing intensely since mobile devices, such as smartphones, iPods, personal digital assistants, tablet PCs and laptop computers have become more affordable and easier to carry. They enable flexible teaching and learning processes, and mobility in times, places and social spaces, both conceptually and physically (Sharples, Arnedillo Sánchez, Milrad, & Vavoula, 2009; Wagner, 2008). Through mobile ICTs, everyday worlds can be transformed into spaces for learning (Pachler, 2009; Pachler, Bachmair, & Cook, 2010).

As the technologies that assist and support teaching and learning change, pedagogical thinking and views on learning are also in constant flux. Questions around the role of technology in learning processes and individual learning histories are currently the focus of a great deal of attention. Learning is considered a lifelong, lifewide and lifedeep phenomenon (Banks et al., 2007), not always bound to an institution or a degree. Innovative technologies are changing the practices through which people aim to learn, but also the way learning is understood, and what it means to 'know' something. Technology changes the objectives of learning: what you should know is where and how to find information, how to assess its relevance to a current situation, convert it, apply it to your needs at that moment and share it with others (Säljö, 2010).

In this thesis I present my research, in which I have focused on students' perceptions and experiences of using mobile laptops and wireless local area networks (WLAN) in learning processes in university settings. In particular, my focus was on how these technologies could and should be used to support learning in and through a personal and mobile learning environment (PMLE), through which a more individual and flexible learning path could be achieved. I have delineated the empirical research to cover the students' point of view. My study contributes to an increasing number of investigations that have been conducted to discover how mobile laptops are used in higher education, identify the benefits and challenges of the pedagogical use of mobile laptops, and ascertain what would be the best pedagogical practices concerning the use of mobile ICTs in university-level teaching and learning in general.

I investigated the topic through six studies that were carried out on the wireless campus of the University of Lapland, where a large-scale laptop initiative was executed between 2004 and 2009. In practice, all enrolled students had an opportunity to acquire a laptop computer through the university, which organised the purchase of the laptops and took care of approximately two-thirds of the total cost of each; the students paid the remainder. The students received the laptops with an open-source office software package, firewall, virus protection and statistical analysis software pre-installed. Art students also received the specific pre-installed software that they needed during their studies for such things as three dimensional (3D)-modelling and animation. In addition, a campus-wide WLAN was launched at the beginning of the initiative. This WLAN currently covers all spaces at the university, including hallways and cafés, as well as lecture and seminar rooms. Other organisation-level decisions were also made regarding the network-based learning environment at the university. The only organisationally supported network-based learning environment on campus is Discendum Optima. Many other similar environments are available, but a strategic choice was made at the university to support the use of this one, due to resource issues.

Earlier research conducted around the world concerning similar laptop initiatives at the post-secondary education level had discovered that laptops and wireless networks could improve students' ICT skills and attitudes toward the use of ICTs in teaching and learning processes in general, as well as diminish the digital divide often presented by gender and field of study (Finn & Inman, 2004; Mitra & Steffensmeier, 2000; Wurst, Smarkola, & Gaffney, 2008). Students have perceived that the use of laptops has been important for their academic success, and this has resulted in positive changes in their study habits and improvements in different kinds of group collaboration activities (Demb, Ericksson, & Hawkins-Wilding, 2004; Nicol & MacLeod, 2004). Using laptops has been shown to enhance student-centred, hands-on and exploratory learning (Barak, Lipson, & Lerman, 2006; Weaver & Nilson, 2005), as students embrace the mobility that laptops afford (Pospisil, 2009).

The fact that students can be distracted from activities taking place in a classroom while multitasking on their laptops has been mentioned most often in the discussion of the possible challenges and negative effects that laptop use has produced (Fried, 2008; Hembrooke & Gay, 2003; Wurst et al., 2008). Having many laptops in the same room also presents a challenge to the interior design and ergonomics of classrooms. Bad interior design can, in the worst cases, hinder the usability of laptops, and also interaction and participation during lectures. (Cutshall, Changchit, & Elwood, 2006; Wurst et al., 2008). Unsolved or frequent technological problems can also limit the positive potential that the laptops afford (Cutshall et al., 2006; Demb et al., 2004).

Both the technological and theoretical changes imply changes to pedagogical approaches and to the practice of, and research into, teaching and learn-

ing processes, which include ICTs. The challenges can be met, and the positive potential of the mobile technology realised, by careful planning and preparatory work before the implementation of mobile ICTs in education (Hannafin, Orrill, Kim, & Kim, 2005). I defined the two fundamental purposes of the present study on the basis of empirical studies (Studies I–VI) carried out at the University of Lapland. I first wanted to explore students' perceptions and experiences regarding the use of laptops in higher education. I then used these ideas to develop a conceptual understanding of PMLEs by considering the research results gained in individual studies through the activity theory framework (Engeström, 1987).

My first empirical study provides insights into students' expectations of computer-supported collaborative learning (CSCL), and the mobility and data security of using laptops and WLAN in higher education. The second study analyses the domestication process that students experienced as they received their laptops at the start of their studies. Domestication is a general concept that is used to explain how ICTs become part of our everyday lives (Hynes, 2005; Silverstone & Hirsch, 1994; Silverstone, Morley, Dahlberg, & Livingstone, 1989). The third study reveals students' perceptions of the role and meaning of data security in mobile and collaborative learning processes. The fourth explores students' perceptions of the additional pedagogical value of using laptops and WLAN in CSCL processes. The fifth study dissects whether the use of laptops and the WLAN improved flexibility or effectiveness of learning, according to students. Finally, in the sixth study, two groups of students, those with and those without children, shared their understanding of the pros and cons of using laptops in higher education.

In this thesis, I suggest that educational stakeholders, instructors, students and administration in universities should engage ICTs in their processes in a more profound manner, in order to support learning processes in mobile and personal learning environments for university students. I state that improved support for the individual needs of students might make study periods more flexible and fluent for students, enhance ICTs, and provide students with valuable tools with which to work and develop their own expertise later in life. Supporting the needs of different kinds of students is really rather simple; the most important thing is the willingness to develop and to rework current policies and practices.

The design of learning environments should always rise to the challenges of learning; PMLEs are expected to foster learning. A socio-cultural perspective is central in all six of the studies conducted for this thesis. Learning is thus seen as always having social origins and cultural relationships, and being mediated by intellectual or theoretical tools. Learning is not only internal, but involves participation in social discussions, and communication is inseparable from the development of knowledge (Säljö, 2004, 2010). The socio-cultural basis is strengthened through an analysis of the results of individual studies using the activity theory framework, which has a strong, in-built socio-cultural understanding of activities, such as learning.

1.2 The Research Process

I began the research in 2004, and the empirical data were gathered between 2004 and 2009. The timeline in figure 1 illustrates the sources of data and the research processes of the MobIT project,[1] of which this thesis is a part.

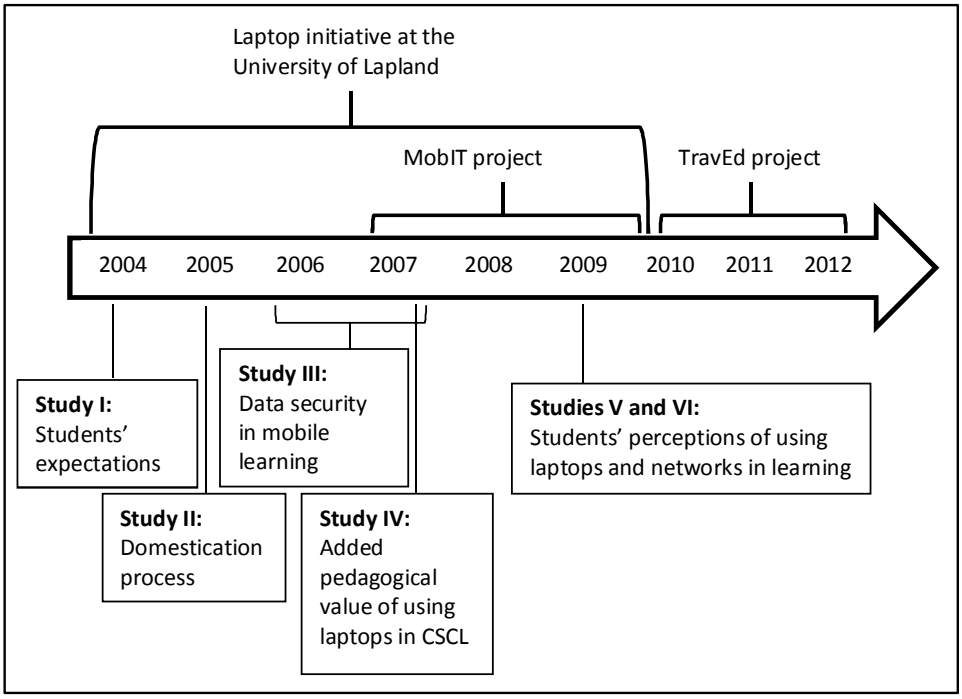

FIGURE 1. The history of research of this thesis

From spring 2004 onwards, I conducted my research as a part of a transdisciplinary research group[2] that aimed to ascertain what happens when mobile ICTs, in this instance, laptop computers and WLAN, are put into operation in higher-education settings. The researchers' disciplines included education, media education and applied information technology. The research idea was developed when the administration of the University of Lapland decided to launch a laptop initiative in autumn 2004. At that time, initiatives on this scale were very rare, and we saw that it would offer several research opportunities, through which it would be

1. The MobIT project: Developing Mobile Network-Based Teaching, Studying and Learning Processes (2007–2009), funded by the Ministry of Education. http://www.ulapland.fi/mobit
2. The group consisted of Heli Ruokamo, Miika Lehtonen, Hannakaisa Isomäki, Päivi Kuvaja and Hanna Vuojärvi.

possible to gain information that could be subsequently used when carrying out possible similar initiatives and developing the pedagogical use of mobile ICT's.

For the first 2.5 years, I conducted my research alongside my work as a lecturer in information technology. When our research group received funding from the Ministry of Education at the beginning of 2007, I began to work as a project manager and a researcher at the MobIT research project.[3] The project was originally divided into three sub-studies: (1) Studiability, Learnability and the Management of Everyday Life; (2) The Utilisation of Laptop Computers and WLAN; and (3) Teachers' Utilisation of MobileTechnology. I had proposed to concentrate on the second sub-study in my thesis, but, as the work progressed, the themes cross-pollenated, and this thesis thus includes themes from the first and the second sub-studies. The third sub-study remained in its original form, and therefore my thesis covers only the students' points of view, as the studies regarding the instructors' points of view were to be completed by another researcher.

The first data collection was organised in autumn 2004, when we considered it important to map out students' expectations of laptop use in their university studies before the laptops were actually put to use (Study I). The data were collected in collaboration with other members of the MobIT research group, and we designed the questionnaire together, in an attempt to cover all of our research interests. My responsibilities in Study I were to formulate survey questions that would give me relevant information for use in answering my research questions, to conduct the statistical analysis and to write the conference article. The first article was published under my maiden name, and the remainder under my new family name.

On the basis of initial results of the first study, we realised that we wanted to focus more on the information-technology perspective, and studied the use of technology and students' domestication strategies (Study II). I was responsible for designing the structure and content of the qualitative interviews, contacting potential study participants, interviewing the students, transcribing the interviews and analysing the data. The order of authors of the paper was discussed early in the study, and, as the first author, I was primarily responsible for writing the article and I also acted as the corresponding author. The second author[4] was an expert in research on domestication and the collaboration with her strengthened both the analysis and the article.

At the beginning of the laptop initiative, data security issues were much debated among the university staff and students, therefore we also perceived it important to study the data security issues associated with learning that is supported by mobile technology (Study III). The third study was a design-based

3. MobIT project was directed by Heli Ruokamo, and Miikka Eriksson worked as a researcher with me.
4. Deirdre Hynes

research (DBR) process that included the design of a new course on the data security of a wireless learning environment. I designed the pilot course in collaboration with two other instructors[5] of information technology at the University of Lapland, as well as the secondary supervisor of my PhD studies[6]. Each of us was responsible for teaching 4 hours of lectures and tutoring the related network-based discussions. After implementation of the pilot course, I refined its contents, together with my secondary supervisor, and we implemented the first actual course. At that time, I was responsible for lecturing and also tutoring all the network-based discussions. After both the pilot course and the first actual course had been implemented, I independently gathered the data for my study, conducted the analysis procedures of the grounded theory (GT) approach and wrote the first draft of the related journal article. I subsequently discussed the analysis and results with the second author of the article and we co-authored the paper in its' final form.

After increasing concentration on the information-technology issues, I changed my focus on educational issues to students' perceptions of the added pedagogical value of laptops in learning (Study IV). For the fourth study, I collaborated with an instructor of media education[7] and together we designed a study concerning the added pedagogical value of using laptops in CSCL processes. After the students had returned their learning diaries to the instructor, I obtained them for use as the data for this study. I independently went through the coding steps of the GT approach and wrote the initial article. I subsequently discussed the analysis and the results with the instructor and we finalised the paper, together with the third author.

The laptop initiative ended in 2009, and we thought it important to survey students' experiences (Study V). I collaborated in the design of the web-based questionnaire with another researcher[8] from the MobIT research project. Together we discussed which questions to use in the questionnaire, planned its testing and decided on the changes to be made to it following testing. I was responsible for applying for permission to use the information in the university's student registry to obtain the contact information of potential participants, discussing the analysis with the other researcher and writing the paper as the second author. The fifth study revealed the need to focus particularly on the experiences of students with children and this research task was taken up in Study VI. We used the strengths, weaknesses, opportunities and threats (SWOT) data gathered by the questionnaire in Study V as the starting point. We analysed the students' answers to SWOT questions in collaboration, and, after deciding to continue data col-

5. Kimmo Kokkonen and Kirsi Päykkönen
6. Hannakaisa Isomäki
7. Miika Lehtonen
8. Miikka Eriksson

lection with analytical hierarchy process (AHP) interviews, I contacted potential participants via email, and arranged the meetings with those students who were willing to take part. I conducted the interviews of students with children independently, and transcribed the majority of the interviews. Some were transcribed by an intern who was working on the project at that time. The related research article was written collaboratively.

The MobIT research project ended at the end of 2009. By that time, I had completed collection of all data that contributed to this thesis, and continued my work as a researcher on another project, TravEd,[9] for the next 3 years. Although TravEd did not focus on higher education issues, the continuum was logical, as working with the TravEd research team[10] gave me the opportunity to focus more closely on the theme of mobility and its applications and effects in education. Although none of the data collections conducted during the TravEd project yielded publications for this thesis, the theoretical groundwork carried out during the project inevitably played a critical role.

1.3 The Outline and Aims of the Research

In this thesis, I aimed to conceptualise PMLEs. The PMLE framework casts students as the central agents in technology initiatives, their personal needs and learning strategies should be the starting point for any technology initiative, large or small, conducted in higher education. In the case of the University of Lapland, the university's administration made the decisions, chose the equipment and formulated the rules regarding the initiative. Students and instructors were not consulted during the process.

At the time the laptop initiative was launched in 2004, it was rare for a university student to own a laptop. The challenges of putting laptops into use as learning tools were immediately evident to me, as I was working as a lecturer in information technology at the University of Lapland at that time. Nowadays, students carry multiple types of mobile ICTs with them every day. It may seem that the time for this research topic has gone, but I am confident that the discussion is still relevant and topical. Students may now have all the technological equipment they could possibly need, but these tools are still undervalued and much of their potential is still not used. A theoretical framework that covers multiple concepts, and which is based on empirical results, as well as on strong theoretical views,

9. TravEd: Research and Development of Travelling Services through Mobile Education, funded by Finnish Funding Agency for Technology and Innovation (TEKES), European Regional Development Fund (ERDF) and several municipalities and tourism companies in Eastern Lapland. http://www.ulapland.fi/traved

10. The group consisted of Heli Ruokamo, Miikka Eriksson and Hanna Vuojärvi.

could help outline the structure of the tools, people and functions that make the most of the intersection of post-secondary learning and ICTs. This affords the possibility for more meaningful learning processes, and emphasises students' personalities and their central role in the learning process. Students become active agents, rather than just consumers (Fiedler, 2012). Stensaker, Maassen, Borgan, Oftebro, and Karseth (2007, p. 431) succinctly commented on this in their article:

> Without a focus on the personal needs of those who actually are to use and integrate new technology on the "working floor" of the higher education institutions, one can imagine that many institutions will have great difficulties getting beyond the first phase.

I have structured my thesis into six chapters, which are followed by the six original research publications. Following the introduction, the first chapter introduces the theoretical approach of the study, i.e. socio-cultural understandings of the learning and activity theory framework, through which I combined the results of individual studies. The research design, methodological approaches and data sets are described in detail in Chapter 3. This is followed by an overview and evaluation of the six empirical studies and their contributions to the main research question (Chapter 4). Chapter 5 presents the concept of a PMLE by using activity theory as a basis for analysis of the research results. The concluding Chapter 6 discusses the general results of the research, as well as their relation to topical discussions in the field of education, evaluates general methodological and ethical issues and finally considers some future research directions.

2 THEORETICAL UNDERPINNINGS OF PERSONAL AND MOBILE LEARNING ENVIRONMENTS

Personal learning environments (PLEs) or PMLEs were not, in themselves, the focus of the six studies forming part of this thesis; rather, their aim was to reveal the experiences and perceptions of university students involved in the laptop initiative carried out at the University of Lapland from 2004 to 2009. The purpose was to conceptualise PMLEs through a consideration of the findings from individual studies in the activity theory framework.

In the following sections, I present the socio-cultural approach to learning that provided the basis for my study. The idea of the activity theory framework and the consideration of the concepts of virtual learning environments (VLEs) and PLEs are then presented and discussed.

2.1 Socio-Cultural Approach to Learning

In this study, learning is understood from the socio-cultural approach (Packer & Goicoechea, 2000; Säljö, 2004; Vygotsky, 1978), in which learning is seen to take place in every human action. This means that learning cannot be viewed as limited to only certain environments or actions, such as universities and teaching, as there are possibilities for learning in everyday discourse and events within, and outside of, lecture rooms and university walls, in individual and communal social encounters, whether face-to-face or through mobile ICTs, and via social media applications.

According to the socio-cultural approach, the ways in which learning takes place and knowledge is gained depend on the cultural settings in which we live. These cultural settings refer to sets of practices that are developed historically and dynamically shaped by communities that aim to accomplish valued goals (Säljö, 2004.) University as an institution has a strong academic culture, and some of its scientific traditions have been founded on principles that were formulated thousands of years ago. Whilst times have changed and values and objectives along with them, the university institution has also adjusted and re-focused. The latest significant structural change in the Finnish university sector has been taking place during the last few years. At the time of writing, it has been almost 4 years since the University reform, during which the new Universities Act was passed.

The reform has meant considerable changes to universities, as their autonomy has been extended by giving them an independent legal personality, either as

public corporations or as foundations. In addition, their management and decision-making system was reformed. Among other things, the reform ambitiously aimed to enable universities to better react to changes in the operational environment, diversify their funding base and to improve their capability to compete for international research funding and cooperate with foreign universities and research institutes. The aim was also to allocate resources to top-level research and their strategic focus areas, ensure the quality and effectiveness of universities' research and teaching and to strengthen their role within the system of innovation (Aarrevaara, Dobson, & Elander, 2009.).

For instructors, researchers and students at universities, these changes have become especially visible in stronger strategical guidance and the pronounced competition in every operational field. Students are encouraged to complete their Bachelor's and Master's degrees within the time appointed, to form and participate in social networks during their studies and to gain international experience through, for example, attending international Master's programmes and exchange periods in a foreign university. As organisations, universities are seeking to provide students with fluent and uniform study periods, during which they gain expertise in their field of study, and also general skills required when participating in working life after graduation, if not earlier. At the same time, the student population is becoming growingly heterogeneous, which makes it challenging to meet the individual needs of students with varying study histories and life situations.

In 2012, there were 169,000 students in Finnish universities[11]. The largest majority of enrolling students, approximately 30%, were 19 years old, but a significant number, around 20%, were over 25 years old. This means that there is a considerable group of students that have received some previous education, and perhaps work experience, prior to commencing their university studies. It has also become common for a university student to have other commitments along with their studies, such as families with children, or term-time employment (Virtala, Vilska, Huttunen, & Kunttu, 2011). All these factors emphasise the importance of personal consideration of each student's learning processes and the pedagogical practices at universities, as they have a direct impact, for example, on the study times that have recently been under intense discussion in Finland. There is currently pressure on young, highly educated adults to start their working lives earlier, and not to spend so much time on their studies. However, for students with children or term-time work, for example, it can be challenging to accomplish their degrees in regulated time periods, and study times must be prolonged.

With my thesis, I suggest that the attempt to build a coherent understanding of students' learning environments could help to support their learning processes. The tools that mediate these processes are also considered a critical part of socio-cultural understanding of learning, as an important source of cultural

11. http://www.tilastokeskus.fi/til/yop/2012/01/yop_2012_01_2013-04-23_tie_001_fi.html

resources in daily activities (Nasir, Rosebery, Warren, & Lee, 2006). In the literature, these tools are also called mindtools (Jonassen & Carr, 2000) or mindware (Säljö, 2010), but the common idea behind these is the role of tools as mediators of actions and thoughts, and they are, for example, mobile ICTs, curriculum or pedagogical models, social networks in and outside the educational institution, as well as the organisation of activities and discourses.

In universities, some important tools are also different kinds of strategies that guide their teaching and research, as well as the direction of their resources. For me, of particular interest along with mobile ICTs, are the strategies concerning their pedagogical use, as my focus has been on utilising laptops and networks in university learning processes. At the beginning of the new millennium, Finland began to create nationwide strategies concerning the pedagogical use of ICTs. In terms of universities, this was supposed to mean 'an academic revolution' (Pohjonen & Sariola, 2003, p. 33) that would lead not only to doing old things in a new way, but also new things in a new way. The aim was to create a network of universities that would develop into dynamic and customer-oriented organisations.

A starting point for this was seen at the Finnish Virtual University, which was perceived as leading the way in network-formed modes of operation (Pohjonen & Sariola, 2003). However, this university closed at the end of 2010. It is possible that combining the strategies of the Ministry of Education, the Finnish Virtual University, every other university in Finland, and different networks was too challenging a task to complete, and the initiative was written off. At the moment, every organisation is responsible for developing and maintaining their strategies regarding the pedagogical use of ICTs. The current situation at the University of Lapland where the empirical studies took place is presented in Chapter 5, where the results of individual empirical studies are discussed through the activity theory framework.

However, identification of the tools is not sufficient for them to support learning. A critical part of knowing is also being capable of using the tools to access the information stored in the external social memory, which Säljö (2010) described as the pool of insights and experiences that people are expected to know and use. Thus, the focus of attention shifts from the contents of the information to the ways in which the information in the social memory can be accessed, analysed and processed:

> What we know and master is, to an increasing extent, a function of the mediating tools we are familiar with (Säljö, 2010, p. 53).

The socio-cultural approach to learning therefore challenges students to develop their learning strategies and the university teachers to develop their pedagogical approaches that are also considered as tools. Inevitably also the goals of learning need to be deliberated and redefined—to consider what it actually means to learn

something. It is no longer relevant simply to memorise and repeat already-existing knowledge; we should now aim to combine aspects and pieces of information in a fresh way that produces something novel, and which is adaptable to particular settings (Säljö, 2004; 2005). This, I believe, is also the aim of teaching and learning in university settings. Traditional theories and concepts are not stable or inadaptable, but offer a starting point for discourses in present and future cultural settings.

To support the socio-cultural lines in this thesis, I use activity theory as an analytical framework to summarise and unite the findings from individual empirical studies (see Chapter 5). The idea of activity theory is presented in the following sub-section.

2.2 Activity Theory

Activity theory is a philosophical and cross-disciplinary framework for studying human practices as development processes, in which individual and social levels are interlinked (Kuutti, 1996). It originated in Soviet socio-cultural psychology in the 1920s, and was the work of Leont'ev and Vygotsky. By offering a set of perspectives on human activity, and a set of concepts for describing that activity, it is understood as a descriptive tool, rather than as a strongly predictive theory (Nardi, 1996). As such, it suits my aims of attempting to conceptualise PMLEs in higher education from the students' perspective. Activity theory has a strong drive towards practice, it considers what people do, and a basic tenet is that activity is connected with consciousness; "you are what you do" (Nardi, 1996, p. 7). I state that, through conceptualisation of PMLEs, it is possible to reach a practical level by identifying the elements that are present in university students' learning processes and the ways in which the workload is, or should be, divided between different stakeholders. These deliberations can yield a practical and future-oriented approach to developing university education, especially the pedagogical use of mobile ICTs.

In activity theory, activity and actions, in this instance learning processes at universities, are seen as situated in their relevant environmental context (Kuutti, 1997). However, context cannot be understood as something that comes from outside, it is more than university walls, for example. Rather, through a constant series of adjustments, students gain greater agency in the creation of their own learning contexts, which are individual, and represent a form of personalisation of the world and of the elements of the world that contribute to learning. Context is defined through interactions in, and with, the world, which are themselves historically and culturally situated (Luckin, et al., 2011), and which provide opportunities for transferring knowledge from theory to practice and *vice versa*. Therefore, activity theory specifies the context as the activity itself (Nardi, 1996); in this instance, learning processes in, and through, a PMLE. Students have their own goals in their learning processes, such as learning how to inter-

pret and apply some laws or learning how to teach pupils to read. Through these goals, they generate their contexts by involving other objects, artifacts, other students, instructors and specific settings in their learning processes.

The unit of analysis in activity theory is activity. Engeström (1987) presents its components as activity systems organised as a set of triangles, as shown in Figure 2.

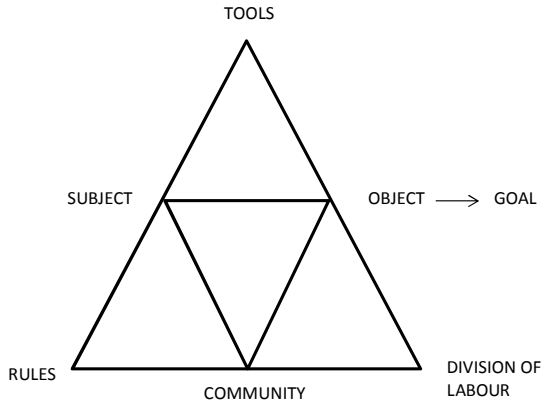

FIGURE 2. Activity system according to Engeström (1987, 78)

In an activity system, the subject is a person (e.g. a university student), or a group of persons, engaged in the activity, and the object is the physical or mental product that is sought and that is transformed into an outcome. Objects are dynamic; it is possible that they change during the activity (Kuutti, 1996). An activity always contains various artifacts, tools, which can be either mental (e.g. strategies, curriculums) or material (e.g. laptops, books). Activity theory proposes a strong notion of mediation; all human experience is shaped by the tools and sign systems we use; they connect us to the world. The community consists of one or more persons (e.g. instructors, peer students) who share the objective with the subject. Rules cover both explicit and implicit norms, conventions and social relations within a community (e.g. principles of assessment). Division of labour refers to how tasks are divided between members of the community, as well as how power and status are divided.

The activity in activity theory is understood as consisting of a goal-directed chain of actions that are used to accomplish the object (Jonassen & Rohrer-Murphy, 1999; Leont'ev, 1978) (Figure 3).

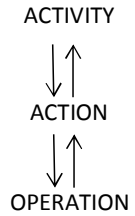

FIGURE 3. Hierarchical nature of activity, actions and operations

Participating in an activity such as learning means performing conscious actions (e.g. registering for a course) that have an immediate defined goal (e.g. completing a course). Before an action is performed in the real world, the subject typically orientates to it, which means planning the actions in the consciousness, using a mental model (Nardi, 1996). Actions consist of chains of operations, which are well-defined habitual routines (e.g. logging into a learning management system to register). Initially, each operation is a conscious action, consisting of both the orientation and execution phases, but when the corresponding model is sufficiently good and the action has been practiced, the orientation phase will fade and the action will collapse into an operation that is far more fluent. To become skilled in something, operations must be developed so that one's scope of action can become broader as the execution itself becomes more fluent.

Activities have a double nature: every activity has both an external and internal side (Kuutti, 1996). The subject and the object of an activity are in a mediated reciprocal relationship: the subject is transforming the object. This can be seen for example in that students' objectives of their learning processes change over time and experience while the properties of the object affect and change them as learning processes change their values, opinions and professional identity. Activities are never static, but are always changing and developing at all levels. New operations are formed from previous actions, as students' skills and knowledge increase. At the action level, students can determine following actions from a wider perspective, and also attempt some new actions through which they can pursue their objectives. Finally, at the level of activity, the object itself, the learning process, is reflected, questioned and perhaps adapted (Kuutti, 1996.).

The use of activity theory as an analytical framework in this thesis makes my understanding of learning as a socio-cultural phenomenon more visible than it appears in individual empirical articles. Kuutti (1991) recommended that the researcher should constantly refocus the object of interest in order to provide different views. In this light, activity research can serve as a kind of formative evaluation, whereby the researcher attempts to improve the outcome of the process, which is precisely my aim with this introductory chapter: to analyse the empirical research results of individual studies as a whole in a theoretical frame through

which it is possible to reach something greater than the individual studies alone could provide. None of the empirical studies commits to a conceptual definition of a PMLE, but, when united in a theoretical framework, it is possible to move towards defining this concept.

For a researcher, using activity theory means being an active participant in a process that takes place in real-life practice (Kuutti, 1991). Acting first as a lecturer in information technology, and later as a researcher and project manager at the campus of the University of Lapland, I see myself fulfilling this condition by participating in the hands-on everyday practices in my field of research. I have also used various data collection methods and perspectives, which activity theory necessitates (Jonassen & Rohrer-Murphy, 1999; Nardi, 1996). The conceptual map in my empirical studies is perhaps even too fragmented at times, as I have approached students' experiences and perceptions from multiple points of view, but I see activity theory as a uniting agent that presents all the key concepts in a frame, through which they can find their places in the bigger picture.

Activity theory is a widely used framework in research concerning human activity in various contexts. It has also been varied for multiple purposes and particular research settings. Regarding studies about the pedagogical use of mobile ICTs, an application of activity theory has been used for example to model mobile learners' tasks (Taylor, Sharples, O'Malley, Vavoula, & Waycott, 2006; Sharples, Taylor, & Vavoula, 2007; Sharples, Taylor, & Vavoula, 2010) and to review and categorize mobile learning projects (Frohberg, Göth, & Schwabe, 2009). As the themes and concepts in my thesis deal with mobile ICTs and mobility in learning processes the task model for mobile learners (Taylor et al., 2006) would seem as a logical choice to be used as a framework for my analysis. I however chose to use Engeström's (1987) presentation of activity system as the starting point because my data sets do not reveal students' learning processes on such a detailed level that would allow me to analyse the dialectic of learning and technology, which is what the task model for mobile learners aims to do.

2.3 Learning Environments as Conceptual Constructs

The concept of 'learning environment' cannot be explicitly defined by the list of characteristics that it would entail. On a general level, the concept describes a dynamic entity that contains the designs of a curriculum, and the arrangements of teaching and learning processes that are thought to offer the best support for particular students in specific settings. In its broadest sense, a learning environment entails the social, cultural and political contexts within which higher education operates. To narrow it down, learning environments can be approached from institutional, organisational, disciplinary and professional standpoints (Entwistle, McCune, & Hounsell, 2003).

Learning environments that support developing skills and knowledge-building should initiate active and constructive learning processes, enhance self-regulation and support the socio-cultural basis of learning through mediated interaction and collaboration (De Corte, 2003; van Merriënboer & Baas, 2003). Such understanding of learning environments places students at the centre of all activities, and the aim of the learning processes is to construct knowledge that is transferable to other contexts, such as workplaces (Vaatstra & De Vries, 2007).

The discourse on learning environments has also led to the consideration of teaching in the design of learning environments. This places much responsibility with the instructor, who must know more than what it takes to teach a certain piece of information. However, the original aim has not changed: the aim of teaching is to make learning possible (Ramsden, 2003). The focus has changed from planning procedural teaching and learning processes that aim to achieving isolated learning objectives to designing pedagogy that views students as independent thinkers, with complex skills and competencies, and which acknowledges the multi-layered nature of learning (Laurillard, 2012). However, if learning environments are viewed as entities that cover a variety of instructors, information sources, social networks, curriculums and all that an individual student carries with him or her, the responsibility must be divided between several academic stakeholders who share the same goal of supporting student learning. That is why learning environments must be conceptualised and made visible, and the responsibility shared.

Several tools, such as mobile ICTs, also play a role in the ways in which learning environments are understood, due to their significant role in the socio-cultural understanding of learning processes. They afford ways of working and sharing ideas, mediating thoughts and activities and, perhaps most significantly, enable flexibility with regard to times and places, as well as when and where to study (Attwell, 2007). The weighting that ICTs have in learning processes is dependent on the pedagogical design.

As learning environments began to emerge as research agendas, and teaching began to be considered in the design of learning environments, ICTs were sometimes used as a structure to define a learning environment, such as a VLE or a learning management system (LMS). Both of these are often considered as institutionally provided and maintained. An example of such an environment is the Discendum Optima, which is the only organisationally supported learning environment at the University of Lapland. Both VLEs and LMSs are often criticised for attempting to offer one-size-fits-all learning environments that support a homogenous experience of context and traditional teacher-student interaction, in which the student is seen only as a passive recipient of content (Wilson et al., 2007).

From a wider perspective, several studies (e.g. Demb et al., 2004; Georgina & Hosford, 2009; Hannafin et al., 2005) have acknowledged that changes in imple-

menting ICTs in teaching and learning processes in pedagogically reasonable ways do not occur simply by making technology available. Instructors and students are everyday users of ICTs, but not necessarily when it comes to teaching and learning. The reasons why so many initiatives have failed to integrate ICTs into universities' core activities often involve a neglect of the end users' views; the views of teachers and students (Stensaker et al., 2007). Providing instructors with adequate ICT skills and time to develop their teaching practices is one thing, but considering students' personal preferences regarding devices, applications and ways of using ICTs in learning is another critical factor behind successful implementation (Cutshall et al., 2006; McMahon & Pospisil, 2005).

This criticism has led to more attention being paid to personal views on educational ICTs and learning environments. The role of institutions has been challenged, and more weight is being given to students' own preferences and habits of using ICTs, to the communities of which they are a part, and to their everyday lives, as these are the contexts in which learning takes place and that have an impact on learning. Schaffert and Hilzensauer (2008) have identified seven crucial aspects in which the changes in moving from VLEs and LMSs to PLEs are most obvious: (a) the learner becomes an active and self-directed creator of content; (b) community members provide support and data for personalisation of the learning environment; (c) learning resources are seen as unlimited; (d) social involvement has a central role in learning; (e) ownership of learner's data is critical; (f) the meaning of self-organised learning changes the culture of educational institutions and organisations; and (g) social software tools are central to learning processes. Table 1 presents definitions of PLEs gathered from a selection of the available literature.

TABLE 1. Definitions of personal learning environments

Reference	Definition
Milligan et al., 2006	PLE is an application that coordinates a number of different services and agents and makes the roles of instructor and learner ambiguous.
van Harmelen, 2006	PLE is a single user e-learning system that provides access to a variety of learning resources and people.
Attwell, 2007	PLE is a new approach to using technologies for learning, not a software application.
Wilson et al., 2007	PLE is a pattern that describes the practices of users learning with diverse technologies, rather than a category of software. It can be a single application or a range of specialised tools.
Severance et al., 2008	PLE is a system that enables several possibilities to adjust and customise the features, tools and functionalities of a network-based environment that can be optimised for learning.
Schaffert & Hilzensauer, 2008	PLE is a technological realisation in which social software applications and web services are combined, e.g. as a mash-up in a single portal for the purpose of learning.
Henri et al., 2008	PLE refers to a set of different applications, services and other learning resources gathered from different contexts. It can seamlessly combine all formal and informal learning, and affords potential for more meaningful learning by facilitating reinvestment of knowledge in different contexts.
Wilson, 2008	PLE is an environment in which people, tools, communities and resources interact loosely.
Johnson & Liber, 2008	PLE is a practical intervention concerning the organisation of technology in education. PLE is more than a technological initiative: to be fully effective, it must address deeper educational issues, as well as provide ways of controlling the technological infrastructure.
Educause, 2009	The concept of PLE describes the tools, communities and services that constitute an individual educational platform that learners use to manage their own learning and pursue their goals. The term does not refer to a specific service or application, but rather to an idea of how individuals approach the task of learning.
Coutinho & Bottentuit, 2010	PLE is a conceptual tool with which students present their professional qualifications and follow their advancement. PLE is constructed by an individual and used in everyday life, for learning. It is not an application or a system, but an autonomously built collection of information, ubiquitous technologies and social software that support learning. PLE is permanent, adaptable and evolving, enabling different types of learning, in different contexts and at different times in life.
Taraghi, Ebner, Till & Mühlburger, 2010	PLE is a technological concept describing a next-generation environment that can help to improve learning and teaching behavior.
White & Davis, 2011a	PLE is not a system, it is a mindset. Through PLE, a learner is enabled to operate within a consolidated environment in which he or she mixes different environments that have functions to perform in support of the processes of learning.
White & Davis, 2011b	PLE is a technological framework that can evolve with emerging technologies throughout its lifetime.
Millard et al., 2011	An institutional PLE is an environment that provides a personalised interface to university data and services, and exposes those to a student's personal tools.

Interpretations of PLEs discussed in the articles presented above can be viewed in two dimensions, as presented in figure 4.

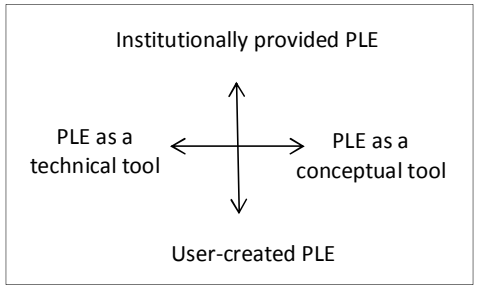

FIGURE 4. Dimensions of PLE definitions

The first dimension is the technical–conceptual. The technical view of PLE sees it as a technical tool or an application that can be used to manage information or tools that students use for learning (van Harmelen, 2006; Millard et al., 2011; Milligan et al., 2006; Schaffert & Hilzensauer, 2008; Severance, Hardin, & Whyte, 2008; Taraghi, Ebner, Till, & Mühlburger, 2010; White & Davis, 2011b; Wilson, 2008; Wilson et al., 2007). The conceptual view of PLE understands it as an abstract framework that combines all devices, applications, information, people, communities, contexts, and previously adopted knowledge that relate to learning activities in which students engage (Attwell, 2007; Coutinho & Bottentuit, 2010; Educause, 2009; Henri, Charlier, & Limpens, 2008; Johnson & Liber, 2008; White & Davis, 2011a).

Second is the institutionally provided–user created dimension. This is driven by ambitions to create a learner-centred, but provider-driven, environment. In the most recent literature, this type of PLE is referred to as an institutional PLE (Millard et al., 2011; White & Davis, 2011b), which seems contradictory as a concept. The problem is that institutionally provided ICTs are designed with a specific purpose in mind, and such design is usually oriented towards the reduction of choice (Luckin et al., 2011). The other side of this dimension understands PLEs as a mindset, a different way of thinking about how individuals approach the task of learning (Attwell, 2007; Educause, 2009; White & Davis, 2011a).

The point at which the understanding of PLEs could be located in this thesis is somewhere in the lower-right quadrant of Figure 4. I espouse the view that university students are independent and responsible for their own learning, and that they should be allowed to choose and use ICTs in their learning, but that universities can also better promote and support the use of ICTs by implementing organisational practices that are created and negotiated in consultation with all whom they concern. In addition, it should be acknowledged that students carry personal mobile technological devices, such as laptops, with them every day,

moving from one place and topic to another. The focus should shift from organising environments around a single course use, or providing and allowing only one system for all, to coordinating connections between the user and services, and, most importantly, providing the possibility for learners to organise and connect the information and knowledge within contexts as they see fit, and choose the information and tools to situate within them (Johnson & Liber, 2008). The point is that it is not necessary to create, design, or purchase yet another system (e.g. Milligan et al., 2006); technological choices within a single university are merely one way to make learning with the support of ICTs more personal, and it is not enough to simply combine social software applications and web services, for example, as a mash-up in a single portal for the purpose of learning (Schaffert & Hilzensauer, 2008; Severance et al., 2008). Concentrating solely on the availability aspect of ICTs does not fully utilise the potential of mobile ICTs in learning.

Therefore, PLE is here understood as a wider concept that combines tools, individuals, communities, cultures and history—everything that surrounds a student and all that he or she carries with him or her, both physical objects and invisible meanings. None of the definitions of PLEs presented above includes considerations of the mobility aspect, nor do they take into account students' personal life situations. They also lack the identification of all of the agents that have an impact on students' learning processes in certain kinds of learning environments, and a description of the role of each agent. I suggest that an activity theory-based understanding of university students' PMLEs helps to place these students at the centre of their learning processes, and to identify all agents that are engaged in that process and the tools that are used. It also acknowledges the responsibilities of each agent. Identified contradictions between the agents can be perceived as a 'to-do-list' through which the development of PMLEs could be driven forward on a practical level. Learning is a continuum, and individuals play a central role in organising their own learning as a part of their everyday lives, since it takes place in different contexts and socio-cultural communities (Luckin, 2008, 2010a; Säljö, 2010), with the help of mobile ICTs that are not necessarily organisationally provided, but are at least enabled and supported. The challenge is to discern how students access and harness mobile ICTs to move towards their own learning goals (Johnson & Liber, 2008).

3 RESEARCH DESIGN

The empirical research described in this chapter was conducted at the University of Lapland between 2004 and 2009. The studies were a part of the MobIT research project, and have been reported in several research publications, six of which are included in this thesis. Three have been, and one will be, published in refereed international scientific journals, while two have been published in refereed international conference proceedings.

The research design is presented in Table 2. In this chapter, central methodological issues are presented, introducing the methodologies, data sets, and analyses used. Overviews and evaluations of the six studies, as well as their contribution to the main research question, can be found in Chapter 4.

TABLE 2. Research design

Aims and Contributions	Research Questions
Study I Revealing students' expectations	**1)** What kinds of expectations do students have concerning data security, mobility and computer-supported collaborative learning on a wireless campus? **2)** Which features of students' background information correlate with their expectations?
Study II Students' domestication strategies	**3)** How do university students domesticate laptop computers at the beginning of their studies on a wireless campus? **3.1)** What kinds of actions do students take when domesticating laptops, and are there differences between female and male students, or ICT novices and ICT-experienced students? **3.2)** How is the domestication process manifested in this case study?
Study III Data security	**4)** What is the role of data security in CSCL on a wireless campus? **4.1)** How do university students seek to achieve and maintain data security in CSCL on a wireless campus? **4.2)** How are data security aspects manifested in this study? **5)** What implications do the results have for the course design and refinement of the course?
Study IV The added pedagogical value of laptops in a course based on computer-supported collaborative learning (CSCL)	**6)** What added pedagogical value do laptop computers afford to students in CSCL-based media proficiency studies on a wireless campus? **6.1)** How are the key elements of CSCL manifested in this case study? **6.2)** How do university students use laptop computers in CSCL?
Study V Students' perceptions of laptops' potential to increase flexibility and effectiveness of studying	**7)** Do students actively using computers and networks experience personal laptop computers and networks as study tools that increase flexibility and effectiveness? **8)** Do commitments such as having children, being employed during term-time, and being in a steady relationship, or characteristics such as gender or age, affect students' experiences with laptops and networks as study tools that increase the flexibility and effectiveness of studying?
Study VI Students' perceptions of a laptop initiative, with special focus on the differences between students with and without children	**9)** What are the perceived strengths, weaknesses, opportunities, and threats of using laptop computers and wireless networks in teaching and learning, according to university students? **10)** What is the order of significance of identified strengths, weaknesses, opportunities, and threats, according to students with and without children?

Data	Methods	Publications
Survey data from students (N=197) starting their studies at the university	*Statistical approach* Factor analysis and reliability tests, calculating frequencies, correlations and their significances	**Refereed international conference proceedings:** Räisänen, H. (2007). Students' expectations of data security, mobility and computer-supported collaborative learning on a wireless campus. In H. Ruokamo, M. Kangas, M. Lehtonen & K. Kumpulainen (Eds.), *The Power of Media in Education*. Proceedings of the Network-Based Education (NBE) 2007 Conference. University of Lapland Publications in Education 17 (pp. 217–226). Rovaniemi: University of Lapland.
Qualitative interviews of ICT experienced (N=10) and ICT novice (N=10) students, who were selected as interviewees through K-Means cluster analysis	*Grounded theory approach* Analysing the data through open, axial and selective coding	**Refereed international scientific journal:** Vuojärvi, H., Isomäki, H., & Hynes, D. (2010). Domestication of a laptop on a wireless campus: A case study. *Australasian Journal of Educational Technology*, *26*(2), 250–267.
Feedback from the pilot course Network-based discussions (N=139 forum messages written by students (n=15)) Learning diaries of students (N=15) participating on CSCL-based *Data Security of Wireless Environments* course	*Design-based research* Analysing the data through open, axial and selective coding	**Refereed international scientific journal:** Vuojärvi, H., & Isomäki, H. (2012). Designing and implementing a CSCL-based course on data security of a wireless learning environment. *Online Journal of Media and Communication Technologies, 2*(2), 57–78.
Learning diaries of students (N=8) participating on CSCL-based *Media Proficiency* course	*Grounded theory approach* Analysing the data through open, axial and selective coding	**Refereed international conference proceedings:** Vuojärvi, H., Lehtonen, M., & Ruokamo, H. (2008). The added pedagogical value of laptop computers in computer-supported collaborative learning on a wireless campus. In *Proceedings of the ED-MEDIA 2008 conference* (pp. 2760–2768). Chesapeake, VA: AACE.
An online questionnaire data (N=392 students)	*Statistical approach* Factor analysis, reliability tests, Chi-square tests and significances	**Refereed international scientific journal:** Eriksson, M. J., Vuojärvi, H., & Ruokamo H. (2009). Laptop computers and wireless university campus networks: Is flexibility and effectiveness improved? *Australasian Journal of Educational Technology*, *25*(3), 322–335.
SWOT data collected by using an online questionnaire (N=392 students) Analytic hierarchy process (AHP) interviews (N=24 students)	*Mixed-methods approach* Statistical and qualitative content analysis of the SWOT data AHP analysis, calculating consistencies and geometric means	**Refereed international scientific journal:** Eriksson, M. J., & Vuojärvi, H. (Accepted). Different backgrounds—different priorities? Perceptions of a laptop initiative. *Higher Education Research and Development*.

3.1 Research Themes

The main research question of this thesis was:

How can personal and mobile learning environments be conceptualised from a student perspective?

This question was examined through six studies. Study I explored students' (N=197) expectations of using laptop computers and wireless networks in the learning process before these laptops were put to use. Study II concentrated on the domestication process that students (N=20) went through with their laptops at the beginning of their studies.

Study III sought to ascertain students' (N=15) perceptions of data security in wireless learning environments. The study was the first cycle in a DBR (Barab & Squire, 2004; Brown, 1992; Design-Based Research Collective, 2003; Wang & Hannafin, 2005) process of designing, implementing, and refining a CSCL-based course on the data security of a wireless learning environment for the Faculty of Education's media education curriculum. Study IV examined students' (N=8) perceptions of the added pedagogical value of using laptops in a CSCL-based *Media Proficiency* course.

Study V explored students' (N=392) perceptions of laptops' potential to increase the flexibility and effectiveness of studying. Particular attention was paid to the influence of students' age, gender, family, or possible employment, on their perceptions. Study VI continued the work started in Study V, and explored university students' (N=392) perceptions of the SWOT of using laptop computers and wireless networks in the study process. On the basis of the results gleaned from Study V, two groups of students were the focus of attention: those with and without children. The order of significance of selected SWOT themes was studied through an analytical hierarchy process (AHP), and students with children (N=20) were interviewed.

3.2 Methodological Approaches

To address the research questions presented in Table 2 (pp. 36–37), four methodologies have been drawn on: (1) the statistical approach (Cohen, Manion, & Morrison, 2011); (2) the GT approach (Corbin, 1997; Glaser & Strauss, 1967; Strauss & Corbin, 1998; Suddaby, 2006); (3) DBR (Barab & Squire, 2004; Brown 1992; Design-Based Research Collective, 2003; Wang & Hannafin, 2005); and (4) the mixed-methods research approach (Tashakkori & Teddlie, 2010; Teddlie & Tashakkori, 2009).

The reasons for using multiple methodologies derive from the fact that this study contains varying and multidimensional research tasks. The methodological path was not predetermined, but the methodologies were selected as the work proceeded and individual studies yielded more information. All of the adopted approaches can be viewed as a functional combination that serves the overall aim of the research. The overarching ambition was that together they would provide reliable, valid and useful information with regard to the phenomenon under study. The characteristics of selected approaches will then be discussed, and the methods, data and analysis used in the six studies will be presented. The general methodological evaluation is presented in Chapter 6.

3.2.1 Statistical Approach

The statistical approach was used twice, in Studies I and V. Table 3 presents the studies and contributions, based on the statistical approach.

TABLE 3. Studies and contributions based on the statistical approach

Statistical studies	Focus of analysis	Theoretical contributions
Study I Students' expectations of data security, mobility, and CSCL on a wireless campus	Students' (N=197) expectations	Knowledge regarding students' expectations and a basis for further studies
Study V Students' perceptions of the flexibility and effectiveness afforded by laptops	Students' (N=392) perceptions of the potential of the laptops to offer learning flexibility and effectiveness The effect of students' (N=392) commitments (having children, being employed), gender, and age on their perceptions	Knowledge regarding the perceived flexibility and effectiveness The differences in the perceptions between traditional and non-traditional students Knowledge regarding the special needs of students with children

In Study I, the aim was to explore students' expectations of data security, mobility and CSCL on a wireless campus. The data collection aspect of the study was conducted in collaboration with the MobIT project researchers[12] by means of traditional questionnaires handed out in paper form to students who began their studies in the autumn term of 2004. Data collection was organised so that it was possible to extract the parts covering the themes of all three sub-studies of the MobIT project from one body of data. Students' expectations of data security, mobility, and CSCL on a wireless campus were the main themes of the second sub-study of the MobIT project, so this is the reason why my Study I focused only on these topics. Results regarding other student expectations covered in the

12. Heli Ruokamo, Miika Lehtonen, Hannakaisa Isomäki, and Hanna Vuojärvi.

data, combining studies with family life and taking care of children, were to be published by researchers working on the other sub-studies.

The statistical approach was selected because the group of students (N=682) at the centre of the study was rather large. This approach stood to provide knowledge regarding the nature of the starting point of the laptop initiative and possibly reveal some relationships that existed between students' background information and their expectations (Aldridge & Levine, 2001; Cohen et al., 2011; Creswell, 2008).

With the benefit of hindsight, gathering data from a large group likely compromised the quality. The number of respondents (N=197) remained low and the data did not offer any particularly new or exceptional knowledge with regard to the topic. It would have been beneficial, for example, to gather some additional qualitative data that would have strengthened the knowledge gained from the descriptive statistics, as well as some basic inferential statistics. It is also possible that it may have been more reasonable to organise data collections separately, rather than including all of our questions in a single questionnaire, which was ultimately fairly extensive. However, the teamwork involved provided all of us with some knowledge of the students' background and expectations from the time period before the laptops were delivered to students. Separate data collections would have forced us to organise them over a longer period of time, and this may have influenced the students' expectations, as they would already have had the laptops in their possession. However, despite the obvious deficiencies, the statistical approach and the first data set did give us a starting point, a foundation on which some future data collections were built.

A statistical approach was also used in Study V to query students' (N=392) perceptions of the flexibility and effectiveness of learning with laptops. Of special interest were the possible differences in the experiences of non-traditional and traditional students; non-traditional students referred to those having commitments, such as children or term-time employment. In this instance, an online questionnaire was used for data collection, as the target population was rather large, covering all students (N=2888) who had entered the University of Lapland between August 2004 and April 2008.

Previous studies have shown that online methods have proved to be effective in reaching the population, keeping track of the responses, and sending reminders (Best & Krueger, 2008; Fricker, 2008). Although one could nonetheless wonder if some other methodological approach would have yielded more eligible data, in this instance, the statistical approach had its strengths. We had the opportunity to obtain statistically grounded answers to questions concerning students' experiences of a laptop initiative. We did not perform sampling (Cohen et al., 2011), because the entire target population was easily reachable through email. However, had we done so, it might have been possible to reach the students more personally, and in this way perhaps increase the response rate to gain more statistical value for the data.

Using email as a medium for contacting students does leave some questions about the integrity of the data (Cohen et al., 2011); what if the recipient gives the questionnaire to someone else to be answered? Although the research process, or the data themselves, gives no reason to doubt that the students would not have filled out the questionnaires themselves, this is something to bear in mind when reflecting on the results.

3.2.2 Grounded Theory Approach

GT was used as a methodological approach in Studies II and IV. The coding procedures of GT were also used in Study III, but the research task in that particular study was approached with DBR (see chapters 3.2.3 and 3.3.3). This rather flexible use of GT both as a methodological approach and as a method for analysis may seem contradictory, but the idea behind GT allows this as Strauss and Corbin (1998) present it both as a methodology providing a vision of where the researcher wants to go with the research and also as a set of techniques and procedures that furnish the means for bringing that vision into reality.

In Study II, the aim was to find out what kind of domestication process students (N=20) go through with their laptops at the start of their studies. Study IV aimed to reveal students' (N=8) perceptions of the added pedagogical value of using laptops in CSCL processes on a wireless campus. The GT approach (Glaser & Strauss, 1967; Suddaby, 2006) was perceived as providing a functional way to understand how students interpret their relationships to the ICTs in use, in communities around them, and in learning. GT is generally considered to be well-suited to educational research, because of its roots in examining social activities and interactions, and also in describing individual experiences and meanings (Cohen et al., 2011). Both these aspects were present in Studies II and IV. Table 4 describes the GT-based studies in this thesis and their theoretical contributions.

TABLE 4. Studies based on GT and their contributions

Grounded Theory studies	Focus of analysis	Theoretical contributions
Study II Students' experiences of the domestication process	Students' (N=20) domestication practices The way the domestication process was manifested in this case	Understanding of the challenges students face and what kind of support they need when starting their studies on a wireless campus Richer knowledge of how the habits of using the laptops in learning evolve over time
Study IV Students' perceptions of the added pedagogical value of laptops in CSCL processes	The manifestation of the elements of the CSCL process Ways of using laptops and networks in CSCL	Students' perceptions of the added pedagogical value of mobile tools in a CSCL process

In practice, GT is understood as an analytical way of composing theoretical constructs by three steps of coding of the data at hand. These are: (a) open coding, (b) axial coding, and (c) selective coding (Strauss & Corbin, 1998). In open coding, the data are conceptualised and categorised, which means making representations of significant pieces of data. In axial coding, the data are reassembled to form more precise and complete explanations of the phenomena under study. Finally, in selective coding phase, a more concise theory is integrated and refined. The theory is then validated by comparing it to the raw data (Strauss & Corbin, 1998).

Although the process of analysis is presented as separate steps, it is often realised in a more flexible manner, as data collection, analysis and interpretation are interwoven. The data need not be collected in their entirety before the analysis; the coding can begin as soon as some data are available. New data are constantly compared to existing codes and categories (Corbin, 1997; Strauss & Corbin, 1998). With respect to the nature of GT, the presentation of analysis process and emerging theoretical considerations could be something other than what the majority of researchers, including myself, are accustomed to when writing scientific articles, for example (Suddaby, 2006). As a novice researcher, I ultimately used the traditional sequenced way of presenting the phases of coding in articles related to Studies II and IV.

Although GT can come across as a flexible research approach, this seeming flexibility sets a challenge to researchers: not to aim to test hypotheses arising from prior knowledge (Suddaby, 2006), but to build theoretical constructs that have origins in the data. Both in Study II and Study IV, the focus of research, domestication and students' perceptions of the added pedagogical value of laptops and networks in CSCL processes, was very pragmatic and domestication was a rarely explored area in education, which is in accordance with the core of GT (Thornberg, 2012).

A further challenge for a researcher applying GT is the concept of saturation, which defines when sufficient data have been collected. This raises questions with regard to my two studies. In Study II, a target group of participants was sampled from quantitative data through K-Means cluster analysis and randomly picked from the list of possible students. A total of 20 students were interviewed. Following the idea of GT, data collection could have been stopped before all 20 students were interviewed, as signs of saturation began to emerge: the same occurred in the interviews, and new interviews confirmed initial codings (Suddaby, 2006). However, I wanted to proceed with data collection to underpin the validity of the data. In study IV, the sample was predetermined, as the data were collected from the *Media Proficiency* course, and the number of participants in the study was the number of students on the course. The data consisted of students' learning journals, and for verification it could be considered whether the students should also have been interviewed, for example, as groups to conduct a closer dissection with regard to their collaboration procedures with laptops.

GT is not an easy approach, as Suddaby (2006, p. 639) clearly states:

> The seamless craft of a well-executed grounded theory study, however, is the product of considerable experience, hard work, creativity and, occasionally, a healthy dose of good luck.

Being a PhD student, I naturally did not have 'considerable experience', but I attempted to creatively follow the coding procedures. Although it is difficult at times, GT is also an efficient tool for practicing. My work inevitably benefited from my commitment to the empirical site (Thornberg, 2012), as I worked at the University of Lapland and was aware of students' everyday activities at the university through my work. As a researcher, I was required to constantly evaluate the data and their possibilities to describe the phenomenon at hand, carefully consider existing theoretical knowledge, and analyse the data sufficiently thoroughly to be capable of making abstract theoretical statements regarding causal relationships between actors (Suddaby, 2006).

3.2.3 Design-Based Research Approach

Study III was conducted in keeping with the principles of DBR (Barab & Squire, 2004; Brown, 1992; the Design-Based Research Collective, 2003), and started the design cycle of research on the meaning of data security in CSCL practices on a wireless campus. DBR is generally considered to be a series of approaches designed to improve educational practices through iterative stages of design, implementation, analysis and refinement. Its intrinsic character is the tight connection between theory and practice, which can be seen in the fact that all activities in DBR studies are based on tight collaboration between researchers and practitioners (Barab & Squire, 2004; Brown, 1992; Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Wang & Hannafin, 2005). In this instance, a team of four instructor-researchers[13] was responsible for designing the course during the DBR process. Table 5 presents the DBR-based Study III and its theoretical contributions.

TABLE 5. DBR study and its contributions

Design-based research study	Focus of analysis	Theoretical contributions
Study III Data security in learning processes on a wireless campus	Students' (N=15) data security practices The manifestation of data security aspects in students' (N=15) actions	The role of data security in learning on a wireless campus

The tight connection between research and practice produces the dual goal of DBR. First, it aims to produce new theories, artefacts and practices that may have an impact on learning (Collins, Joseph, & Bielaczyc, 2004; Edelson, 2002).

13. The teachers were Hannakaisa Isomäki, Kimmo Kokkonen, Kirsi Päykkönen, and Hanna Vuojärvi.

Second, it unfolds these theories for assessment and investigates the changes they suggest on a local level. In this instance, this meant considering data security as a factor influencing teaching and learning processes with mobile technology. Students participated in the process as co-designers, by providing information about their experiences with data security issues and making their views on data security explicit through learning diaries and network-based discussions. This dual goal brings DBR very close to a kind of learning that takes place in real-life, naturalistic settings (Barab & Squire, 2004), such as the wireless university campus used in this study.

During the first cycle of the DBR process in Study III, a course on the data security of wireless learning environments was designed and implemented as a collaboration among four instructor-researchers. The goal of the first stage was to (1) gather knowledge of current research on data security in academic environments, (2) arrange a pilot course on data security of wireless learning environments, and (3) use the experiences gathered during the pilot course in further course design.

There is no solid research tradition concerning data security issues in CSCL or other ICT-supported learning processes, which justified the choice of using DBR as a methodological approach in Study III. The course that was designed during this first cycle was based on existing literature from the fields of information technology, human-computer interactions and education, as well as our own reflections of what the role of data security in CSCL processes could be. Our team of instructor-researchers shared a common interest in ICT and its application in teaching and learning processes, but we represented various disciplinary backgrounds, such as education, administrational and social sciences and applied information technology.

Although this close involvement with both teaching and researching can be perceived as a strength, it can also be viewed as a threat to validity of the research (Barab & Squire, 2004). The context and our engagement at the university campus where we were all working inevitably influenced the theoretical underpinnings on which the course was built, and also the analysis that was conducted after the data were collected. However, it is acknowledged, that DBR works with, through and alongside the contexts, which are never neutral or without agency. Researchers are expected to intervene (Cobb et al., 2003). DBR has been criticised for having an impact mostly on a local level, and not having sufficient power to produce large-scale and far-reaching structural changes in educational systems (Anderson & Shattuck, 2012). The challenge for the researchers is to develop such theories that can be applied to new, local contexts and yet remain useful (Barab & Squire, 2004).

Following implementation of the pilot course, the second DBR cycle was started by refining the course on the basis of the experiences gained, and several forms of data collected, during the pilot. In general, DBR welcomes the use of

various types of data, which help to achieve data triangulation. The *Data Security of Wireless Learning Environments* course was then implemented as a part of subject studies in *Applied Information Technology* and advanced studies in *Media Education*. Data were collected during implementation of the first full course, and analysed, with the implementation goals in mind, in the final phase of the second DBR cycle. The goals were (1) to examine the role of data security in CSCL on a wireless campus, how university students sought to achieve and maintain data security, and how data security aspects were manifested; and (2) to use the research results in refining the course.

Design experiments have some fundamental limitations that make the conclusions uncertain, and that cannot be left without consideration. A large number of variables affect the success of the design, many of which cannot be controlled. Effective pedagogical practices develop through subsequent refining and testing, and it can be claimed that the course has not been implemented often enough to reach sufficient coherence. Real-world situations and contexts are complex in nature and reaching the entire course is difficult, even with large amounts of varying data. In our study, we used textual feedback, network-based discussions and students' learning diaries as data, but the knowledge could have been increased by also interviewing the students. Quantitative data would have provided some statistical information, although the group of participants was rather small (N=15), so the differences would not have been statistically significant. In addition, as we only implemented the course once after the pilot, due to the changes in the curriculum of *Applied Information Technology,* it was not possible to compare across designs or across contexts to gain more variable information regarding the content, as well as the design, of the course (Collins et al., 2004).

3.2.4 Mixed-Method Research Approach

In Study VI, a mixed-method approach was used to gain versatile knowledge of students' experiences and views of using laptops in learning in general, and also to aid in understanding the individual needs of students with children. Study VI was based on the results gained in Study V.

A mixed-method approach means that mixing enters all stages of the research process: philosophical foundations, research questions and design, methodology and data collection and data analysis and interpretation, as well as reporting of results. It has been proposed that this enables richer understanding of the phenomenon at hand (Bryman, 2007; Cohen et al., 2011; Teddlie & Tashakkori, 2009). Study VI, with its mixed-method approach and theoretical contributions, is presented in Table 6.

TABLE 6. Mixed-method study and its contributions

Mixed method study	Focus of analysis	Theoretical contributions
Study VI Students' perceptions of the laptop initiative at the University of Lapland	Students' (N=392) perceptions of the strengths, weaknesses, opportunities, and threats of using laptops on a wireless campus The differences in the perceptions of students with (N=14) and without (N=10) children	Richer understanding of students' experiences in general, and of the individual needs of students of different backgrounds

In Study VI, a 'sequential mixed design' (Teddlie & Tashakkori, 2006) was used, meaning that quantitative and qualitative approaches ran one after the other, as the research required, and the major findings from all were synthesised at the end to gain answers to the research questions. With regard to different stages of the research process, mixing can be seen, for example, in the way in which qualitative SWOT (Glaister & Falshaw, 1999) data were quantified to identify relevant themes in the four categories. Quantitative calculation was also conducted to validate the results of the AHP (Saaty, 1977, 1980), which was used here to support and strengthen the results gained through SWOT analysis. In addition, when interpreting the results, it was necessary to look at both statistical and qualitative interview data to discover their relevance, and to decide what kinds of practical suggestions could be made on their basis.

It would be fair to dispute whether the research design in Study VI actually represents a mixed-methods research design at all. However, it does reflect some core characteristics that this approach implies, and which are most directly related to problem-solving (Tashakkori & Teddlie, 2010). The starting point for determining which methods to use were the research questions at hand; what were the SWOT of using laptops in learning as perceived by the students, and what was the order of significance of perceived SWOT themes? These questions led to a diverse array of methodological tools, as well as to the use of a large-scale Internet questionnaire to gather as much data as possible, using qualitative content analysis (Gray, 2004) to theme students' answers, statistical calculations to find out the frequencies of the revealed themes, and AHP to ascertain the order of significance and calculate consistencies and geometric means.

In general, Study VI was conducted using an iterative and cyclical approach to work (Tashakkori & Teddlie, 2010). This was required to gain a deeper understanding of students' perceptions and possible influencing factors, and to question the reliability of combining SWOT analysis (Glaister & Falshaw, 1999), which is often perceived as somewhat unscientific and too 'light' as a method, with AHP, which has rarely been used in educational research. The strength of using AHP is that it appeared less complicated to compare just two characteristics with each other than to ask the students to judge the importance of an individual characteristic on, for example, a Likert-scale from 1 to 5.

When considering the reliability and legitimation of the mixed-methods research conducted during Study VI, representation, integration and legitimation can be problematised (Onwuegbuzie & Johnson, 2006). The problem of representation in Study VI is that it is debatable whether SWOT analysis and AHP interviews can capture students' lived experience sufficiently thoroughly to enable conclusions to be drawn. The problem of legitimation refers to the difficulty in obtaining findings that fulfil the demands of credibility, and are confirmable as well as transferable. All components used during data collection (questionnaire, SWOT analysis, quantification of text-based data, AHP interviews and their analysis) each have their problems and weaknesses (see Chapters 3.3.2 and 3.3.3), which are apparent in a mixed-methods research setting, which produces the problem of integration.

3.3 Research Data, Methods and Analysis

Empirical studies were carried out on the campus of the University of Lapland between 2004 and 2009. The students who enrolled during that period comprised the target population of these studies. Figure 5 illustrates data sets and the titles of the relevant thesis articles.

As Studies I–VI all had differing goals and tasks of research, multiple types of theoretically relevant data were used: statistical questionnaire data, qualitative interviews, textual learning diaries, network-based discussion messages, textual SWOT data and AHP interviews.

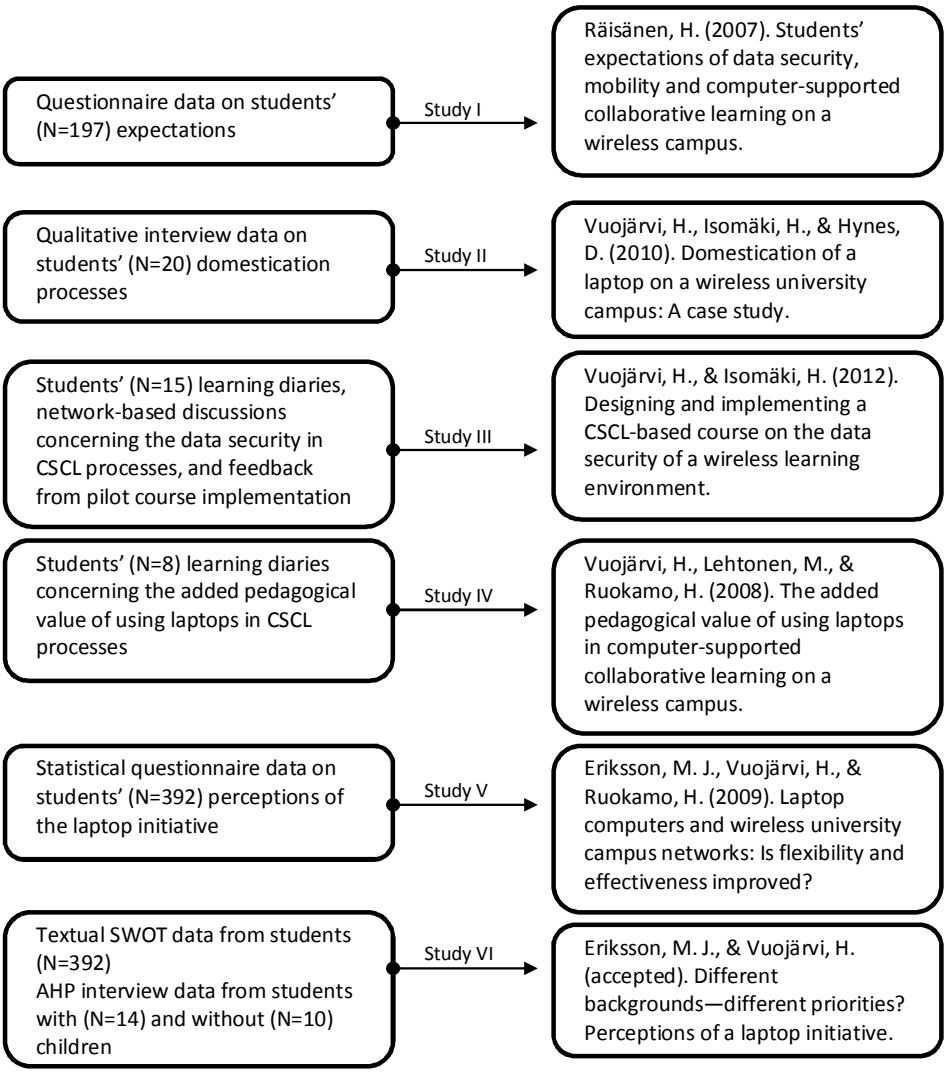

FIGURE 5. Data sets and articles comprising the thesis

The data collection was completed in 2009, which understandably calls into question the recency of the research presented here. This question is especially topical in research concerning the pedagogical use of mobile ICTs, as the field of technology is changing rapidly.

However, although technologies change rapidly, people and the ways technologies are used in everyday lives, and particularly in learning processes, do not necessarily do so. Recent research has discovered that university freshmen still use a fairly limited range of technologies (Guo, Dobson, & Petrina, 2008; Jones, Ramanau, Cross, & Healing, 2010; Kennedy, Judd, Churchward, Gray, & Krause, 2008; Thompson, 2013), and they are not utilising the Internet to its full potential or critically reviewing the information they obtain (Thompson, 2013).

In my view, the concept of a PMLE, as presented in this thesis, is not dependent on the technologies that are used in learning processes. In addition, the concept is not limited to single-technology use, but multiple devices and software could be utilised instead. It was my intention to not tie the concept with any particular device precisely because the technologies and devices develop so fast. This is in accordance with recent findings that showed that university students are not deterministic in their approaches to learning (Thompson, 2013).

When assessing the time period after the final data collection in 2009, the pedagogical practices of applying technologies in teaching and learning processes do not seem to have been developed in sequence. Although young adults enrolling for their university studies use ICT in their everyday lives, they do not necessarily exploit the affordances of technologies in learning (Thompson, 2013). Students' learning histories do not necessarily include any more experience of using ICTs now than they did prior to 2009. In fact, there is now a common concern in Finland that, despite the good intentions, strategies and implementation plans, we are still under-utilising the promises of technologies in teaching and learning, beginning with primary education (Sipilä, 2013).

In the following chapters, an account of all the data collection methods and analyses that were used in Studies I-VI is presented.

3.3.1 Questionnaire Data and Statistical Analysis

Statistical questionnaire data were used to answer research questions 1, 2, 7 and 8, set in Studies I and V (See Table 2 on pages 36–37). In Study II, statistical data provided a basis upon which decisions concerning further steps in the data collection process were made.

In Study I, data were collected by means of an initial questionnaire sent out on paper with an invitation letter and an informed consent (Appendix A) in autumn 2004, before the laptops and wireless network had been put into use. Students filled out the form as a part of their tutored activities during the first week of their studies. The return of the questionnaire was organised through their tutors, and there was also a mailbox especially for this purpose in the main hall of the university.

It was considered important to gather knowledge regarding students' expectations before they received the laptops, as it was thought that having the laptop in use would influence the expectations regarding their use in the learning process. However, it should be noted here that the laptop initiative at the University of Lapland was widely reported in newspapers and education-related exhibitions, which most likely had some effect on expectations. The timing of the data collection was nevertheless critical, and the decision was made to gather the data by means of a questionnaire in the first week of the autumn term of 2004.

The entire survey elicited both quantitative and qualitative data, as it covered all sub-studies of the MobIT project, but in the case of Study I, only statistical data were used. In the questionnaire, students were asked for background information

and queried about their previous experiences and expectations regarding the use of computers and information networks, and how they reconciled the demands of studying and family life. Married students and students with children were asked about their housing arrangements and their family situations, as well as their expectations regarding the demands of studying and family life. Most of the questions were answered on a Likert-scale from 1 to 5 (Not at all–A lot), but there were also open questions about the students' expectations of teaching and learning with laptop computers and a WLAN, and also regarding the SWOT (Glaister & Falshaw, 1999) that students expected the laptops and WLAN to possess.

Statistical replies were saved using SPSS for Windows software, and analysed. Responses were received from 197 new students, representing 29% of the total population of 682 entering students. The response rate remained fairly low, but the respondents represented all four faculties of the University of Lapland (Faculty of Education, Faculty of Law, Faculty of Social Sciences, and Faculty of Art and Design), although some faculties were clearly over-represented and some under-represented, when compared to the entire student population.

Seeking to cover all sub-studies with one massive data collection via a paper questionnaire was a rather ambitious goal, and resulted in an arduous questionnaire; it could be debated that its design reduced the number of respondents (N=197, 29% of the entire population). For example, it would have been possible to consider more careful sampling; instead of collecting data from the entire population of students enrolling in the University of Lapland in autumn 2004; taking a sample of informants from that population would perhaps have provided a greater number of opportunities for conducting more careful data collection. Another possibility would have been to use an online survey, but, at the time of the survey, students were just beginning their studies, and had neither the user identification needed to use computers in the university's classrooms, nor the laptops in their possession.

To answer the first research question of Study I, questionnaire items describing students' expectations of data security, mobility and CSCL were transformed into sum variables the reliability of which was tested by calculating the Cronbach's alpha (Cronbach, 1951). The frequencies of the three variables representing students' expectations were then calculated. To answer the second research question in Study I, sum variables of students' backgrounds, describing their positive images of using computers, software and the Internet, were first created using reliability tests (Cronbach, 1951); the same was done with previously gained basic computer skills. Next, their frequencies and, finally, correlations (Pearson correlation) with students' expectations were calculated, along with their levels of significance (*p*).

In Study V, data collection was organised through an online questionnaire sent out to all 2888 students who had entered the University of Lapland between August 2004 and August 2007, and who had agreed that their e-mail addresses

could be used for learning-related polls (see Appendix B). Reminder e-mails were sent a week after the questionnaire, which was generated using the Webropol website (www.webropol.com). It was tested by sending it to colleague researchers, who filled it in and provided feedback, before delivery to students; as a result, overlapping questions were removed, and the questionnaire was shortened. The students were asked for background information (e.g., gender, age, number of children they had, possible employment, marital status and faculty), and about their experience in, and knowledge of, using computers and the Internet, as well as their experience of laptops and networks in learning contexts. Most of the questions were multiple-choice on a Likert-scale from 1 to 5, but some open-ended questions, such as the SWOT analysis questions, were also used.

It was acknowledged that the selected data collection method could lead to self-selecting, as it could rule out those suffering from computer anxiety (Chua, Chen, & Wong, 1999; Vehovar & Manfreda, 2008) or those whose use of computers was otherwise infrequent. However, this was not viewed as a major problem with the selected method, as the aim was to gather data specifically from students who were actively using laptops in their learning and everyday lives. The response rate in Study V was 13.6%.

To answer the research questions in Study V, the data were analysed quantitatively, using SPSS statistical software. First, 10 preselected items were exposed to factor analysis (principal component analysis; varimax rotation) to ascertain the items that best described flexibility and effectiveness of studying. Individual questionnaire items grouped by the factor analysis were then used to create two scales. The internal consistency of these scales was tested by calculating Cronbach's alpha (Cronbach, 1951).

The Kruskal-Wallis chi-square test was used to analyse the association between the two scales and background information (contingencies). When possible, the exact significance was computed, otherwise, a Monte Carlo estimation of the significance was used, based on 10,000 samples (Mehta & Patel, 1996). The strength of the relationship among variables was calculated using Goodman and Kruskal's tau (Goodman & Kruskal, 1954).

In Study II, statistical methods provided the means by which to identify ICT experts and novices among the student population. An exploratory sampling was conducted by using K-Means cluster analysis, in which the number of final clusters is decided beforehand (Aldenderfer & Blashfield, 1987). In this case, the goal was to divide students into two groups of users: ICT novices and ICT experts. The next step was to find these user groups according to gender. This was achieved through cross-tabulation.

Statistical analysis thus functioned in two different positions during the research process. First, it was used as the sole research method in Studies I and V, and second, it led the data collection process from one step to another in Study II. Textual data sets and their analysis methods are presented below.

3.3.2 Textual Data and its Analysis Methods

In Studies III, IV and VI, textual data were used to answer the research questions 4, 4.1, 4.2, 5, 6, 6.1, 6.2 and 9 (see Table 2 on pages 36–37).

In Study III, three types of data were collected. First were asynchronous network-based discussions that the participating students generated during the pilot and first course implementation. Altogether, there were 139 discussion messages. Second were 15 learning diaries that the students wrote during and after the Data Security of Wireless Learning Environments course. Both the discussions and diaries were saved in the Optima environment. Optima would have allowed the use of synchronous chat, but with its asynchronous discussion board, the students were afforded flexible time and place management for their learning. In the diaries, they reflected on the topics of the lectures and discussions and considered the role of data security in their learning, as well as in other areas of their lives. They also wrote about situations in which they encountered data security problems and described how they managed those situations. The third type of data collected in Study III involved the feedback the students gave anonymously after the pilot course. No feedback was available from the first actual course implementation, because, to ensure students' anonymity, the learning management system Oodi, through which the feedback was gathered, did not allow the instructor to access feedback data if the number of students giving feedback was insufficient.

The data in Study IV also consisted of learning diaries that students (N=10) had written during the Media Proficiency course. In both Studies III and IV, three steps of coding, open, axial and selective, adopted from the GT approach, were used (Strauss & Corbin, 1998). Although the phases appear to consist of individual steps that follow one another, in reality they do not necessarily take place in stages, and a researcher may move among coding procedures as required.

Open coding began soon after a reasonable amount of data had been collected, and the goal was to conceptualise these data and define categories that formed the basis of the theory. Axial coding reassembled the data that was fractured during open coding by relating categories to sub-categories to form more precise and complete explanations. Finally, in selective coding, a central category that represented the main theme of each study, the role of data security in CSCL-based learning on a wireless campus in Study III, and the students' perceptions of the added pedagogical value of using laptops and networks in CSCL in Study IV was formed.

In both Study III and Study IV in which students' learning diaries and network-based discussion forum messages were used as data students were informed at the beginning of the course about the data collection and their possibility to forbid their material to be used as research data. None of the students informed us that they did not want to participate in the studies.

In Study VI, data were gathered on students' perceptions of the SWOT (Glaister & Falshaw, 1999) presented by using laptops and networks in learning.

Traditionally, SWOT has been perceived as an analysis and development tool for business, but lately its use has widened to other areas in which strategic planning is needed, such as education (e.g., Balamuralikrishna & Dugger, 1995; Jackson & Helms, 2008). For Study VI, SWOT data collection was selected as a method because it was perceived as a useful tool to gather a large number of ideas and thoughts that could be processed further with other methods.

In practice, SWOT data were gathered as a part of the online survey concerning statistical data used in Study V. The questions regarding SWOT analysis were open-ended items on the online questionnaire generated using Webropol. Respondents (N=392) were students who entered the University of Lapland between 2004 and 2007. It should be noted that students who are frequent users of ICTs are generally more likely to complete an online survey than students who use computers less frequently. As the aim was to survey students' perceptions of laptops and wireless networks in learning contexts, it was considered important that all respondents be active computer users. Therefore, the use of 'self-selecting' online questionnaires as a data-collection method was suitable. Consequently, the results should be interpreted as representing active computer users, rather than all students of the university.

Traditionally, strengths and weaknesses are viewed as connected with the internal environment of an organisation, and opportunities and threats with the external environment (Glaister & Falshaw, 1999). In Study VI, the four components were used to describe the students' views of how things are at present, and how they see the future of laptop and network use in teaching, studying and learning. The strength of the SWOT approach was that it offered a view of the current state of the laptop initiative at the University of Lapland. It opened up the possibility of identifying areas that, according to students, are not functioning, and areas that students view as the biggest opportunities for, or threats to, the development of laptop and network use at the university.

There is generally a danger that SWOT analysis may be carried out at too simplistic a level, and that no further implications can thus be drawn. The SWOT method has been criticised for vagueness and oversimplification (Panagiotou, 2003). Therefore, a more detailed thematic analysis was also carried out within the four SWOT categories (Gray, 2004), whereby students' answers were coded and themed by two of the authors of the related research article to enhance the credibility of interpretation. Further, the distribution of students' answers into different themes within the four SWOT categories was calculated.

3.3.3 Interview Data and its Analysis Methods

Traditional qualitative interview data were gathered in Study II. The data provided answers to research questions 3, 3.1 and 3.2 (see Table 2 on pages 36–37). The questionnaire data gathered during Study I was used as a basis for data collection in Study II. A K-Means cluster analysis (Aldenderfer & Blashfield, 1987)

was performed to identify the ICT-experienced and ICT novice students in the responding student population. The division of the student population into these two clusters was made on the basis of students' answers to questions querying their perceptions of their own basic ICT skills and experiences in using computers, different kinds of hardware and software, as well as networks and network service.

After cluster analysis, the two clusters were cross-tabulated with the question concerning respondents' genders to identify the ICT-experienced students and ICT novices within the groups of female and male students. After cross-tabulation, 20 students were randomly chosen as interviewees: 10 from each cluster, and an equal number of male and female students representing all five faculties. I contacted each student by phone and asked if they would volunteer as interviewees. Thematic interviews were carried out in a quiet office at the University of Lapland by the author. The qualitative interviewing method (Clemmensen, 2004; Kvale, 1996) was used to structure the interviews, which included a discussion of the researcher's interpretations of the interviewees' answers. Interviewees had the opportunity to correct and fill in the interpretations during the interviews, which strengthened the reliability of the data. The questions were designed to be simple and understandable, so that the risk of misperceptions on the part of interviewee would be minimised. Interviews were recorded and later transcribed to assist with the data analysis (Cohen et al., 2011).

In a similar manner to Studies III and IV, the three steps of coding (open, axial, and selective) of the GT approach (Strauss & Corbin, 1998) were also used to analyse the data in Study II, and AtlasTi qualitative analysis software was used to assist the procedure. In this study, the analysis was conducted by the first author, and then discussed with the other authors to increase its reliability.

Interviews following the AHP (Saaty, 1977, 1980, 2008) were conducted to collect data for Study VI during spring and autumn of 2009. The aim was to answer research question 10 (see Table 2 on pages 36–37), that is, to ascertain which preselected five themes in each SWOT category students were considered most important, and if there were differences in perception between students with (N=14) and without (N=10) children. Students were contacted via email (Appendix C) and written agreements of the interviews were done with the students.

Saaty (1977, 1980) originally developed AHP to analyse complex decision problems with multiple criteria. It has been frequently used in the areas of selection and evaluation in several fields (Zahedi, 1986; Vaidya & Kumar, 2006; Saaty, 2008), but has been criticised for producing arbitrary rankings that are not meaningful with respect to decision-makers' preferences (Dyer, 1990). An attempt to minimise this weakness in the method was made by the combined SWOT-AHP approach that was first introduced by Kurttila, Pesonen, Kangas, and Kajanus (2000) to produce quantitative values for SWOT factors or themes. In Study VI, the selected themes that were covered in the interviews were primarily those that came up most frequently in students' SWOT analyses, but some themes were

also included because researchers believed they were important in estimating the success of the laptop programme.

AHP is a general theory of ratio scale measurement, based on mathematical and psychological foundations (Kangas, 1993). Although it was originally developed as a tool for resolving complex individual decision-making problems, it is also adaptable to group decision-making. It should be noted that a sample size of one is enough to implement the methodology because AHP is not a statistically based method; the number of informants in Study VI (N=14) was thus perceived to be adequate.

Using AHP, the problem at hand is divided into its decision elements to construct a hierarchical model for decision-making or assessment. In Study VI, the decision elements were the themes acquired from the SWOT analyses conducted previously. Each participating student compared the themes within each SWOT category in a pair-wise manner against a given criterion (strengths, weaknesses, opportunities, or threats involved in using laptops and WLANs for university studies) to answer the following questions: (1) Which of the two themes is a greater strength, weakness, opportunity, or threat when students use laptops and WLANs in their studies? and (2) How much greater?

The matrix of pair-wise comparisons is constructed as shown below. In this matrix, the element aij = 1/aij and thus, when i = j, aij = 1. The value of wi may vary from one to nine; 1/1 indicates equal importance and 9/1 extreme importance.

$$A = (a_{ij}) = \begin{bmatrix} 1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & 1 & \cdots & w_2/w_n \\ \vdots & \vdots & \cdots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & 1 \end{bmatrix}$$

The relative local priorities of the compared themes were computed using the eigenvalue technique (Saaty, 1977). In Study VI, the priorities were calculated using free, web-based AHP Calculation Software made by CGI (http://www.isc.senshu-u.ac.jp/~thc0456/EAHP/AHPweb.html). Comparison matrices, both individual and grouped, can be expected to have some inconsistencies, and this is acceptable. The consistency of judgments is tested by computing the consistency index (CI),

$$CI = (\lambda max - n)/(n - 1)$$

where λmax is the largest eigenfactor of the matrix. Because CI is dependent on the number of rows (n) in the matrix, consistency ratio (CR) is also estimated.

To estimate CR, the consistency index of randomly generated comparisons, ACI, is used. ACI varies functionally, according to the size of the matrix (Saaty, 1980). For matrices of n = 5, ACI is 1.1.

$$CR = 100(CI/ACI)$$

CR measures the coherence of the pair-wise comparisons. According to Saaty (1980), CR values of 10% or less are considered acceptable. Inconsistencies in students' judgements were examined, and if found, the students were given a chance to reconsider their judgements.

In Study VI, particular attention was paid to the differences between the preferences of two groups of students; those with and without children. Therefore, the 'decision-makers' in the AHP process were actually two groups of survey respondents that agreed to participate in an AHP interview to determine the order of significance of five themes in each SWOT group. As each of these groups became new 'individuals', and would be assumed to behave like individuals, the reciprocity requirement was satisfied by using the geometric mean to aggregate individual judgments for both groups (Forman & Peniwati, 1998). The geometric mean was calculated using SPSS 15.0. As the main concern was the aggregated priorities, inconsistent individual judgements were also included. For example, Duke and Aull-Hyde (2002) used a similar process to group individual judgements of respondents from four different locations, although an overwhelming majority of the 129 individual comparison matrices were not of acceptable consistency (Aull-Hyde, Erdogan, & Duke, 2006). The final CI and CR were computed to find the aggregated values of both student groups. Unlike in the article by Kurttila et al. (2000), the importance of the four SWOT categories was not examined, as the main objective was to evaluate the laptop initiative's success and future opportunities and threats perceived by students, not direct decision-making.

4 OVERVIEW AND EVALUATION OF THE EMPIRICAL STUDIES

This chapter provides overviews and evaluations of the six empirical studies and also discusses the contributions of each study to the main research question. The following sections do not thoroughly present the individual studies, their methodological choices or the data sets, as this has been addressed in detail in Chapter 3. Here, the individual studies and their results are summed up with a discussion of focal concepts and considerations of some methodological issues. The individual studies' contribution to the definition of a PMLE is presented in Chapter 5, in which the results of the studies are presented and discussed through activity theory framework.

4.1 Study I: Exploring Students' Expectations

Related publication

Räisänen, H. (2007). Students' expectations of data security, mobility and computer-supported collaborative learning on a wireless campus. In H. Ruokamo, M. Kangas, M. Lehtonen & K. Kumpulainen (Eds.), *Proceedings of the 2nd International NBE 2007 conference* (pp. 217–226). Rovaniemi: Lapland University Press.

As the research that comprises this thesis has its roots in the MobIT research project's second sub-study, the aim of Study I was framed by the aims and focus of the latter: revealing students' expectations of data security, mobility and CSCL on a wireless campus. The study also examined what types of correlations may exist between students' expectations and their background profiles. At the time of Study I, in autumn 2004, a large laptop initiative was an exceptional occurrence in Finland, and it was thought that knowledge of students' expectations would provide fruitful ground for further studies on the one hand, and for guiding pedagogical planning and development on the other.

Data security was a focus of interest in Study I, and later in Study III, because it constantly arose in my job as a lecturer of information technology. Related research literature also revealed that, although both data security education and course contents had been developed, the education had primarily been aimed at either the staff of the university or students who were majoring in information systems (Sharma & Sefchek, 2007). For example, some studies had queried uni-

versity staff's perceptions of data security (Drevin, Kruger, & Steyn, 2007), and had attempted to determine how to prevent students from cheating in electronic tests (Graf, 2002). It had been outlined that carrying out network-based learning demands paying particular attention to authentication and accountability, access control, intrusion detection, protection of network communications and non-repudiation issues were useful (Furnell et al., 1998). In addition, previous studies had emphasised the viewpoint of end-users with regard to online learning (Furnell & Karweni, 2001).

It is now relevant and necessary to discuss data security issues in a particular context that concerns university students and their learning processes. It has been perceived that the continuously increasing use of mobile ICTs in teaching and learning processes compels researchers to re-examine data security and its role in education. Traditionally, the nature of universities' operations has required public openness, but that should be balanced with data security. Mobile ICTs afford flexible learning activities, but students must also be responsible for their maintenance, including data security. From the organisation's point of view, this creates a need to ensure that students are aware of data-security risks and realise that they are key actors in maintaining not only their own, but also the organisation's, data security.

During an extended research period, it often happens that the aims and focuses of a project shift and change, as they come to reflect topical debates, discussions and developments in the field. It is thus unsurprising that the original aim and task of the second sub-study of the MobIT research project, which was meant to be the focus of this thesis, has taken new directions over the years, and studies currently being conducted include themes that were not present in the discourse concerning the pedagogical use of mobile ICTs at the time this thesis was started. However, the choice of concentrating on only three themes in students' expectations, data security, mobility and CSCL, later appeared to be an appropriate one, since the analysis indicated that mobility and data security and their relationship with learning processes on a wireless campus should be studied further.

The data collection in Study I was conducted by means of a questionnaire that was composed in collaboration with all members of the MobIT research team. The paper questionnaire, along with informed consent (cf. Sieber, 1992; Appendix A), were delivered to all enrolling students (N=682) in introductory seminars that were arranged by the relevant faculties, and in which students participated during the first week of their studies, before they had their laptops in use. A total of 197 students returned the questionnaire (29% of the total student population). The low response rate was possibly affected by the fact that the questionnaire was rather long, even though it had been tested and shortened before it was delivered to students. The questionnaire was a collaborative effort of four researchers, all of whom used it to gather data for individual studies, which explains its length.

Students received it at the student orientation sessions arranged by their faculties; this may well have influenced the response rate, because it occurred at a time when students are typically inundated with information, and the schedule during those first days of the autumn term is fairly hectic. It is plausible that students simply did not have enough time to answer the questions. It would have been possible to try to increase the response rate by repeating the inquiry, but that might have skewed the results, because the laptop computers were delivered to students beginning during the first week of term, and the aim was to collect the data before the delivery of the laptops.

The students' answers were saved into SPSS statistical software and analysed using some basic statistical methods, described earlier in Chapter 3.3.1. Despite the low response rate to the questionnaires, the analysis could still be conducted as originally planned, as the students who answered and returned the questionnaire moderately well represented the student population that began studies at the University of Lapland in autumn 2004, which was the starting point of the laptop initiative. The formulation of the research questions was clear, and it was possible to answer both research questions (see Table 2 on pages 36–37) on the basis of the gathered data and the analysis that was carried out. This rationalises the chosen data collection method, even though the results are not particularly generalisable. The decision to use open-ended questions to support the claims made on the basis of the statistical analysis appears to have been correct, as they afforded depth and support.

According to the results, having positive images and previous basic computer skills appears to increase expectations regarding the data security of learning processes taking place on a wireless campus. In addition, the older the students were, the more they expected their learning processes to be data-secure. Expectations regarding mobility may be explained by the students' positive impressions of using computers, software and the Internet, as well as by the students' age. The more positive impressions the students had, or the older they were, the more they expected studying and learning on a wireless campus to be mobile. Expectations around computer-supported collaborative learning may be explained by all three chosen features of students' background information. These results seem to particularly indicate that having positive images and previous basic computer skills evokes certain expectations of CSCL. Furthermore, the older the students were, the more they expected from CSCL. The most influential factor among the three attributes of students' backgrounds was having generally positive images of computer use; this highlights the emotional aspect of learning, its relationship to the creation of a learning community (Jones & Issroff, 2005).

As this study revealed, student expectations were not significantly different when compared to previous studies on the subject. One aspect that had not previously been frequently addressed was data security. In general, Study I was meant to be a starting point for the research presented in this thesis, and, as such, it met

expectations, although the entire path of the study of this thesis was not clear until much later. Study I offered a novice researcher the first glimpse of what it means to work as a member of a research team, an introduction to some basic statistical methods and an opportunity to learn from the weaknesses that were revealed in the study. Moreover, the data gathered during Study I functioned as a basis for the data collection conducted in Study II, as the interviewees in Study II were selected from among the Study I respondents.

4.2 Study II: Students' Domestication Strategies

Related publication

Vuojärvi, H., Isomäki, H., & Hynes, D. (2010). Domestication of a laptop on a wireless campus: A case study. *Australasian Journal of Educational Technology, 26*(2), 250–267.

Study II sought new openings, or scarcely researched topics, in the field of the use of mobile ICTs in university education by considering the concept of domestication in the context of a wireless university campus. These new openings were later pursued through the consideration of data security issues and the special needs of non-traditional university students, and also through the use of an experimental methodological combination of SWOT and AHP analysis in the field of educational research.

The concept of domestication is widely used by researchers to explain how technologies and, in particular, media and computing technologies, become part of our everyday life. It is used to help explain patterns of ICT usage and non-usage; adoption and experience (Hynes, 2005; Silverstone, et al., 1989; Silverstone & Hirsch, 1994).

The reason why domestication was perceived as a suitable concept to focus on in the case of Study II was that it moves beyond linear adoption models and allows for a more embracing analytical methodology, taking in a wider range of variables and contexts. In contrast with more technologically focused or technologically deterministic adoption models, the particular value of the domestication approach is that it is sensitive towards the user and the social conditions and environment of use (see Hynes & Richardson, 2009).

The concept of domestication captures the practical, temporal and spatial place, but, most importantly, it underlines how this is mixed with the cultural as an expression of lifestyles and values. Therefore, it also reflects the themes apparent in socio-cultural views on learning. Central to the domestication process is the attempt to make technologies fit into their surroundings in a way that makes them invisible or taken for granted. Domestication is concerned with giving technology a place in everyday life. Hynes and Rommes (2005) have used

the concept of domestication to argue that policy-makers, course designers, and educators should pay attention, not only to material resources (such as hardware provision and tuition), but also to the symbolic resources students bring with them (such as motivations, reasons to learn and attend, and the importance and meaning the artefact holds for the individual). By addressing both material and symbolic resources, the likelihood of successful domestication is increased.

The data were collected by interviewing 20 students who were selected as participants from the group of respondents who answered the questionnaire used as a data collection method in Study I. The participants were selected from the groups of ICT novices and ICT-experienced students, with an equal amount of male and female students. The selection was made through K-Means cluster analysis. However, when considering the reliability of the results, it should be noted that the distinction between ICT novices and ICT-experienced students achieved through K-Means cluster analysis produced only the two groups from which the interviewees were selected. Therefore, although the students were divided into two groups, this does not imply that all students in one group were identical in their ICT skills. There are differences among the skills of ICT novices, although they all represent the same group. The students close to the limiting-value on both sides of the dividing line are actually quite close to each other in terms of their skills, but some significant factor determined to which group a student belongs. The sampling of the interviewees may also have been affected by the quite low response rate to the survey that was used as a basis for the data collection. However, interviewees were ultimately included from all faculties of the university, were both male and female, and of varying age groups.

GT analysis (Glaser & Strauss, 1967; Strauss & Corbin, 1998) of interview data revealed a multi-aspect domestication process consisting of: (a) assisted and communal domestication, (b) active domestication, (c) perpetual domestication, and (d) efficacious and mobile domestication. In practice, I started the open coding process by reading through students' interviews and paying attention to how they described the actions that they did to make the laptop more personal or useful for them in their learning processes. These accounts of students' actions were used as the unit of analysis. Examples of such actions are installing preferred software or asking for help to get something done. Also, explicit descriptions of applying existing knowledge into domestication process or adjusting studying habits were included as units of analysis. During axial coding I reassembled the data by relating categories along the lines of their properties and dimensions (Strauss & Corbin, 1998) and concluded after selective coding that according to Study II, students approached the domestication process from four perspectives that also present the dimensions and variation of students' experiences of their domestication processes. The perceived value of each perspective for an individual student substantially depended on students' personal experience and needs. I did not quantify how students presented or adopted different perspectives, which

with the benefit of hindsight would have made the systematic variation between students more explicit.

It is worth stating that, although domestication is presented from four perspectives here, in reality, the experience of domestication is never as simple, but rather is ultimately a more fluid process with overlapping aspects and blurred boundaries, and is one that is unfixed in sequence and nature. Moreover, although Study II presented the domestication process as something that occurs at the beginning of studies, in reality the domestication and studies begin more or less simultaneously, and students are probably already using their laptops, although they are still in the middle of the process. The amount and type of support students need changes as time passes, the ways in which laptops are utilised become more diversified and, in time, the tools start to look like their own for their users.

The reliability of the interview data, and thus the results, was strengthened by the discussions that were a part of the selected qualitative interviewing technique (Kvale, 1996). The strength of this method is also that it highlights the discursive nature of interviewing, which may enable interviewees to be more open and relaxed during an interview. The researcher's interpretations of the interviewees' answers were discussed during the interview, and interviewees had the opportunity to correct and complete the researcher's interpretations. The data collection and analysis were conducted by the first author of the related research article, but, as mentioned in the Chapter 3.3.3, the analysis was discussed with other authors to achieve mutual understanding of the results and their meanings. This strengthened the reliability of the analysis.

The overall consideration of the statistical data gathered in Study I revealed that, for many students, the laptop they had acquired through the university was the very first computer that they had owned and for which they were responsible. However, during Study II, it was discovered that the university had not arranged special training sessions to help students learn to use their laptops. The only aid that was organised was short device-introduction sessions arranged by the laptop vendor, but students did not perceive them to be helpful. They reported that those introductions were mostly advertising occasions that allowed the vendor to promote related products.

> After we got the laptops I participated in the training session, but I didn't find it useful. . . . . I would have needed more instructions concerning data security issues. . . . . issues regarding WLAN installation and use were missed (Jonathan, interview).

According to the results, successful domestication is a critical phase of studies on a wireless campus, since students consider having access to a personal laptop computer throughout their university careers to be a significant asset. It enables them to store their entire study history in one place in a form that means, for

example, essays, designs, reports and study diaries can be accessed, read and edited, and can be carried anywhere. Universities should ensure that they organise functional support systems that will serve students at different times during their post-secondary education, not just at the beginning. The need for social support appears to be especially significant at the beginning of the process, but this does not mean that a student would not also further benefit from it in the future.

In Study II, the students' need for flexibility also became evident. In the interviews, they indicated that the laptops had enabled learning at times and places that best suited their individual needs and family situations.

> If we had only one computer in use at home, it would be in somebody's bedroom, and when I had the time to study, that somebody would be sleeping in that room. Now I can go someplace else. Also, when thinking about motivation, it's good to be able to do things when I feel like it and wherever it's most peaceful (Sarah, interview).

> I'm not dependent on the place I'm in, but I can take my books and laptop and go, for example, to a pier to write. . . . I don't have to ask for quietness from anyone, but go to a quieter place myself (Mark, interview).

This information regarding the effect of students' everyday lives on their learning processes provided suggestions for further studies. The experiences of students with children were investigated more closely in Studies V and VI.

4.3 Study III: Data Security

Related publication

Vuojärvi, H., & Isomäki, H. (2012). Designing and implementing a CSCL-based course on the data security of wireless learning environments. *Online Journal of Media and Communication Technologies, 2*(2), 57–78.

Study III was conducted as a DBR process for designing and implementing a CSCL-based course on the data security of wireless learning environments. The study was a continuum of the work started on the research activities of the second sub-study of the MobIT research project. After surveying students' expectations of data security in Study I, I now wanted to ascertain whether data security issues affect the learning processes that take place in CSCL communities.

In CSCL-based courses, students ideally actively participate in collaboration by interacting, sharing experiences and completing tasks together (Jonassen, Lee, Yang, & Laffey, 2005; Stahl, Koschmann, & Suthers, 2006). Reaching a level

of productive interaction requires a safe emotional environment; students need to feel accepted by their peers; to feel trust, respect, belonging and a sense of community (Allan & Lewis, 2006; McInnerney & Roberts, 2004). One way of promoting this could be enriching users' awareness of, and ability to, manage the data security of their CSCL environment. If students trust that data security solutions are working properly and know how to manage personal data security themselves, they can concentrate on learning, without feeling the need to 'hold back' just in case their data security might be compromised.

At present, research concerning university students' perceptions of the data security of their mobile CSCL environment is virtually non-existent. Moreover, the majority of information on security research tends to focus on the technical context (Siponen & Oinas-Kukkonen, 2007). This can be considered a critical deficiency, because students are a significant group of users that use university ICT services every day, possibly with devices that are not organisationally maintained. It has often been suggested that the members of organisations constitute a major data-security threat to those organisations (Furnell, 2008; Leach, 2003; Schultz, 2008). In an academic environment, this includes not only the staff, but also the students. At minimum, all users should have the ability to protect their computers against malicious software or other attacks with anti-virus and firewall programmes, and to control access to their computer or user account. Moreover, successfully implemented data-security solutions have the potential to produce feelings of belonging and safety, thus supporting the formation of a secure community, which is seen as a critical feature in promoting learning in computer-supported communities (Chapel, 2008; Jones & Issroff, 2005; Moody & Schmidt, 2004; Wegerif, 1998).

During the first stage of the DBR process, a course on the data security of wireless learning environments was designed and piloted as collaboration among four university teachers. The aim of the first stage was to gather knowledge of current research on data security in academic environments and arrange a pilot course on the data security of wireless learning environments. During the second stage, the *Data Security of Wireless Learning Environments* course was refined on the basis of the experiences gathered during the pilot course, and implemented as a part of information technology studies and advanced media education studies.

As the research topic had been so little explored, the choice to use a DBR approach appears to have been correct. A strength of the study is that the pedagogical design and teaching arrangements were carefully planned and implemented in collaboration with four instructor-researchers. This dual role forced researchers to consider the design of the course from the pedagogical, as well as the research, point of view. In this respect, the experiment adhered to the principles of DBR (e.g. the Design-Based Research Collective, 2003). However, despite the careful design and theoretical groundwork, the experiment was not without challenges during the pilot course. As each of the four instructor-

researchers gave one lecture and guided his/her part of the network-based discussions, the course was perceived as somewhat fractured for both students and instructors, even though the collaboration among the four instructor-researchers was smooth. This was corrected during the implementation of the first actual course, as this was arranged by two instructor-researchers, which simplified the management of the bigger picture of the course.

Multiple types of data were collected during the pilot and the first actual course implementation, which is typical for design studies. This can be considered as strength of this study. The data consist of asynchronous network-based discussions, in which students participated during the course, of user diaries that they wrote during, and for 1 month after, the course, and of their feedback on the pilot course. However, the number of students (N=15) who enrolled in the course was rather small, which inevitably affected the amount of data that could be collected and analysed. A much longer period of repeating DBR cycles would have provided a better understanding of how data security aspects appear in different types of learning situations, in both physical and virtual places. However, the amount of time during which this research could be conducted was determined by the time resources of the research project, and also by the changes in the curricula in which the course was included.

The data were analysed again using the three coding steps in the GT approach (Strauss & Corbin, 1998). Students accounts of searching for information about data security, choosing data security software and secure learning tools and creating strategies of maintaining data security in learning processes as units of analysis. The analysis revealed that students perceive the role of data security as a user-centered and communal feature that frames collaborative learning practices in private and public spaces, and in places that can be physical or virtual. Students described how data security created rules and restrictions for their actions, but also worked as a tool that could protect learning outcomes and their privacy. Despite the limited amount of data the variation between students was quite relevant, reflecting their personalities and ICT experience.

Students strongly perceived the laptop to be their personal and individual learning tool, which created a private space in which they could learn. That is why access control was one of the most important practical tools through which they restricted access to their own laptop by using only one user account protected by a password, for example,. Students were also very keen on selecting the tools that they used on their laptops. Office tools, such as word processors and Internet browsers, were selected in terms of usability and data security, which was especially highlighted when the students mentioned their selection of an Internet browser. Possession of specific data-security software was also perceived as essential.

The idea of a private learning space arose when students described the places in which they used their laptops. The awareness of private and public places played a very important role in students' decisions regarding when and where to study. The

data security of the WLAN and of public spaces, such as the university campus, was perceived as weak, which is why some activities were performed in a home environment. In particular, the inconsistent availability and the slowness of the WLAN were perceived as undermining the security of the learning environment.

Data security can also be viewed as framing learning when it comes to the level of knowledge of data security that students possess. In their writing, all the students noted that they did not really have a clear idea of data security or possible threats to it, or sufficient expertise to manage their own laptops, and thus did not fully utilise them. They mentioned that participating in this course had opened their eyes and given them knowledge they could fall back on when using their laptops.

The educational use of ICTs involves considering the technology and analysing how it can be used in a manner that supports students' collaborative actions, problem-solving and interaction in a safe community as a part of pedagogical design. Data-security training should be offered as a part of CSCL-based teaching and learning. Students must generally familiarise themselves with, and learn to use, their ICT tools in addition to learning the subjects of the courses in which they enrol. In this case, the primary goals of the course were learning about technology and exploring data-security issues in particular, which was perceived as beneficial by students, not only in terms of the completion of this particular course, but also in terms of their studies in general. Although today's university students are more computer savvy than those of the past, they appear to require a deeper understanding of data-security issues in order to be capable of assessing their own computer usage from this angle.

4.4 Study IV: The Added Pedagogical Value of Laptops

Related publication

Vuojärvi, H., Lehtonen, M., & Ruokamo, H. (2008). The added pedagogical value of laptop computers in computer-supported collaborative learning on a wireless campus. In *Proceedings of the ED-MEDIA 2008 conference* (pp. 2760–2768). Chesapeake, VA: AACE.

Study IV sought to reveal university students' perceptions of the added pedagogical value of using laptops and networks in CSCL processes during their studies in media education. The research analysed the occurrence of key elements of CSCL, that is, collaboration, interaction, strong social ties, shared goals and the role of ICTs as a mediator in collaboration, as well as the contextualised and situated nature of learning (Jonassen et al., 2005; Jones, Dirckinck-Holmfeld, & Lindström, 2006; Koschmann, 1996). All of the above-mentioned elements of CSCL also reflect the socio-cultural view of learning: learning is seen to take place through mediated interaction between students and their contexts.

The data for this study were collected in spring 2007 during a media education course, entitled *Media Proficiency*. The course was organised in keeping with the principles of CSCL: in addition to participating in thematic lectures, students completed course assignments collaboratively in groups of three. Course assignments were designed to correspond to the students' future work as media education professionals. The students were expected to decide collaboratively on their topic and to arrange and manage their group's work. During the course, they also kept personal learning diaries, in which they described and reflected on learning in CSCL groups and described the ICT tools they used during their collaborative work. In addition to having laptops at their disposal, students used the network-based learning environment Optima during the course.

The course diaries were used as the data for this study, and analysed using the GT approach (Glaser & Strauss, 1967; Strauss & Corbin, 1998). During open coding, I aimed to identify incidents, ideas, events or acts that students presented to describe their learning process. Of particular interest were those related to collaboration between students, tools they used, the ways in which they they set learning goals and the times and places where they studied. These were used as units of analysis.

A weakness of Study IV lies in the fact that there were only small amounts of data from which to draw answers to the research questions. This evidently had an effect also to the limited variation that appeared during the analysis. In this study, the students' experiences were mainly in line with each other and therefore the resulting theoretical conclusions do not contain as much explanatory power as desired. However, it was not possible to obtain more participants for the study, as there were only 10 students on the *Media Proficiency* course, which was optional in the degree programme at that time. To add variation to the theory and to understand better the practicalities and the students' perceptions of the added pedagogical value of using laptops in collaborative learning, the data could have been collected from several courses following collaborative pedagogical methods and including students using their laptops in learning. An experiment of just a few weeks' duration does not necessarily introduce all aspects of students' laptop use during their learning processes.

According to the students, the laptops' added pedagogical value was that they afforded them the ability to operate on two levels of the learning activities involved, namely, the task-organising and the task-completion levels. Students inevitably became involved in organising their studies when they were assigned an ill-structured task that they could not complete alone. Managing the practicalities of learning, along with focusing on the substantive issues of the course, strongly tied students to CSCL processes and to one another.

Mobile tools not only enabled and mediated interactions between students, but also, and in particular, made it easier for them to maintain their study-related interactions, and thus to attain their shared goal of completing their collaborative

course assignment. Students used their laptops to interact with each other and with the lecturer. In their interactions, the students used both synchronous tools, such as Messenger, Skype and Optima chat, and asynchronous tools, such as email and the Optima forum. They also used their laptops to complete different parts of the assignment while on their way to achieving their shared goals. Laptops were also used to organise learning processes flexibly with regard to time and place. The present analysis suggests that the possibilities of enhancement can be realised on multiple levels of actions: laptops can support CSCL, not only in task-related actions, but also in organising the practicalities of CSCL.

4.5 Study V: The Experiences of Flexibility and Effectiveness Perceived by Students With and Without Children

Related publication

Eriksson, M. J., Vuojärvi, H., & Ruokamo, H. (2009). Laptop computers and wireless university campus networks: Is flexibility and effectiveness improved? *Australasian Journal of Educational Technology, 25*(3), 322–335.

Study V was motivated by a prior survey inquiring into students' expectations of laptop and network use in learning (Eriksson, Vuojärvi, & Ruokamo, 2008). The results of that survey showed that commitments, such as having children or working during term-time, affected students' expectations of the way in which laptops and networks could support the integration of studying into their everyday lives. The focus of Study V was to ascertain if students actively using computers and networks, and experiencing personal laptop computers and networks, perceive them as study tools that increase flexibility and effectiveness, and also if commitments such as having children, being employed during term-time, and being in a steady relationship, or characteristics such as gender or age, affect students' experiences with laptops and networks as studying tools in a way that increases the flexibility and effectiveness of studying. Flexibility was perceived as the possibility of using laptops for studying when and where it best suited the student. The 'effectiveness' scale primarily described how laptops and networks affected the progress of studies.

The data were collected by means of an online questionnaire created with Webropol software. The deliberations and decisions concerning the use of the questionnaire, along with the presentation of the analysis methods, are described in detail in the methods section (see Chapter 3.3.1). The data leave some questions regarding their reliability. It must be reiterated that the respondents in these studies do not represent all students of the University of Lapland, but only those actively using computers and networks. This is due to the somewhat self-selecting nature of the chosen data collection method; it is more than pos-

sible that some valuable insights remained hidden, as those students who do not actively use computers probably did not answer the questionnaire. However, as students actively using computers and networks are exactly the group that can best estimate the possible benefits these studying tools can offer, this possible bias in the data was not perceived to be sufficiently critical to impede the analysis. In addition, the large proportion (22.2%) of students with children among the respondents, compared to the 10% national Finnish average of university students with children (Viuhko, 2006), shows that students with children were over-represented among respondents. This suggests that these students set great store by the theme of this questionnaire, but it could also emphasise their point of view in the data.

Overall, almost 80% of respondents thought that laptops and networks increased flexibility, while fewer than 40% considered that the effectiveness of learning increased with the use of these tools. Students with children in particular considered that personal laptops and networks increased the flexibility and effectiveness of their learning process; employment did not appear to affect the perceived flexibility. The differences in experience between students with children and employed students might stem from the differing natures of these two commitments. Employment ties the worker to his/her place of work only for a certain period of time, often leaving, for example, evenings or weekends free for studying. When most of the study activities take place at home, a laptop does not provide much additional flexibility compared to a desktop, maybe just the possibility of choosing one's place of study between desk and couch. However, for a student with children this can be a significant advantage, as was also learned in Study II (see a quote from Sarah's interview on page 63). Taking care of children is a 24-hour-a-day job, in which the opportunities for studying cannot always be predicted. It is possible that because of these unpredictable learning environments, students with children have a greater need for flexible study tools than do working students who do not have children. Therefore, students with children have derived greater benefit from laptops and networks that allow learning where and when it best suits the student, which consequently improves the possibilities for efficient time management.

Study V showed that gender significantly affected experiences of flexibility. However differences between genders in terms of how they experienced the effectiveness of studying were not found. Age did not significantly affect experiences of flexibility, but it did have a significant effect on experiences of effectiveness, with older students (over 29 years of age) in particular finding that laptops and networks enhanced the effectiveness of their studies.

Bearing the methodology of this study in mind, the results suggest that experiences of flexibility do not automatically lead to more effective studying, and that a large part of the supportive value of laptops and networks for students consists of the opportunity to carry out their assignments at home, on campus, or

wherever the opportunity arises. The fact that only 39% of respondents thought that laptops and networks increased the effectiveness of studying could be an indication of a failure to integrate laptops into faculties' curricula.

It is increasingly common for university students to have other commitments alongside their studies. It is of the utmost importance that this be acknowledged by universities, particularly as they plan their teaching practices and student support structures. Failing to do so may result in lengthened studying spans or an increasing drop-out rate; consequences that today's efficiency-focused university strategies aim to avoid. Flexibility of time and place consequently leads to changes in the routines of time expenditure, and also makes the integration of studies with everyday life easier, that is, promotes lifelong, lifewide and lifedeep learning. Commitments, such as having children, are the starting point that dictates how other activities occur in students' lives. Detailed plans and schedules provide predictability that helps students plan their everyday lives in general, and not just their studies.

Almost 80% of all respondents and over 85% of respondents with children agreed that laptops and networks increase the flexibility of studying; over half of the students with children, as well as older students, also asserted that laptops and networks increased study effectiveness. The practical implication of this research is thus that the use of laptops or any other type of suitable mobile ICTs should be encouraged.

4.6 Study VI: Students' Experiences of the Laptop Initiative

Related publication

Eriksson, M. J., & Vuojärvi, H. (accepted). Different backgrounds—different priorities? Student perceptions of a laptop initiative. *Higher Education Research and Development.*

The aim of Study VI was to collect students' perceptions of laptop and WLAN use in university teaching and learning. Particular focus was placed on the differences between students with and without children. This division was motivated by the results of previous studies (Bolam & Dodgson, 2003; Jacobs & Berkowitz-King, 2002; Taniguchi & Kaufman, 2005; Study V). The data were collected by means of the online questionnaire also used in Study V and AHP interviews. The data collection and analysis methods are described and discussed in detail in Chapters 3.3.2 and 3.3.3.

The combined use of SWOT and AHP was experimental, as this type of methodology does not seem to have appeared in educational research previously. Early in this project, this combination approach seemed appropriate for mapping and ranking both positive and negative aspects of the laptop initiative. However,

SWOT and AHP differ significantly enough methodologically that the reliability of the study may be put in question. When responding to a SWOT analysis, students may list just one or two things that come to mind without further consideration; possibly for such reasons, this method is perceived as lightweight. SWOT thus cannot be recommended for estimating the importance of different themes. However, it did offer a valid method for collecting a large sample of opinions and ideas that were used for further analysis. AHP suited the further processing of SWOT results, as it gave respondents clear choices between which judgements should be made, even if the respondents would never previously have thought of the particular themes. When students participated in an AHP interview, they had to consider their judgements very carefully, as each set of judgements was further analysed for inconsistencies, and the participant was given a chance to reconsider. Statistical testing was not conducted because of the nature of the AHP method, therefore, ranking of the themes with close attribute weights should be treated with caution. Nevertheless, the AHP application used in this study should provide rough estimates of the relative importance of the themes selected from each SWOT category.

The results indicated that the laptop initiative had positive effects on learning. Students generally considered that laptops and the WLAN had enabled effective performance of learning activities, such as writing essays or information seeking, as well as more effective learning-management activities, such as checking e-mail during short breaks. These two types of activities described also reflect on the two levels of collaborative learning activities revealed in Study IV.

According to Study VI, there are some critical weaknesses that need more attention in the organisation of similar mobile ICT implementations, and that have an influence on the conceptualisation of a PMLE. 'Deficiencies in teaching', or, in other words, insufficient integration of laptops into teaching practices, were perceived as a very important weakness of the laptop initiative. This confirms the information gained in previous studies (Demb et al., 2004; Finn & Inman, 2004), and emphasises that far more could be achieved if technology was truly integrated into university teaching and learning practices. As has been previously examined, poor pedagogical planning may lead to practices that, at worst, may harm learning (e.g. Fried, 2008; Hembrooke & Gay, 2003).

A particular focus was placed on the possible differences between students with and without children. Study VI revealed the preference for 'mobility and flexibility' among students with children, and the obvious dissatisfaction with the 'old-fashioned' university infrastructure among students without children. Students with children indicated that their lives and studies were heavily dictated by their commitments to their families and (in some cases) employers. Therefore, effective learning for this group may be dependent on the mobility and flexibility afforded by laptops. Conversely, students without children, have more freedom in scheduling their studies, and can spend far more time at the

university. Therefore, a functional learning environment at the university is more important for these students.

All interviewees subjectively analysed the themes under comparison, so a natural bias in the ratings between participants may exist. This bias was reduced during the process by dividing the interviewees into two separate groups: students with and without children. Saaty's (1980) measure of consistency can be used as a test for the impact of inconsistency on aggregate results of one or more respondents. The results of this test indicate that the aggregated results in each category, and for both student groups, are under the accepted inconsistency threshold. The number of students interviewed was also reasonably high when compared with the AHP literature (e.g. Alho & Kangas, 1997; Peterson, Silsbee, & Schmoldt, 1994). The potential for any individual bias to significantly affect the aggregated preferences is therefore reduced. As this was the first time the combined use of SWOT and AHP has been applied in gauging student perceptions, the study also provides one alternative for estimating the results of corresponding initiatives.

With regard to future teaching and learning practices, students believe that there are great opportunities to improve their mobility, flexibility and versatility. For example, 'pedagogical versatility' in Study VI refers to increasing the use of laptops and networks in lectures to support face-to-face teaching and increasing interactivity and distance-learning opportunities. Students with children accentuate the mobile and flexible side of learning, as they clearly have a need to manage and control their time, place, and mode of study. By investing time and money in improving pedagogical practices, the university has the potential to develop all these aspects of study. However, development that makes possible the integration of ICTs into instructors' practices, potentially resulting in more flexible practices, requires that instructors be proficient with computers and that they be given the time and instruction needed to learn the pedagogical potential of ICTs.

In line with the perceived opportunities, both student groups viewed the lack of pedagogical development as one of the biggest threats. The greatest difference between the two groups within the threats category was that students without children ranked 'lack of communality' second, while students with children gave 'lack of communality' clearly lower weight in their comparisons. This difference is likely related to the fact that, confirmed by interviews, the social networks of students with children are strongly family-oriented, while those of students without children are more university-centred, and for them, face-to-face interaction in the university context is far more valuable.

To conclude, although the students found that technology supported their learning, far more could be achieved if the institution supported the use of ICTs, and these were actively integrated into teaching and learning practices. The facilities where these devices are used should be updated to their standards; otherwise, usability will suffer, utilisation rates will remain low, and invested money will be wasted. The results displayed here also show that students in different life

situations have differing preferences when estimating the pros and cons of certain technologies. For example, in Finland, the approximate national percentage of university students with children is a sizeable 10% (Virtala et al., 2011). This diversity in the student population should always be considered when planning investments in new technologies, or the implementation of new courses, regardless of whether any technology is involved.

5 DEFINING PERSONAL AND MOBILE LEARNING ENVIRONMENTS THROUGH ACTIVITY THEORY

Pre-set learning environments are increasingly being replaced by learner-generated contexts, within which learners pull together available resources to meet their own needs. The challenge in this is to scaffold the creation of these effective learner-generated contexts (Luckin, 2008, 2010a). Technology alone does not produce better learning; rather, its impact depends on several variables (Säljö, 2004, 2010) that in this case have been approached in individual studies. They are understood here as defining the concept of a PMLE and are now made visible by their consideration through an activity theory framework.

A clear weakness in my application of activity theory is that the data were collected only from students, therefore all participants' views cannot be included in the analysis. This inevitably omits some contradictions that could be vital for driving changes and activities on a practical level. However, the understanding gained through application of activity theory here provides a students' perspective, which is significant as students are in the core of their own learning processes. My study can also be viewed as a starting point for further research. For now, the analysis of students' experiences and perceptions is of greatest use to instructors, developers and researchers, but with more in-depth experimentation and research into all practical agents, the conceptual understanding can be used to design learning environments in universities and to better support learning in and through them.

To guide the analysis of the combination of the individual studies, I apply Jonassen and Rohrer-Murphy's (1999) suggestion as a process for applying activity theory for designing learning environments. Their process consists of analytical steps, through which the components of the activity system, here a PMLE, can be determined. In the following, I present and discuss the analysis of (1) the purpose of the activity system (5.1); (2) the activity system (5.2); (3) activity structure (5.3); (4) context (5.4) and (5) activity system dynamics (5.4) in the light of the results obtained in individual empirical studies and from the available literature.

5.1 Analysing the Purpose of the Activity System

According to Engeström (1987), the clarification of the motives and goals of the activity system is essential, because it helps in understanding the context within which the activities and the motivations for the activity being modelled occur.

As I used activity theory to conceptualise a PMLE, the purpose of the activity system was to support students' learning processes. As stated in Chapter 2, it is possible that the current definitions of PLEs do not cover the phenomenon as widely as is necessary. They lack the understanding of students' everyday life situations and the affordances (Chemero, 2003; Gibson, 1979) mobile ICTs provide for learning processes in higher education. Beginning with Study I, it became evident that students embraced the opportunity to study more personally and flexibly in terms of times and places, and to potentially combine studies with work and family-life more effectively. Mobile ICTs were envisioned as a seamless (Chan et al., 2006) part of learning processes, providing versatility in teaching and learning processes, access to networks and also driving, most importantly, pedagogical, but also infrastructural, as well as technological, development (Study VI).

According to students' experiences, laptops have indeed enabled effective performance of learning activities, as well as more effective learning-management activities (Studies IV and VI). However, when studying students' experiences closer in Study V, it was found that those who were perceived to have benefited the most from this flexibility afforded by mobile ICTs were students who had families with children, omitting the majority of the students at the University of Lapland. Studies V and VI identified some problems students had either encountered, or expected to encounter, when applying mobile ICTs in learning processes in their current higher education context. Students currently perceive that laptops are insufficiently integrated into teaching practices, and that the neglect of pedagogical development is threating the ability to apply mobile ICTs in learning processes in general. Other commitments, such as having children, and sometimes also working during term-time, were reported to greatly dictate students' lives and studies, therefore, effective learning for this group would be dependent on the mobility and flexibility afforded by laptops (Riggert, Boyle, Petrosko, Ash, & Rude-Parkins, 2006; Study VI). University infrastructure, such as sufficient provision of plug points and spaces for independent working with laptops, is perceived as old-fashioned.

Studies II–VI all support the understanding that, according to students, successful implementation of mobile ICTs in teaching and learning processes is a result of the work of several participants (Säljö, 2010). Students are at the heart of the activity; the efforts of all others should be geared towards supporting students in their learning. The conceptualisation of PMLEs through activity theory helps identifying all needed participants and their responsibilities.

5.2 Analysing the Activity System

The second step of the analysis process is to define the components of the given activity, that is, the subject, object, community, rules and division of labour (Jonassen & Rohrer-Murphy, 1999). The aim is to provide an understanding of how the participants perceive their roles in relation to the goals of the system, but again, it is critical to remember that at this point this analysis provides knowledge of the system only through students' experiences and perceptions.

The PMLE as an activity system (Engeström, 1987) is presented in Figure 6. The elements of a PMLE, subject, object, tools, community, rules and the division of labour, are subsequently presented and discussed in sub-sections 5.2.1–5.2.6.

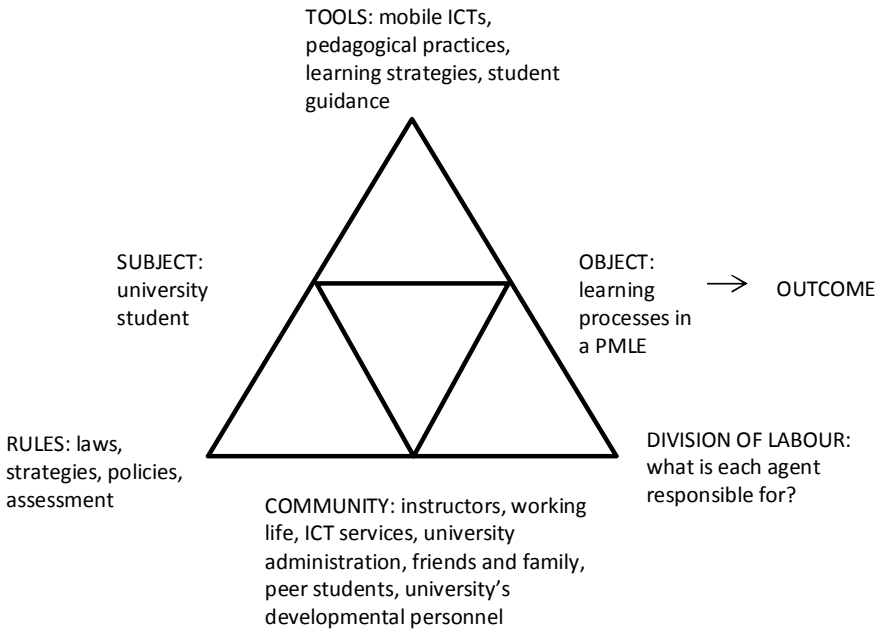

FIGURE 6. A PMLE as an activity system

5.2.1 Subject

The subject of a PMLE is the student, who is at the centre of teaching and learning processes at the university, driving the system forwards. According to results from Studies V and VI, this position is sometimes challenged by deficiencies in pedagogical practices and there is occasionally uncertainty as to whether instructors' and universities' truly apply student-centred approaches in their activities. Feeling in charge of one's own learning enables students to self-regulate their learning process, which may contribute significantly to motivation, which is critical for the academic progress (Zimmerman, 1998).

To fully utilise the affordances (Chemero, 2003; Gibson, 1979) of mobile ICTs in learning, students' positive attitudes towards implementing laptops, and a WLAN as a part of their learning, are important (Study I). The more knowledge the students possess with regard to how they could benefit from and implement mobile ICTs in their learning processes, and the more they can influence the technology choices, for example, the greater the chance that they will support this (Elwood, Changchit, & Cutshall, 2006).

5.2.2 Object

The object of an activity system can be a product, a communication or any combination of elements (Engeström, 1987; Jonassen & Rohrer-Murphy, 1999). In this instance, the object of the activity system is a learning process taking place in and through a PMLE. The process leading to outcomes are highly individual and therefore, even though I attempt to present a conceptualisation of a PMLE in my thesis, the activity systems of individual students could all look a bit different than what I am presenting on previous page. Students represent different demographic and cultural groups, have varying backgrounds in terms of previous education and work experience, and have different aims in terms of their motivations for studying at university. Individuality relates also to the historical nature of learning, but history cannot be perceived merely as the possibility of looking back at what has been accomplished; quite the contrary. By engaging in learning processes students create a basis for future learning opportunities and considerations of their learning goals.

In addition to the notion of 'personal' there is also the notion of 'mobile' in the concept of a PMLE. Embedding mobile ICTs into learning processes thus highlights the affordances of mobility for learning processes. According to Sharples et al. (2009), the notion of 'mobile' can be dissected from five points: (a) physical mobility, (b) mobility of technology, (c) mobility in social space, (d) learning dispersed in time, and (e) mobility in conceptual space. As stated previously, university students are mobile, and may shift places and spaces several times a day; opportunities for learning may thus be encountered in various settings. Mobile ICTs can help create a continuum among them by offering a range possibilities for choosing the methods of studying, in helping students with classroom assignments, interaction, and research, in the opportunity to access learning materials and other information sources, their own learning histories (Säljö, 2010), as well as in the way in which the learning process becomes student-centred, hands-on and exploratory (Barak et al., 2006; Demb et al., 2004; Honey, 2004).

5.2.3 Tools

The components of the PMLE do not act on each other directly, but their interactions are mediated by signs and tools. These mediators can be material devices or mental models; anything that connect a person with the world and other peo-

ple (Jonassen & Rohrer-Murphy, 1999). The obvious set of tools in a PMLE is the mobile devices: in this case laptops and networks. My focus was not on the technologies that university students use in their learning processes, but on the students using those technologies. As my final data collection ended in 2009, and mobile devices have continued to develop towards a more portable direction, with countless usage options, it is relevant to dissect whether laptop computers can still be regarded as mobile tools (Sharples & Beale, 2003). For many, mobile technology in education refers to any device that fits in a pocket or a purse (Roschelle, 2003; Wagner, 2008; Wexler, Brown, Metcalf, Rogers, & Wagner, 2008), therefore laptops are not regarded as mobile tools for learning (Traxler, 2007). Some contradictory opinions have also been advanced (Naismith, Lonsdale, Vavoula, & Sharples, 2004; Sharples, 2013; Winters, 2006).

I understand the differences in researchers' opinions, especially in such a new a field of research as mobile learning. However, in my opinion, these differences do not hinder the relevance of my interpretation of laptops as mobile tools. In 2004, when the MobIT research group began its work, the definition of a mobile tool was perhaps a bit wider than it is now. In addition, as the aim of the MobIT project was to examine the use of laptops and the trigger behind this research agenda was the laptop initiative at the University of Lapland, there was no reason to widen the perspective to the use of other devices in empirical studies, even though the technical development has had a strong impact on the technological aspects in education and in mobile learning in particular.

As I stated previously, my focus has not been on the technological device or its size, but on the students and their learning processes as they have experienced them. Understanding the notion of 'a mobile tool' as a learner- or activity-centred concept, rather than a mere technical tool makes it even more problematic to form a widely accepted definition of the concept. As learning is perceived as something that is individual, historical, seamless, mediated and contextual (Säljö, 2010), the nature of 'mobile' has a variety of meanings for each learner, and the technologies they use may be of multiple types. They can serve as an external memory and information source (Säljö, 2010) that assists learners in organising activities, knowledge, and resources (Study IV) over a range of topics, times and places, in ways that integrate learning experiences to create personal and meaningful records of learning over a lifetime (Vavoula & Sharples, 2009). It is possible for students to follow their own development, as all the material they have produced during their post-secondary education is available on their laptop. In addition to providing simple access to information, laptops also make it possible to analyse and process stored information almost, if not absolutely, endlessly.

Mobile ICTs also have the potential to improve students' time-management skills by transforming so-called dead-time, such as time between classes or while children are sleeping, into productive time (Studies V and VI). The flexibility that students experience as a change in their study habits and academic,

as well as social, lives may result in increased possibilities for studying. This may improve academic results and, in turn, reduce time to graduation, thus proving the increased effectiveness of studying (Study VI).

In addition to devices, equally important are the software and networks that are accessed through them. The basic office tools for a university student include a word processor, presentation graphics, spreadsheets, Internet browsers, a network-based search engine (for example Google), and library databases (Osika & Sharp, 2003). As their studies proceed, they may have to learn how to use such things as data analysis software (for example SPSS and AtlasTi) or 3D modelling software (for example ProE). Social media tools, such as experience- and resource-sharing tools (among them Delicious, WordPress and Twitter), media-sharing tools (including Flickr and YouTube) and social networking sites (such as Facebook and LinkedIn) must also be added to the list, as their use is becoming more widespread and important in higher education (Dabbagh & Kitsantas, 2012; Selwyn, 2012).

For university students, laptops are the most convenient device to use in PMLEs in most cases, due to their screen size and keyboard usability (Study II). A potential follower of laptops is the tablet PC, which has recently become popular. There has recently also been a shift from designing learning environments that support only one type of technology to 'bring your own device' learning environments, in which students can use their own smartphones, tablet PCs, laptops, or any other type of mobile ICT device for learning (Johnson, Adams, & Cummins, 2012; Lennon, 2012; Nykvist, 2012). With regard to a PMLE as an activity system, I suggest that the options of using different mobile tools in learning processes not be limited only to laptops; quite the contrary. The mobile device, or a combination of several devices, can be anything that can be used in learning processes taking place in, and through, PMLEs, as long as their use is pedagogically reasonable, because technologies are not neutral. They have implications for social activities, and such variables as the way in which a university student engages in lectures, listens to the instructor, takes notes and reads literature is affected by the media he or she has in use (Säljö, 2010).

Technological aspects and selection of devices are inevitably an issue in mobile learning. However, in many research articles, the deliberation always ultimately emphasises the pedagogical aspects, no matter the way new technology is used. Technological and pedagogical development should be dissected hand-in-hand (van Oostveen, Muirhead, & Goodman, 2011). A 1-year follow-up study (van Oostveen et al., 2006), concerning the experiences of students with tablet PCs in a higher education institution that issues students with laptops for their use, found that students with tablet PCs tended to bring their devices to class frequently and that they primarily used them to write notes. However, there was no evidence of changing attitudes with respect to learning, and the researchers concluded that current use of mobile devices in higher education is still "pedagogically conservative and regressive".

Focusing merely on technology and distributing learning contents on different kinds of devices neglects the potential that mobile devices have in the actual processes of teaching and learning, and overlooks the nature of learning and the wider context in which it takes place (Kukulska-Hulme, Sharples, Milrad, Arnedillo Sánchez, & Vavoula, 2011). A clear deficiency in my thesis is that teachers' pedagogical practices were not included and students' own learning strategies were at focus only in Study IV. Learning strategies are critical tools in applying mobile ICTs in learning processes (Ruokamo, Tella, Vahtivuori, Tuovinen, & Tissari, 2002). GT analysis in Study IV showed that students operated on two levels of activities during the CSCL process: task organising and task completion. The two are tightly interwoven and interact with each other. The first level concerns managing practical details and schedules relating to the completion of the course and dividing the work between the group members. The second pertains to activities involving the substance of the course and completing the assignment. The students felt that more profound responsibility for their learning enabled them to choose learning strategies according to their individual needs and in this way achieve their goals effectively. In general, both instructors' and students' strategies remain an under-studied area regarding my conceptualisation of a PMLE and they need to be taken up as a research task in the future.

In addition to the actual mobile devices, a clear organisational vision and strategy are needed to support learning within, and through, a PMLE (McVay, Snyder, & Graetz, 2005; Njenga & Fourie, 2010; Roby, Ashe, Singh, & Clark, 2013). Strategies are practical tools that guide university teachers' work. As discussed already in Chapter 2.1, after University Reform universities are currently a type of business enterprise that are capable of directing their operations reasonably freely, their situation holds potential for a fresh look at strategic work concerning the pedagogical use of mobile ICTs. At the University of Lapland, such a strategy was created for use between 2003 and 2006, but this has not been renewed. Currently, the closest reference to pedagogical ICTs can be found in the overall strategy of the University of Lapland, in which using flexible learning environments are regarded as one way to promote adult education and lifelong learning[14].

The need to have an organisational strategy does not necessarily imply the need for an institutionally provided PLE (Millard et al., 2011; White & Davis, 2011b), but rather the need to commit to developing practices and policies on a larger scale. This cannot be based on administrative decisions alone, but requires an organisationally negotiated strategy to which all parties should be committed to contributing (McVay et al., 2005). The creation of such a strategy requires an openness and a willingness to examine, what it means to teach or learn something, for example, (Säljö, 2010). Support is needed in both technical and pedagogical matters, and strategic work helps in designing an organisational structure

14. http://www.ulapland.fi/InEnglish/About-us/Strategy-2020/Education

that serves both aspects. Strategic choices and financial steering become visible for instructors and students in everyday facilities and concretely, for example, in how many face-to-face lectures an instructor gives during a single study module. Tools are simultaneously both enabling and limiting (Nardi, 1996).

5.2.4 Community

University instructors play a significant role in the community, by engaging in teaching and learning processes with students on a daily basis. They are sometimes criticised for having negative attitudes towards the pedagogical use of ICTs and 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 also became evident in the student perceptions investigated in Studies V and VI. It has been reported that instructors base their decisions not to use ICTs in teaching on the grounds that they do not believe that ICTs can enhance students' learning processes, and that they themselves do not have the time required to master ICTs to the degree required to support these processes (McVay, et al., 2005). One reason for this defensive position could be that the university lecturers and professors themselves have not had the experience of learning with mobile ICTs (Kukulska-Hulme, 2012).

Teachers' current positions in universities are not enviable, as they are pulled in one direction by the grand ideals of academia that represent well-established structures, and in another direction by the corporatisation of universities that has turned them into business enterprises that are evaluated on the basis of their productivity (Selwyn, 2007). Nevertheless, instructors are in a key position to support students' use of ICTs in learning, enabling flexible learning practices and combining learning in formal and informal settings. Instructors who use ICTs can be viewed as 'professional role models' (Harden & Crosby, 2000), and are characterised by their knowledge, skills, attitudes and competencies, all of which are advantageous for the use of ICTs (Drent & Meelissen, 2008).

Empirical studies have revealed that utilising mobile ICTs in higher education also successfully necessitates the involvement of ICT personnel and university administration, which are responsible, for example, for updating university facilities to their standards, thereby providing helpdesk-support for laptop users (Studies II, III and VI). Helpdesk operators provide support in everyday situations and sometimes even the simplest advice can have a big impact on how fluent are the learning processes. For example, this became obvious in Study II, when students reported missing tutorial lectures to ICT services as well as how to put their laptops into use and how to start using the WLAN.

As an administrative agent, university administration is a part of students' community in this framework. Administrative issues arose most evidently in Studies II and VI, both of which reported students' criticism about how the laptop initiative was operated and the types of structural development that would be

needed to fully utilise the affordances of mobile ICTs in university teaching and learning. As it stands, the administration of the university and its' responsibilities in the framework are left somewhat under defined, as it is not clear which actors are in fact those that should be included. This research task should be addressed in the future. Moreover administration cannot be perceived only as an external influence in students' learning processes, as, in Finland, students have been included in official decision-making processes in universities.

As became apparent in the empirical studies, students' community includes also participants who are not part of the immediate university-related community. According to Study VI, students with children have strongly family-oriented networks, while those of students without children are more university-centred. This inevitably affects the ways in which students communicate with the members of their social networks. For students without children, face-to-face interaction in the university context is far more valuable, and students with children may rely on communication mediated by mobile ICTs. Friends or family members can offer support in technical issues (Study II), children and spouses have an impact on how a student's everyday-life is structured (Studies V and VI), and a working student's employers expect that individual to also be a productive employee (Study VI).

5.2.5 Rules

Rules are meant to guide the actions or activities acceptable by the community (Jonassen & Rohrer-Murphy, 1999). In the case of Finnish university education, universities are somewhat independent in their decision-making because they enjoy large autonomy and freedom of research. As an institution, a university, with its traditions, sets a structure in which teaching and learning processes take place. They organise their own internal administration independently, guided by the Universities Act, and their operations are built on the freedom of education and research[15].

For students, rules are visible, for example, in the possibilities of what degrees are attainable at a university, and also in what period of time they are expected to complete their studies. Another significant and very visible set of rules guiding students' learning processes is that of the principles according to which learning is assessed. Assessment is a powerful tool (Gipps, 1999); it is inevitably related to the definition of learning, what is perceived as learning and outcomes (Säljö, 2010), and the types of curriculums through which these outcomes are pursued. Developing pedagogical practices in a more student-oriented direction challenges instructors' understanding of assessment (Häkkinen & Hämäläinen, 2012).

15. Ministry of Culture and Education, http://www.minedu.fi/OPM/Koulutus/yliopistokoulutus/?lang=en

Traditional methods of assessment can be unsuitable or incapable of reaching the outcomes of such self-regulated learning processes as those seen to occur in PMLEs. The key to developing pedagogical practices could be changing the way students are assessed during their learning processes (Pryor & Crossouard, 2008), and asking who should be the one making the assessments in practice. Moreover, assessment should be regarded as something for, rather than of, learning (Norton, Norton, & Shannon, 2013). This could mean focusing on the students' strategies of 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 type of assessment is that it must cross disciplines and reach beyond strict consideration of the mastery of contents.

ICTs are an integral part of universities' everyday administrative operations, especially in the areas of teaching, learning and research. In such large organisations, there are usually administrational rules concerning the use of ICTs, and the University of Lapland makes no exception in this matter. Both students and staff are informed of the general policies and data security issues when they are given the user identification needed to access university networks. As the pedagogical use of mobile ICTs develops, it is not only pedagogical decisions that influence the fluency and effectiveness of the teaching and learning processes; technological aspects, such as data security, are also significant. Data security was the focus of Study III, and it was found that students perceived data security as setting rules and restrictions for their actions, as well as working as a tool that they could use to protect their learning outcomes and privacy.

5.2.6 Division of Labour

The division of labour prescribes the tasks for which each participant is responsible (Jonassen & Rohrer-Murphy, 1999). To strengthen my analysis in the activity theory framework, the division of labour is one critical aspect that should be studied further and negotiated with other members of the community.

As students are set as subjects in this activity system, and learning is perceived as a socio-cultural phenomenon that covers all areas of life, with a strong emphasis on individual experiences and mediated interactions, students have a clear responsibility for their own learning. As students enrol in their university studies, it may sometimes be difficult to start defining their own learning goals, as all university degrees may not lead to a well-defined profession, for example a teacher or a social worker, for the student to enter after they graduate. Reflecting on their own knowledge and its limitations also needs practice, as well as engaging in a process that includes receiving and processing feedback from the members of the community in their activity system.

In a PMLE that applies mobile ICTs in mediating thoughts and activities, students should also take care of updating their ICT skills (Thompson, 2013; Study II). Although many students enrolling at universities are highly tech-savvy,

this generalisation cannot be extended to the entire student population (Osika & Sharp, 2003; Study II). It is also important to note that possession of some basic technological skills does not necessarily mean that a student can employ technology-based tools strategically to optimise learning experiences in university settings (Kennedy et al., 2008) and therefore students' learning strategies should be updated for them to be able to set goals, select approaches and also when searching, handling and producing information relevant to their learning (Häkkinen & Hämäläinen, 2012). Recent research in the field has identified that students' experience of implementing mobile ICTs in learning contexts is limited (Bennett, Bishop, Dalgarno, Waycott, & Kennedy, 2012), and that the workload involved in learning new skills should not be underestimated (Meyer, 2010).

The task of university teachers is firstly to examine their attitudes and openly assess the potential of mobile ICTs to renew and develop pedagogical methods and broaden their pedagogical perspectives (Baylor & Ritchie, 2002; Hannafin et al., 2005; Salinas, 2008; Weaver & Nilson, 2005); in essence, they should thus engage in their own professional development. Academic staff should focus on personal, social and work-related use of personal technologies; learn with mobile ICTs, not about them (Kukulska-Hulme, 2012). For academic staff, learning inevitably means engaging in more research, and tightening the bond between their research and teaching, in both of which mobile ICTs can play a crucial role. Taking time for professional development can yield improvements in the research–teaching nexus, producing more topical research studies and results, which is a critical factor in many governments' university assessments (Healey & Jenkins, 2009; Kukulska-Hulme, 2012).

With regard to laptops, instead of viewing their use during lectures as a disturbance and trying to root out inappropriate use (Fried, 2008), through their own experience of using mobile ICTs, university teachers could adopt more student-oriented pedagogical approaches and consider the use of mobile ICTs to be part of a learning process that continues outside the lecture room. The advantage of, for example, a laptop in the learning process is not just that it can be carried around as a tool; quite the contrary. Laptops or other mobile devices should not be viewed merely as tools that students use in individual learning situations, but as media that create a continuum among those situations (Lindroth & Bergquist, 2010).

In order to develop professional expertise, to be capable of fully using mobile ICTs in their work and to support students in their use of mobile ICTs in learning, university teachers' ICT skills must also be updated in most cases (McVay et al., 2005). Part of this involves seeking knowledge and first-hand experience in how to implement ICT use successfully in teaching. It also means maintaining a network of professional contacts with colleagues who use ICTs in their teaching, as well as with ICT experts for the instructors' own professional development (Drent & Meelissen, 2008). Students can also be among an instructor's professional contacts, as they are sometimes more experienced in using mobile ICTs

in their everyday lives, as well as in learning with them. Mature students, who return to university to update their skills and knowledge, advance their careers, or just learn for interest and enjoyment, can also offer critical hands-on experience, as they bring with them a set of experiences and expectations that are held by workplaces with regard to the use of social and mobile ICTs (Kukulska-Hulme, 2012). University teachers' lack of basic ICT skills and inability to integrate ICTs into instructional practices became evident in Study VI, in which the AHP revealed that, according to students, deficiencies in teaching were a critical weakness of the laptop initiative at the University of Lapland.

As an administrative organisation, a university has a responsibility to assure the availability of sufficient infrastructural facilities, such as enough electrical outlets in lecture halls, printers and working spaces for the implementation to be successful. These may appear to be insignificant details, but in reality they are factors that enable extensive laptop use in the first place (McVay et al., 2005; Studies II and VI). A university should also provide a strong level of faculty and student support. Instructors' motivation to develop their didactics can be enhanced by offering training programmes (e.g. McVay et al., 2005), and ensuring that proper technical support services that facilitate teaching and education-related administrative tasks are available (Georgina & Hosford, 2009; Georgina & Olson, 2008; Mitra, Steffensmeier, Lenzmeier, & Missoni, 2000; Zhen, Garthwait, & Pratt, 2008). It is of utmost importance that teaching personnel and students are included in developmental processes right from the start (Roby, et al., 2013). This prevents feelings of estrangement and lack of ownership in the process (Ertmer, 2005; Mayo, Kajs, & Tanguma, 2005; Stensaker et al., 2007; Zhen et al., 2008.)

As stated earlier, administration cannot be perceived only as something that is external for students, as they also have a role in university administration. For example at the University of Lapland, students have representatives on the boards of individual faculties and also on the University Board. The tasks of the University Board include deciding on the central objectives, strategy and steering principles of the operation and the economy of the university. It also decides on the number of students to be admitted to the university, approves the rules and regulations and other stipulations concerning general organisation and decides on the university's operational structure. These are matters that create a structure for university operations and students are thereby included in the decision-making processes. Another thing is how the information is shared among students.

In addition to following strategies and providing tools and time for the development of implementing ICTs in teaching and learning contexts, universities should also take an interest in the results of their initiatives. It is not enough to pay attention only to figures and numbers, but systematic evaluation of the implementation of ICTs should also be conducted. The information gained through evaluations could be used in institutional learning (Stensaker et al., 2007).

5.3 Analysing the Activity Structure

Activity structure encompasses all of the activities that engage the subject (Jonassen & Rohrer-Murphy, 1999); in this instance the student who is the driving force and responsible for his or her own learning processes. Activities consist of individual and co-operative actions and chains of operations. Together, these three levels (activity, action, operation) comprise an activity structure. Therefore, activity defines PMLEs by extension, because PMLEs focus on an activity. Careful identification of activity structures makes the meaning of intentional actions or operations in creating a PMLE visible for the student.

The activity level has been interpreted as the intentional level because it focuses on the intentions or motives as its driving force (Linnard, 1995). Examples of activities relevant to creating a PMLE include developing learning strategies and finding meaningful ways of implementing mobile ICTs into learning processes. Both of these activities are complex in nature. Learning to adapt ICTs to learning processes is itself a learning process. To fully realise the potential that mobile ICTs have in a learning context, students should actively strive towards seamlessly implementing them into their learning processes. However, this should be carried out not just for the sake of using ICTs, but in order to use them actively to create and maintain a personal learning history that can be accessed virtually and almost anytime, anywhere. Knowledge can, and must, be updated, reshaped and reused over time to reflect experience. I wonder if anyone has counted how many pages of text university students produce over the course of their studies in the form of essays, reports and learning diaries—a historical perspective helps students to understand that all this material is reusable after it has been given to an instructor or a professor at the end of a course. For example, a student who is deliberating on the topic of a master's thesis could use his or her own undergraduate papers as a basis and ascertain if there is something therein that could provide a starting point for something new.

The action level is the functional level (Linnard, 1995) that uses actions to fulfill the activities. Säljö (2010) stated that human learning is hybrid in nature: to know and master means using the mediating tools that are integrated into most of the activities taking place during learning processes. Therefore, to be active in a PMLE, they are also responsible for using the tools. According to the results gained in the empirical studies included in this thesis, examples of actions are domestication (Study II), practicing working methods that promote data security of students' learning environment (Study III), applying mobile ICTs in various levels of task accomplishment (Study IV) and searching for alternative learning strategies or practices that support the overall practices of students' everyday lives and studies as a part of them (Studies V and VI).

A weakness in my application of the activity theory framework is that this action level was not studied closely enough to reveal all ongoing operations. In

Study IV, students' actual learning processes were the focus, but, with only a small amount of data, it offers a narrow look at the operational level, so a further study may have a greater opportunity to reveal more information about the learning processes during which mobile ICTs are utilised.

5.4 Analysing the Context

It is challenging to explicitly define the higher education context in which the PMLE could act, not least because the concept of context itself is rather ambiguous (Nardi, 1996). A context cannot be defined by enumerating people and artifacts, as the dynamic and transformative relationship between students and artifacts is at the heart of the definition of their context. In practice, university students can be constantly on the move, shifting places and spaces several times a day. For example, student-teachers spend time at schools in which they conduct their practical training, tourism students may be on a hiking trail, law students attend trials at a court house, and art students may be outside taking photographs or painting at an atelier. At the same time, learning takes place in bits and pieces according to location, which may be relevant to the actions taking place in that location, or may just be a space to occupy.

The definition of a context here is not referring merely to a physical location; context is not a container (Luckin, 2010b). Rather, context is viewed as the combination of social interactions in which a student engages across various physical and virtual spaces and times. Learners move between places and spaces, encountering various social groups that await different styles of interaction. During any given day, a university student can encounter learning situations in the home, office and university contexts, and in both virtual and face-to-face situations (Luckin et al., 2011; Sharples et al., 2009). Social networks, no matter how small or large, are all units of learning, as well as contexts for it to occur (Bransford et al., 2006). Through interaction, students can reflect on their own thinking and have the affordance of distance-learning opportunities (Study VI). Sometimes the aim of interacting is simply to organise assignments and the division of work within a group of students; sometimes it is related to guidance; and sometimes it takes the form of CSCL that aims for completion of learning tasks through collaborative knowledge-building and problem-solving (Study IV). In those situations, students use mediators and resources that are relevant to their own learning processes. Therefore, the context can actually be defined as a goal-driven activity (Nardi, 1997). The development of knowledge construction becomes visible in students' ability to merge and collaborate using external tools, such as laptops and WLAN, and to integrate them into whatever activities are happening in the present through mediated interaction (Clark, 2003; Säljö, 2010).

Contexts are historical and transferability is one of their qualities, which means extending previously learned material to new contexts (Eraut, 2009). In the case of mobile ICT initiatives, such as the one at the University of Lapland, learning in, and through, a PMLE can be perceived as producing knowledge and skills that could be utilised outside the context in which they were acknowledged. One obvious set of skills and knowledge that seamlessly transfers from one context and setting to another concerns the use of mobile ICTs in general. In many workplaces, at least basic ICT skills are required, but as working life becomes more mobile, skills to handle mediated communication are also increasingly required. Many businesses also demand knowledge construction capacities, in which ICTs play a significant role (Lehtinen, 2008).

However, transfer cannot be viewed as a one-way street, and I believe this is especially highlighted in higher education settings. Students may have years of experience of learning and working, and thus previously learned material, as well as learning strategies can be transferred to the university context. In addition, as many enrolling students, particularly younger ones, have varying skills in using different types of mobile ICTs and social media applications, these capabilities should be considered when designing teaching and learning at universities.

Achieving possibilities for transfer has been a particular challenge in higher education (Enkenberg, 2001), but it has recently been discovered that using mobile ICTs, such as laptops and WLANs, in learning processes may help with the transfer of information, by allowing students to access contents in multiple formats and highlighting the contexts and uses of information (Koole, 2009). Transferability can also be encouraged by promotion of understanding-oriented learning strategies and by giving students enough time to process information (Ausubel, 1978; Bransford, Brown, & Cocking, 2000).

5.5 Analysing Activity System Dynamics

The final step of activity analysis means assessing how the identified components affect each other (Jonassen & Rohrer-Murphy, 1999). I use this step to make visible the contradictions, which I see as driving the developmental work forwards in an activity system; in this instance a PMLE. When assessing my analysis of the contradictions that arose from individual studies it is critical to keep in mind that the data collection ended in 2009, and some additional data would potentially change the situation. The contradictions I see as being most critical in a PMLE as an activity system are presented in Figure 7, where they are labeled **A** to **H**.

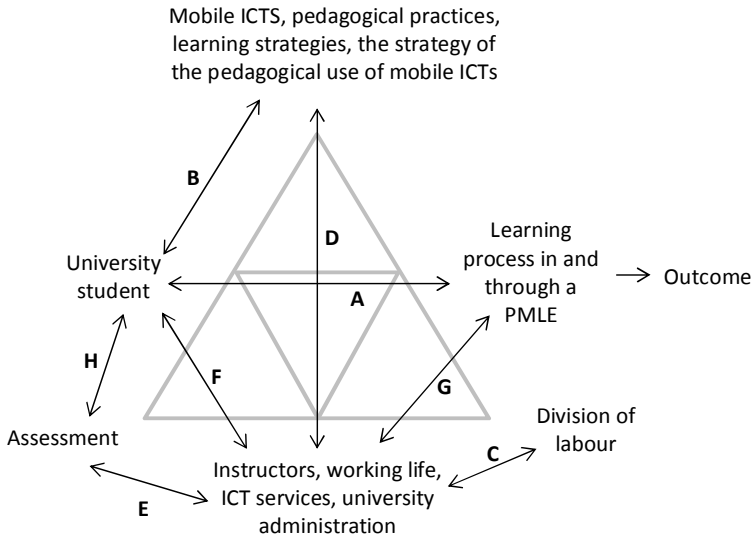

FIGURE 7. Contradictions in PMLEs

Students do not appear to have a coherent idea of a learning process that would implement mobile ICTs in their learning processes in a way that would support the individuality, historical nature, mobility, flexibility and transferability of their studies (**A** Subject—Object). This seems logical because at the moment instructors' pedagogical practices do not necessitate them to learn how to use different kinds of ICT tools and how to meaningfully apply mobile ICTs in learning (**B** Subject—Tools). In the laptop initiative at the University of Lapland, it was not possible for students to choose what kind of laptop they would prefer. This might have hindered their feeling of ownership and, through that, diminished their motivation to search for suitable ways to implement mobile ICTs into their learning processes.

In Studies V and VI in particular, it became apparent that from time to time students seem to have competing roles that they must account for when considering the management of their everyday lives (**F** Subject—Community). Their families, children and employees have expectations that compete with their academic studies. Instead of debating whether students should work during term-time, rather, whether there is some common ground that would benefit both interests could be considered. A recent report (Saari & Kettunen, 2013) of Finnish higher education students' perceptions of their everyday lives and term-time employment reveals that in fact term-time employment can help students to find deeper meaning in their higher education studies if their assignments at work are relevant and inspiring with respect to their studies.

As an academic community, a university should consider whether all relevant participants are included in decision-making processes concerning pedagogi-

cal and technological development in the organisation on the practical level (**C** Community—Division of Labour). The laptop initiative that was the focus of this study was organisationally launched, from top to down. Strategical work must include all participants, as the strategies are meant as roadmaps for practical work. In this study, the students found deficiencies in teaching to be the biggest weakness of using laptops and networks in learning processes at the university (**D** Community—Tools). Neglect of pedagogical development was perceived as the biggest threat. Pedagogical practices and models must be developed in order to keep pace with the development that is occurring elsewhere. Strategies concerning the pedagogical use of mobile ICTs in particular must be updated, and in order to do that, an understanding of what it means to learn must be discussed (**G** Community—Learning process). This also means opening up the question about assessment and the assessment policies at university education (**E** Rules—Community). Is it really necessary to memorise information that can be spelled out during a test and forgotten afterwards? Would it be more beneficial for students to deal with problematic and tricky questions that need collaboration, interaction, information-seeking and combining knowledge from multiple sources in order to be solved? If assessment is focused on the process, how the instructor is able to review learning situations and processes that take place outside the university? Assessment has to bridge time and distance. Instead of considering students as objects of assessment, is there a possibility to include them into assessment practices? (**H** Student—Rules).

5.6 From Theoretical Framework to Pedagogical Practices

My aim has not been to provide a ready-to-use pedagogical tool, but rather to conceptualise PMLEs from students' point of view and consider the types of dynamics that exist in a PMLE as an activity system. The elements of the framework have roots in activity theory and are deliberately practical to enable future conceptual development and practical implementations. The attempt to conceptualise PMLEs can be seen as the first step in a DBR process (Brown, 1992; Barab & Squire, 2004; Design-Based Research Collective, 2003; Wang & Hannafin, 2005). Through implementation and further research, it is possible to refine the concept and develop the activity system of a PMLE in an even more practical direction in order to give guidance and support, a tool, to all involved in teaching and learning with mobile ICTs in higher education.

My understanding of a PMLE can be perceived as covering the five critical factors that Naismith and Corlett (2006) identified as those that should be included in successful mobile learning processes. Firstly, the technology must be available, whether provided by the learner or, as in this study, for the learner. Secondly, there must be institutional support, that is, extensive and well thought-out

support resources, including staff training and device maintenance. Thirdly, there should be a wireless network access available. Fourthly, successful mobile learning must be integrated with the curriculum, the student experience and real life. Finally, the fifth critical factor is ownership. It is important that students own the technology, because it also promotes the ownership of the learning processes.

Making a PMLE, such as that which is presented in this thesis, visible to all stakeholders and functioning in practice is not a simple task. It is a dynamic and challenging process, demanding profound engagement from all parties, not least on the attitudinal level. The challenge is to create structures that support learning in, and through, a PMLE that can promote knowledge creation and maintenance of personal learning history, transfer of knowledge from academic environments to working life (and *vice versa*), the continuum between learning contexts and settings, interactions in various social encounters and flexibility of learning processes.

My application of activity theory focuses on students' activity, the nature of the tools they use in those activities and the social and contextual relationships among the collaborators, as well as the objects and outcomes. As such, the theoretical framework of a PMLE designed here can be deliberated only in the context in which it was designed. It is a descriptive tool, rather than a prescriptive theory, and consideration of the generalisability of these results must be given carefully.

The impact of PMLEs on learning itself has not yet been studied, and some may consider this as a major weakness of this work. However, such criticism should be taken with a grain of salt because PMLEs imply deep integration of mobile ICTs in learning processes, and the impact of technology on learning does not occur in a linear sense (Säljö, 2010). Rather, technology changes the interpretations of what learning is and the expectations of what it means to know something, that is, the conception of the process and the view on outcomes.

From the *process* point of view, students are the focus of PMLEs, but, at the same time, the perspective moves beyond the individual (Studies IV, V and VI). The university teacher's role is aimed more at keeping professional development up-to-date and designing teaching that promotes students' own activity. The learning process cannot be isolated from the activity, culture, context and environment in which it takes place (Vygotsky, 1978). It is a lifelong, lifewide, lifedeep (Banks et al., 2007) and cumulative process, always ongoing, adding to, changing, and shaping what has been learned before. The topics and themes to which a learner is paying attention change with time, space and social interactions, depending on the learner's personal interests, curiosity and commitments (Säljö, 2010). Deep learning is more likely to occur in complex social and technological environments (Sawyer, 2006); a dynamic PMLE can support this kind of learning process.

When it comes to learning *outcomes*, it is no longer enough to concentrate on contents. The learning processes should be oriented towards finding relevant

information that is stable in nature, and turning that information into knowledge by assessing it, adapting it to what was previously known, and sharing it with others (Säljö, 2010). To simplify this, the success of a learning process is tested in every problem-solving situation, complex or simple. The fascination is that every time some questions are left unanswered, opportunities for learning never end.

6 DISCUSSION AND CONCLUSIONS

6.1 Summary of the Results

The main question that I wanted to answer in this research was:

How can personal and mobile learning environments (PMLEs) be conceptualised according to university students?

This aim was pursued by conducting six empirical studies that revealed (1) students' expectations of laptop and WLAN use in learning processes (Study I); (2) the domestication process students went through with their laptops at the beginning of their studies (Study II); (3) students' perceptions of data security in collaborative learning processes on a wireless campus (Study III); (4) the role of laptops in CSCL processes (Study IV); (5) students' experiences of the flexibility and effectiveness afforded by laptops and WLANs in university studies (Study V); and finally, (6) the perceptions of students with families with regard to laptop and WLAN use in learning (Study VI).

The six studies and this introduction were conducted within the framework of two research projects: MobIT and TravEd. The MobIT project grew out of the University of Lapland's laptop initiative, through which all students enrolling between 2004 and 2009 were provided an opportunity to acquire a laptop through the university. The TravEd project did not operate in the higher education context, but nevertheless, the mobility and mobile learning themes that were considered in the project also contributed to the evolution and composition of this thesis.

Together with the results of the individual studies, my thesis tills some fresh ground in the field of research on mobile learning and personal learning environments. I have explored the concepts of domestication and data security, which are rarely examined in the context of a wireless university campus. My thesis also offers insights into the views of non-traditional university students on using mobile laptops and wireless networks in learning. Finally, my work brings an experimental methodological combination of SWOT and AHP to educational research.

For this study, I chose six research articles that, in my opinion, yielded information that could be used in conceptualising PMLEs from the students' perspective using activity theory as an analytical frame (see Chapters 2 and 5). I have combined the results presented in individual articles with relevant research literature on the use of mobile ICTs in teaching and learning, and on the socio-cultural

understanding of learning. Activity theory was not an obvious choice for me to be used as framing the individual studies; I first explored possibilities to form a pedagogical model (Joyce & Weil, 1980) that would reveal the teaching and studying activities in and through PMLEs, and also what kinds of learning results would be possible to achieve through them. During this process I learned that my data sets do not support the formulation of a pedagogical model and therefore I had to explore some other possibilities. Activity theory presented a comprehensive and applicable framework that soon proved to be suitable for my use. My application of activity theory and the resulting description of a PMLE as an activity system include the identification of all engaged stakeholders, with students being the subjects of activities and instructors, university administration, ICT personnel and friends and family, and employers being members of the community. Learning in a PMLE is not a process that is detached from other learning activities, but is one that is individual, historical, interactive and mobile in nature and takes place simultaneously and as a part of students' everyday activities.

The studies comprising this thesis were conducted during a laptop initiative at the University of Lapland, but the knowledge gained and the theoretical framework created could also be applied to the use of mobile technologies in higher education in general. It is not necessary to frame the consideration of the pedagogical use of mobile ICTs around just one type of technological device; one may consider the affordances of different kinds of devices, and combinations thereof in different types of learning situations.

To sum up, personal and mobile learning environments:

1. provide a secure and private environment for learning processes, in which any kind of mobile ICTs can be used (Studies II and III);
2. engage students in their learning processes and promote the structuring of collaborative activities (Study IV);
3. promote the continuous and cumulative intertwining of contexts, times and places, contents, interactions, and experiences in the learning process (Studies II and VI);
4. enable flexibility in learning (Studies V and VI); and
5. respond to students' needs to intertwine studies seamlessly with their personal lives, other commitments and everyday activities (Study VI).

6.2 Methodological Evaluation

As presented in Chapter 3, the six empirical studies reported in the articles applied several methodological approaches. This forced me to consider the factors that might threaten the validity and reliability of the research on several occasions, but the advantages of using a variety of approaches were, in my case,

manifold. They helped me achieve triangulation of methods, sources, investigators and theories to improve the overall validity of the study (Denzin, 1978). Denzin (1978) defined triangulation as using more than one method to view a selected object. I understand that the research methods I chose acted as filters through which the views and perceptions of students were studied; methods are never atheoretical or neutral in representing the world of experience, and multiple methods help achieve a more versatile and complex understanding (Cohen et al., 2011). The flaws of one method are sometimes the strengths of another—this became evident for me, particularly in Study VI, in which the SWOT analysis was accompanied by AHP interviews to confirm and strengthen the interpretations. In addition, in Study II, it is possible that the interviewee selection would not have been conducted as carefully as it was if statistical data had not been used in the selection process.

The triangulation of data also means using multiple data sources or respondent groups (Denzin, 1978). The respondents in my studies were all students at the University of Lapland, but I tried to delineate specific groups within the overall population, in order to present a richer and more complex student viewpoint. In Study II, we looked at respondents according to gender, and also at ICT novices and ICT-experienced students inside the gendered groups. In Studies V and VI, students with families or work commitments were the focus of attention. To develop the concept of a PMLE, future studies should consider the points of view of other stakeholders: instructors, ICT personnel and the administration of the university.

In my opinion, investigator triangulation (Denzin, 1978) is a clear strength in my methodological approaches. More than one researcher has been engaged in different phases of each research process, by participating in its design, data collection, analysis and the writing of the articles. All the researchers who were involved in the six empirical studies had their own observational styles, and this is reflected in the resulting data and analysis.

Theoretical triangulation means exposing research findings born of multiple perspectives and various theoretical points of view (Denzin, 1978). When I started the research process that has led to this point, I had no hypotheses in mind that would have guided me in the conceptualisation of a PMLE. This, I think, was an advantage in the process, as I was able to proceed from one study to another in a somewhat free-floating fashion. During my research, I have viewed findings through various theoretical lenses, for example, I have observed domestication and data security from a more technically oriented perspective (Studies II and III), observed CSCL in a way that offered a view of the collaborative learning process (Study IV), and seen things from the perspectives of students with commitments, such as families and work (Studies V and VI). All these perspectives have offered some contact points that I have been able to use when conceptualising PMLEs from a socio-cultural angle, with activity theory as my analytical frame.

As the group of students who participated in the laptop initiative was such a large one, it was clear from early on that both quantitative and qualitative research approaches should be used. It was thought that a quantitative research approach would provide generalisable and objective information, and qualitative research would offer more in-depth knowledge (Cohen et al., 2011). The strength of the quantitative methods and statistical analysis in my research was that it offered possibilities to gain relevant information from large groups of informants. The information gained through the statistical research approach was used as the basis for the analysis conducted in Studies I and V, and to guide the next steps in the data collection process in Studies II and VI. However, I advise caution in drawing generalisations from the results gained in the statistical analysis (Studies I and V), as the number of responses remained low in both data collections. The amount of data were nevertheless perceived to be adequate for the purposes of answering the research questions in Studies I and V. The statistical data collections and analysis could be replicated in the future in similar settings.

The strength of the qualitative research approaches in my studies was that I was able to work in natural settings at the university and use them as the principal source of socially situated and culturally saturated data. As a researcher working at the university, I was a part of the world being researched, which could be seen as challenging to my ability to dissect issues as objectively as possible; however, I attempted to enhance the validity of my findings by collaborating with other researchers, writing process notes in research diaries and asking for informant feedback, when possible. Informant feedback was also a part of the qualitative interview method (Kvale, 1996) used in Study II.

As a qualitative research approach, GT was a suitable choice for studies II and IV, as it is in its nature to try to identify unfamiliar phenomena (Strauss & Corbin, 1998). In Study II, the concept of domestication was considered in the framework of the laptop initiative carried out at the University of Lapland. In study IV, students' perceptions of the additional pedagogical value of using laptops in CSCL practices were studied. Both of these tasks presented research questions that it was considered best to approach by dividing theoretical knowledge into pieces and building up new theoretical insights. The purpose in neither of these studies was to achieve large, widely generalisable theory, but to highlight certain issues.

DBR was perceived to be a suitable approach for Study III, which aimed to consider the role of data security in learning on a wireless campus. A significant part of the research process was the design of the *Data Security of Wireless Learning Environments* course through iterative cycles of design, implementation and analysis (Barab & Squire, 2004; Brown, 1992; Design-Based Research Collective, 2003; Wang & Hannafin, 2005). During Study III, I assumed a double-role as a researcher and an instructor of the course. This might have limited my view and ability to consider the design process objectively, but, on both the pilot and

regular course implementations, I worked together with a team of instructor-researchers, which helped ensure rigorous interpretations and analysis. During Study III, the course was implemented twice; there was one pilot implementation and one actual course implementation. To obtain a more concise theoretical understanding of the role of data security in learning on a wireless campus, more course iterations and further research into the matter would be needed.

In Study VI, my colleague and I embarked upon a rather exploratory mixed-method research approach (Bryman, 2007; Cohen et al., 2011; Teddlie & Tashakkori, 2009). The first steps of the data collection process had already been carried out in Study V, when students were queried about their experiences of using laptops and wireless networks. Part of the questionnaire sent out to students in Study V involved a SWOT analysis (Balamuralikrishna & Dugger, 1995; Glaister & Falshaw, 1999), designed to reveal the strengths, weaknesses, opportunities, and threats experienced by the students while using laptops and wireless networks in university studies. The SWOT analysis data were used in Study VI. As the SWOT analysis is sometimes perceived as an insufficiently scientific method, we aimed to strengthen the analysis through use of the AHP (Saaty, 1977, 1980). This was, to our knowledge, the first time such an approach was carried out in an educational setting, and it gave us much-needed knowledge about the experiences of students with commitments, such as a family or off-campus employment, in particular. It is becoming more common to carry such commitments along with university studies and, as we found out in Study V, students with children especially benefited from the support laptops and networks afforded in their studies. The viewpoint of these students should thus be considered more closely in the design of learning environments in higher-education settings.

Throughout the process of researching and writing this thesis, the manuscripts of the articles and of this introduction have been read and reviewed by several readers: supervisors, professors and instructors of the doctoral school (*Doctoral Programme for Multidisciplinary Research on Learning Environments* OPMON), anonymous reviewers from journals and conference committees, participants in conferences, fellow PhD students in doctoral courses, and colleagues in the teams in which I have worked. All of these have provided constructive feedback and suggestions for how to improve the quality, validity and reliability of my work.

6.3 Ethical Evaluation

All of the empirical studies were conducted at the University of Lapland. When planning the first data collection in autumn 2004 we considered whether we should apply for official permission from the university administration to conduct the studies on the university campus. We presented our research agenda at the University on several occasions, and discussed it with the personnel of

the university administration, who informed us that no official permission was needed, as none of the topics to be investigated were of such a nature that students' or staff members' health or privacy would be in danger if the ethical codes of conducting an empirical study were to be followed. The University of Lapland does not have an ethics review committee to oversee the research in the university but we followed the directions of Finnish Advisory Board on Research Integrity (TENK),[16] which is responsible for addressing ethical questions relating to research and to the advancement of research ethics in Finland.

However, written permission was needed in order to gain access to, and use, students' contact information that was saved in the student registry. We had to provide a written account of the purposes for which the contact information would be used. The contact information of those students who had chosen not to receive any research-related questionnaires, and had informed the student registry of this, was excluded to protect their privacy.

Before entering the data collection phase in individual empirical studies, informed consent (Cohen et al., 2011; Israel & Hay, 2006; Sieber, 1992) was sought from students (Appendixes A–D). They were informed of the topic of the study, the kind of information that was to be provided, the data collection process and which researchers would have access to the data. They were also informed of their right to be excused from the research at any point in the process. The students were then asked if they would volunteer as informants in the study.

In Study VI in which data were collected by interviewing students, a written agreement was signed by both the responsible researcher and the student (Appendix D). A copy of that agreement was given to students with the contact information of the researcher, whom they could contact in any point if they needed additional information about the study. In Studies I, V and VI, in which the data were collected by means of a questionnaire, an agreement was not signed in paper form, but the accompanied letters (Appendixes A and B) included the following sentence: "We hope that you will answer the questionnaire and that your answer can be considered as a voluntary participation in our research."

The participants were also informed of how the data would be stored. All the data sets presented in this thesis are stored behind locked doors, in paper form or as electronic data. The exact location is known only by the project researchers. To protect the confidentiality, data collection processes and analysis were never discussed in a manner that would have made the participants' identities traceable. On all occasions, students' privacy and anonymity were assured and students' identities cannot be revealed in the analysis. For example, when reporting the analysis of qualitative interviews in Study II, I used aliases to replace the students' real names.

16. Finnish Advisory Board on Research Integrity, http://www.tenk.fi/en

As the majority of the research processes included collaboration, as a team of researchers, students were provided with information relating to the other researchers and how the team would handle the collected data. We have not shared data with anyone outside the research projects, although this may be perceived as acting against the replicability of the studies, which is a key doctrine of science (Stewart, 2011). If data are not shown, is it possible to meaningfully criticise a study? None of the journals in which we have published our papers have required, or made available, a public repository in which electronic data could be uploaded for it to be reviewed or re-analysed.

Five of the six articles reporting the empirical studies that are a part of this thesis have been co-authored. This may raise questions with regard to my independent role in the research process. The authorship and the order of the authors were negotiated during the writing processes of each paper (Stewart, 2011), and it never caused any problems. The consideration of my independent part in individual studies is presented in Chapter 1.

As a member of a research team, I also had responsibilities to the research community (Cohen et al., 2011), such as maintaining the reputation of the Centre for Media Pedagogy as a research unit and the University of Lapland as a credible higher education institution. Working as a novice researcher, I have negotiated all steps of the research processes with all involved researchers. I have sought supervision from senior researchers in my own university, as well as the distinguished professors at OPMON. I have always welcomed and seriously addressed the suggestions for corrections to my work.

Universities have faced a change in the structure of their finance in Finland, and much effort has been given to applying for financing from external sources. The majority of research conducted in universities is now financed through projects with public or private funds. The two projects presented in Chapter 1, MobIT and TravEd, have given me the opportunity to work as a researcher full-time and to proceed with my PhD studies, alongside my work. MobIT was financed by the Ministry of Education, TravEd was funded by TEKES (the Finnish Funding Agency for Technology and Innovation), municipalities and private tourism companies. In addition to these, I have also received funding from OPMON on several occasions. OPMON itself is funded by the Academy of Finland. However, none of these sponsors attempted to govern the purposes of the research, the ways in which individual studies should be conducted or what kinds of results should or should not be published (Cohen et al., 2011). None of the sponsors conveyed a will to remain confidential and the names of the sponsors have been published in each of the research articles.

6.4 Implications and Future Studies

This thesis has a number of implications for higher education. The most important contribution to scientific knowledge offered here is the conceptualisation of a PMLE, in which all related agents and their roles and responsibilities are identified and discussed. It is also critical that the view of PMLEs as a conceptual tool is strengthened, and the understanding is moved away from device- or system-oriented perception of PMLEs. My thesis also broadens the understanding of the use of mobile ICTs in higher education by considering domestication and data security issues and concepts in educational settings.

After studying the concept more closely and from various points of view, in future research endeavors, conceptual understanding of a PMLE can serve as a strategic tool that can be used when developing strategies for ICTs' pedagogical use and when designing possible future ICT initiatives. The developmental work requires not only technologies and facilities, but, most importantly, interest and motivation on the part of educators and decision-makers. It would seem irrational to invest massive resources in ICT initiatives that are left unsupervised and unevaluated, basically leaving the end-users, instructors and students, to figure the best practices out by themselves if they have any time for developmental work. This research process has strengthened my conviction that universities should not assume that they are enrolling students as "digital natives" who do not need training in how to use mobile ICTs in learning; universities should offer training that should both complement students' current knowledge, and take them in new directions.

For instructors, this research offers insights into students' perceptions of using mobile ICTs in learning. As a university instructor, I would take it rather seriously if students reported 'deficiencies in teaching' as a major weakness when using laptops and a WLAN in their learning process (Study VI). The knowledge gained through this thesis could be used by instructors designing courses at the university and seeking to implement mobile ICTs in teaching practices. University instructors can also use this knowledge to assess their own ICT skills and the capacities of mediated interaction made possible by a variety of mobile tools available today. It is critical to keep individual professional development updated, in terms of both content and pedagogy.

It was my intention to place the students of the University of Lapland at the core of all research activities during my research process. I can only hope that students can see the possibilities mobile ICTs afford for their learning and that they will start considering the best ways to use mobile ICTs in their everyday lives, of which higher education studies are a part.

For researchers, concepts are tools and the concept of a PMLE is now one of them. My activity theory based conceptualisation offers a multitude of research tasks to pursue in future. As I have considered the conceptualisation of a PMLE

on the basis of studies focusing on students' perspectives, a logical next step would be to study the concept from the viewpoint of other members of the community. In addition, the learning process could and should be studied in a more profound way. It is likely that future studies will be capable of identifying further qualities that define learning and describe learning processes in, and through, a PMLE. Further studies would inevitably assist in developing the concept into a practically oriented pedagogical model that could be used to guide operations within a university on several levels. Another very interesting research theme would be focusing more deeply on students' life management strategies.

There is currently an ongoing social debate in Finland with regard to how to prolong careers, how to shorten students' study times, especially at the post-secondary level, and how to better develop higher education to meet the needs of a rapidly evolving working life. My thesis participates in these debates by offering insights into university students' perception, and into how mobile ICTs could be harnessed in their everyday lives and their learning processes, in ways that are not limited to university campuses and that do not end upon graduation.

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APPENDIXES

Appendix A: An informed consent sent to participants in Study I

MobIT project 27.8.2004

Dear new student,

We invite you to participate in a study of the MobIT research project that assesses the implementation of laptop computers and wireless networks at the University of Lapland. MobIt is a multidisciplinary research project that studies teaching and learning, as well as the implementation of laptops and WLAN from a mobile learning point of view. The researchers represent the Faculty of Education and the Department of Research Methodologies at the University of Lapland.

The aim of MobIT research is to produce knowledge regarding the implementation of laptops and WLAN, and their use as a part of university teaching and studying. The practical aim is to improve the prerequisites of mobile teaching and studying at the University of Lapland and also to act as an information channel to the wider public. To succeed in the research we need your answer to the enclosed survey.

The data collected using this survey are entirely confidential. The data will be handled only by the researchers of MobIt project, who act under researchers' ethics and the demand of ethically sustainable research presented in the University of Lapland's strategy. Those individuals who have answered this survey will be numbered for identification, so that their names, or other personal information, do not have to be included in the data during future analysis procedures. The names will not be mentioned at any time.

We hope that you will answer the questionnaire and that your answer can be considered as a voluntary participation in our research.

Welcome and thank you.

Hannakaisa Isomäki
Professor
Applied Information Technology

Heli Ruokamo
Professor
Education, specialty Media Education

MobIT-projekti 27.8.2004

Arvoisa uusi opiskelija,

Kutsumme sinut osallistumaan kannettavien tietokoneiden ja tietoverkkojen käyttöönottoa Lapin yliopistossa selvittävään MobIT-projektin tutkimukseen. MobIT on monitieteinen opetuksen ja opiskelun sekä kannettavien tietokoneiden ja tietoverkkojen käyttöönottoa mobiilin opiskelun näkökulmasta lähestyvä tutkimusprojekti. Tutkijat edustavat Lapin yliopiston Kasvatustieteiden tiedekuntaa ja Menetelmätieteiden laitosta.

MobIT-tutkimuksen tavoitteena on tuottaa tietoa kannettavien tietokoneiden ja tietoverkkojen käyttöönotosta ja käytöstä osana yliopisto-opetusta ja -opiskelua. Käytännöllisenä tavoitteena on parantaa oppimisen ja mobiilin opetuksen ja opiskelun edellytyksiä Lapin yliopistossa ja toimia tiedonvälityksen kanavana suuremmalle yleisölle. Tutkimuksen onnistumiseksi tarvitsemme vastauksesi oheiseen kyselyyn.

Kyselyn avulla kerätty aineisto on täysin luottamuksellista. Aineistoa käsittelevät vain MobIT-projektin tutkijat, joita sitoo tutkijan ammattietiikka ja Lapin yliopiston strategiassa mainittu vaatimus eettisesti kestävästä tutkimuksesta. Kyselyyn vastanneiden tunnistamista varten jokaiselle vastanneelle annetaan yksilöivä numerotunnus, jolloin heidän nimiään tai muita henkilötietoja ei tarvitse liittää aineistoon sen myöhemmissä käsittelyvaiheissa eikä nimiä tulla mainitsemaan missään tilanteessa.

Toivomme, että vastaat kyselyyn ja että vastaustasi voidaan pitää vapaaehtoisena suostumuksena osallistua tutkimukseen.

Tervetulotoivotuksin ja kiitoksin,

Hannakaisa Isomäki
professori
soveltava informaatioteknologia

Heli Ruokamo
professori
kasvatustiede, erityisesti mediakasvatus

Appendix B: An informed consent sent to participants in Study V

Dear student of University of Lapland,

We invite you to participate in a study of the MobIT research project that assesses the implementation of laptop computers and wireless networks at the University of Lapland. MobIT is a project funded by the Ministry of Education for 2007–2009; the aim of which is to develop the use of laptop computers and networks in mobile network-based teaching, studying and learning. The project is conducted at the Centre for Media Pedagogy at the Faculty of Education.

It takes about 25 minutes to answer this questionnaire. Every answer is very important. Responses help the researchers to ascertain the current use of laptops and networks and to further develop mobile network-based teaching and learning.

We hope that you respond to this survey and that your answer can be considered as a voluntary participation in the study. One iPod Shuffle mp3-player and three Kingston 4GB datasticks will be raffled among all those who have answered. The raffle will take place on Monday, 5.5.2008.

The data collected using this survey are entirely confidential. The data will be handled only by the researchers of MobIt project, who act under researchers' ethics and the demand of ethically sustainable research presented in the University of Lapland's strategy. Those individuals who have answered this survey will be numbered for identification, so that their names, or other personal information, do not have to be included in the data during future analysis procedures. The names will not be mentioned at any time.

Questions concerning this study can be addressed to Professor Heli Ruokamo, tel. 040 587 9090. You can also find information about the project at http://www.ulapland.fi/mobit

With kind regards and thanks.

Heli Ruokamo
Professor
Education, especially Media Education
Director of the MobIt project

Hanna Vuojärvi
Project Manager

Miikka Eriksson
Researcher

MobIT-projekti
Mobiiliverkko-opetuksen, -opiskelun ja oppimisen prosessien kehittäminen

Hyvä Lapin yliopiston opiskelija,

Kutsumme sinut osallistumaan kannettavien tietokoneiden ja tietoverkkojen käyttöä Lapin yliopistossa selvittävään MobIT-projektin tutkimukseen. MobIT on opetusministeriön vuosina 2007–09 rahoittama hanke, jonka tavoitteena on kehittää kannettavien tietokoneiden ja tietoverkkojen käyttöä mobiiliverkko-opetuksessa, -opiskelussa ja oppimisessa. Projekti toteutetaan Kasvatustieteiden tiedekunnan Mediapedagogiikkakeskuksessa.

Kyselyyn vastaamiseen kuluu aikaa noin 25 minuuttia. Jokainen vastaus on ensiarvoisen tärkeä. Vastaukset auttavat tutkijoita selvittämään kannettavien tietokoneiden ja tietoverkkojen tämänhetkistä käyttöä ja edelleen kehittämään mobiiliverkko-opetusta ja -opiskelua.

Toivomme, että vastaat kyselyyn ja että vastaustasi voidaan pitää vapaaehtoisena suostumuksena osallistua tutkimukseen. Kaikkien vastanneiden kesken arvotaan yksi iPod Shuffle mp3-soitin ja kolme Kingston 4 GB:n muistitikkua. Arvontapäivä on maanantai 5.5.2008.

Kyselyn avulla kerätty aineisto on täysin luottamuksellista. Aineistoa käsittelevät vain MobIT-projektin tutkijat, joita sitoo tutkijan ammattietiikka ja Lapin yliopiston strategiassa mainittu vaatimus eettisesti kestävästä tutkimuksesta. Kyselyyn vastanneiden tunnistamista varten jokaiselle vastanneelle annetaan yksilöivä numerotunnus, jolloin henkilötietoja ei tarvitse liittää aineistoon sen myöhemmissä käsittelyvaiheissa eikä niitä tulla mainitsemaan missään tilanteessa. Tutkimuksen tuloksia julkaistaan kansainvälisissä tieteellisissä konferensseissa ja aikakauslehdissä.

Tutkimusta koskeviin kysymyksiin vastaa Professori Heli Ruokamo, puh. 040 587 9090. Lisätietoja projektista löytyy myös osoitteesta http://www.ulapland.fi/mobit

Ystävällisin terveisin ja kiitoksin,

Heli Ruokamo
Professori
kasvatustiede, erityisesti mediakasvatus
MobIT-projektin johtaja

Hanna Vuojärvi
Projektipäällikkö

Miikka Eriksson
Tutkija

Appendix C: Covering letter sent to participants in Study VI

From: Vuojärvi Hanna
Sent: February 18. 2009 14:24
Recipient: Vuojärvi Hanna
Topic: Haastattelupyyntö

Hi!

Last spring you participated in a survey concerning the use of laptop computers in learning. The survey was organised by the MobIT project. We are now continuing our studies, based on that survey, and I am asking if you would volunteer to be interviewed.

The theme of the interview is how to combine studies with family-life. Students with families have stood out as a special group in previous data, with special expectations and experiences. That is why we want to increase our knowledge, with regard to combining studies with family-life. Through this research it is possible to elicit information about the special needs of students with families, problems in their learning processes and possibly approved learning strategies. Interviews are confidential and guided by the codes of research ethics.

The interview would take about 1–1.5 hours of your time; we can schedule the appointment according to your calendar. We would meet at the University, but other places are also possible if you prefer.

With kind regards,

Hanna Vuojärvi

***

Hanna Vuojärvi
Project Manager
MobIT project
University of Lapland
Faculty of Education
Centre for Media Pedagogy (CMP)
P.O. Box 122, FI-96101 Rovaniemi
Finland
tel. +358 16 341 2496
gsm. +358 40 534 2864
fax. +358 16 341 2401
Hanna.Vuojarvi@ulapland.fi

Lähettäjä: Vuojärvi Hanna
Lähetetty: 18. helmikuuta 2009 14:24
Vastaanottaja: Vuojärvi Hanna
Aihe: Haastattelupyyntö

Hei!

Vastasit viime keväänä MobIT-projektin toteuttamaan kannettavien tietokoneiden opiskelukäyttöä koskevaan tutkimuskyselyyn. Olemme jatkamassa tutkimusta tuon kyselyn pohjalta ja tiedustelenkin nyt, suostuisitko haastateltavaksi.

Haastattelun teemana on perhe-elämän ja opiskelun yhteensovittaminen. Perheelliset opiskelijat ovat erottuneet aikaisemmissa aineistoissa omana ryhmänään erityisine odotuksineen ja kokemuksineen. Tämän vuoksi haluamme syventää tietoa opiskelun ja perhe-elämän yhteensovittamisesta. Tutkimuksen kautta on mahdollisuus tuoda esille perheellisen opiskelijan erityistarpeet, opiskelun ongelmakohdat ja mahdollisesti myös hyväksi havaitut opiskelustrategiat. Haastattelu tehdään luottamuksellisesti ja tutkimuseettisiä ohjeita noudattaen.

Aikaa haastattelussa menisi noin 1-1,5 tuntia, tarkemman ajankohdan voimme sopia sen mukaan, miten kalenterissasi on tilaa. Haastattelu tehtäisiin yliopistolla, toki muukin paikka on mahdollinen niin halutessasi.

Ystävällisin terveisin,

Hanna Vuojärvi

***

Hanna Vuojärvi
Project Manager
MobIT project
University of Lapland
Faculty of Education
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P.O. Box 122, FI-96101 Rovaniemi
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fax. +358 16 341 2401
Hanna.Vuojarvi@ulapland.fi

Appendix D: A written agreement of an interview in Study VI

Interviewer: Project Manager Hanna Vuojärvi, Faculty of Education / CMP
Interviewee:

Date:

This interview collects data regarding the combination of studies with family-life for research conducted in the MobIT project. The data will be analysed only by the researchers involved in that project. The study is financed by the Ministry of Education.

The names of the interviewees will not be presented in reporting the research results. The data will be kept and handled, and the analysis reported, in such a manner that identifying a single interviewee is impossible.

The interviewee participates in this research voluntarily. She or he as a right to receive information about the study and, if willing to do so, to see the transcriptions of the interviews. The interviewee can withdraw from the study at any point and forbid the use of some or all of the collected data.

The research results will be reported in national and international media, such as scientific journals, conference presentations and books or articles.

The contact information of the interviewer:

Hanna Vuojärvi
Unviersity of Lapland/ Faculty of Education
Centre for Media Pedagogy
Hanna.Vuojarvi@ulapland.fi
040 534 2864

Rovaniemi 2009

_____ _____

Hanna Vuojärvi

Haastattelija: Projektipäällikkö Hanna Vuojärvi, Kasvatustieteiden tiedekunta / MPK
Haastateltava:

Päivämäärä:

Haastattelussa kerätään tietoa opiskelun ja perhe-elämän yhdistämisestä MobIT-projektissa tehtävää tutkimusta varten. Aineistoa käsittelevät vain projektin tutkijat. Tutkimusta rahoittaa Opetusministeriö.

Haastateltavien nimiä ei käytetä tutkimustulosten raportoinnissa. Aineistoa säilytetään, käsitellään ja sen analyysiä raportoidaan siten, että yksittäisen tutkimushenkilön tunnistaminen on mahdotonta.

Haastateltava osallistuu tutkimukseen vapaaehtoisesti. Hänellä on oikeus saada tietoa tutkimuksesta ja niin halutessaan nähdä haastattelusta tehdyt litteroinnit. Haastateltava voi missä tahansa vaiheessa vetäytyä tutkimuksesta ja omalta osaltaan kieltää kerätyn aineiston käyttö tutkimustarkoituksiin joko osittain tai kokonaan.

Tutkimustuloksia raportoidaan sekä kansallisissa että kansainvälisissä medioissa, kuten esimerkiksi tieteellisissä aikakauslehdissä, konferenssiesityksissä, kirjoissa tai lehtiartikkeleissa.

Haastattelijan yhteystiedot:

Hanna Vuojärvi
Lapin yliopisto / KTK
Mediapedagogiikkakeskus
Hanna.Vuojarvi@ulapland.fi
040 534 2864

Rovaniemellä 2009

_____ _____

Hanna Vuojärvi

ORIGINAL PUBLICATIONS

Study I

Räisänen, H. (2007). Students' expectations of data security, mobility and computer-supported collaborative learning on a wireless campus. In H. Ruokamo, M. Kangas, M. Lehtonen & K. Kumpulainen (Eds.), *Proceedings of the 2nd International NBE 2007 conference* (pp. 217–226). Rovaniemi: Lapland University Press.

Students' Expectations of Data Security, Mobility and Computer-Supported Collaborative Learning on a Wireless Campus

Hanna Räisänen
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Recent developments in mobile technology have initiated new practices in teaching, studying and learning (TSL) processes. This article presents students' expectations concerning data security, mobility and computer-supported collaborative learning (CSCL) on a wireless campus at the University of Lapland, Finland, where incoming students since fall 2004 have been given the opportunity to acquire a laptop computer through the University. A wireless local area network (WLAN) has also been launched on campus. In addition to students' expectations the correlation of features of students' background information with their expectations are examined. Before the laptop computers and wireless network were introduced, data was collected by means of a questionnaire, in which students' background information, expectations were queried. There were also open questions concerning students' expectations of using laptop computers and WLAN in teaching, studying and learning as well as the strengths, weaknesses, opportunities and threats (SWOT) they anticipated the laptops and WLAN to have. The questionnaire was aimed at the 628 students who started their studies at the University of Lapland in fall 2004. Responses were obtained from 197 students and they were analyzed quantitatively, written answers were analyzed qualitatively. Results show that students expect studying and learning on a wireless campus to be mobile and data secured. Students also expect to be able to take part in computer-supported collaborative learning. The main influencing factors behind the expectations seem to be students' positive images of using computers, software and the Internet, previously gained basic computer skills and their age.

Keywords: mobility, computer-supported collaborative learning (CSCL), data security, laptop computers, students' expectations

1 Introduction

In recent years, the use of mobile technology in education has been increasing intensely since mobile devices, such as multimedia cell phones, iPods, personal digital assistants (PDAs), tablet PCs and laptop computers, have become more affordable and easier to move around. The term mobile learning has also emerged; it refers to studying and learning which is supported by mobile technology. Students are not necessarily bound to a classroom in order to take part in different courses, but studying activities can take place almost wherever a student happens to be at that moment. Materials, teachers, tutors, other students and learning environments can be reached from any place where a network connection is available.

Using mobile technology is often expected to have certain advantages in educational settings. These expectations are supported by positive research findings showing that mobile technology may, for example, enable continuity between learning contexts, adaptability and accessibility, time and learning management, and also flexible interaction (Hoppe, Joiner, Milrad, & Sharples 2003). Lately, however, it has been acknowledged that technology alone does not do the trick; introducing technology in education needs careful planning and a clear view of the purpose for using technology (Goldberg, & Riemer 2006). Recent research findings indicate that in addition to advantages, mobile technology may also diminish the fluency of studying (Waycott, & Kukulska-Hulme 2003). Moving and carrying around laptop computers, for example, can make them more fragile and the battery duration and the capacity and security of the wireless network may not yet meet utilization requirements (Isomäki, Päykkönen, & Räisänen [in press]).

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While challenges are acknowledged, whole wireless campuses have been and are being developed to support students using their mobile devices and to enhance information and communication technologies' (ICTs) pedagogical use. This paper describes a wireless campus initiative taking place at the University of Lapland, Finland, where incoming students have been given the opportunity to acquire a laptop computer through the University since autumn term 2004. Additionally, at the end of 2004 a wireless local area network (WLAN) was launched on campus.

The goal of this article is to describe students' expectations of data security, mobility and computer-supported collaborative learning (CSCL) on a wireless campus. It also examines what kinds of correlations exist between students' expectations and students' background information (cf. Räisänen 2005). This paper is a part of a case study called 'The utilization of laptop computers and wireless local area network'. The case study is a part of the MobIT (Developing Mobile Network-based Teaching, Studying and Learning Processes) research project. The project is funded by the Ministry of Education and altogether it comprises three case studies in which the use of mobile technology, such as laptops and a wireless network, in teaching, studying and learning is studied (Räisänen, Lehtonen, Ruokamo, & Isomäki 2005).

Following, the theoretical background and research questions are introduced. After that, the methods of research, data collection and analysis are presented. Finally, the research findings are presented and discussed.

2 Theoretical Background and Research Questions

Previous research on laptop initiatives report positive outcomes (Varvel, & Thurston 2002). Accordingly, distributing laptop computers to each incoming full-time student may help diminishing the digital divide between genders and generating positive attitudes about the state of technological readiness. Students find laptops to be beneficial during their studies (Finn, & Inman 2004). Laptop computers made a significant difference in students' study habits and to their academic and social lives. Students found the laptops helped with classroom assignments, interaction and research (Demb, Erickson, & Hawkins-Wilding 2004; Nicol, & McLeod 2005).

Positive experiences build up positive expectations, but it also needs to be noticed that students are already quite computer savvy when they commence their studies since they are used to using, for example, mobile phones and multimedia players. Students have some kinds of perceptions of mobile technology and are thus able to lay expectations on using it in education. Research about students' expectations of laptop initiatives in particular show that men expect laptop computers to help them with finding information and with individual tasks. Women expect to achieve high quality learning through interactive collaboration (Saunders, & Quirke 2001).

In this case, students' expectations of mobility, data security and CSCL are studied. Studying and learning are thus seen as taking place in CSCL communities, which means that students are members of a studying and learning community that uses mobile ICTs i.e. laptop computers and WLAN, as mediating tools for social interactions and collaborative methods within studying (Kirschner, Martens, & Strijbos 2004; Stahl, Koschmann, & Suthers 2006). Mobility, perceived here as movability of devices (Luff, & Heath 1998) enables studying and learning also in situations when all members of a studying community are not in the same place, not even in the same country. Studying and learning are used here separately to accent students' active role in the teaching-studying-learning (TSL) processes. Teaching does not directly lead to learning, but needs students' own activity before learning can be attained (Uljens 1997; Kansanen, Tirri, Meri, Krokfors, Husu, & Jyrhämä 2000).

The key to successful learning in CSCL is to support maintaining dialogical culture and convergent goals by means of technology. This is why one particular feature of mobile ICTs – data security – is taken as one discussion topic. Developing collaborative network-based TSL environments should raise questions about security issues, even though it has been missing from CSCL research. Only quite recently has there been research of security solutions in mobile learning (Kambourakis, Kontoni, Rouskas, & Gritzalis 2007) and of user experience of security in mobile collaborative learning (Isomäki, & Räisänen [paper in progress]). Data security is perceived here as an experienced feature of mobile network-based studying and learning environments that enables secure collaborative studying and learning practices and promotes students' sense of community, which is essential for collaborative learning (Allan, & Lewis 2006; Dourish, Grinter, Delgado de la Flor, & Joseph 2004).

The research questions of this study are:

1) What kinds of expectations do students have concerning data security, mobility and computer-supported collaborative learning on a wireless campus?
2) Which features of students' background information correlate with their expectations?

3 Research and Data Collection Methods

The data was collected by sending a questionnaire to all 682 students who started their studies at the University of Lapland in fall 2004, before the laptops and WLAN were introduced. It was considered to be important to chart students' expectations before they began using the devices because getting and using the laptop could change their expectations. (Räisänen et.al. 2005.) However it has to be noted here that the laptop initiative was widely reported in newspapers and education related exhibitions, which most likely has had some effect on expectations. Before the questionnaire was delivered to students it was tested, and overlapping questions were removed and the questionnaire was shortened.

The questionnaire was accompanied by letter, in which the research topic was introduced and students were asked for informed consent (cf. Sieber 1992). In the questionnaire, students were asked about background information, previous experiences and expectations regarding the use of computers and networks in studying and learning, and how they reconciled the demands of studying and family life. There were also two open questions about students' expectations of teaching, studying and learning with laptop computers and WLAN and also two questions about the possible strengths and opportunities, weaknesses, and threats (SWOT) that students expected the laptops and WLAN to have. Statistical replies were saved by using SPSS for Windows software and analyzed statistically. Open ended questions were read and categorized; the answers are used here along the statistical data to support and to give depth to statistical analysis.

A total of 197 students returned questionnaires, which is 29% of the whole population. The amount of answers is small, which must be taken into consideration when discussing the results, but on some parts it can be considered to be reasonably representative of the overall population. There are both men (22%) and women (78%) among the respondents from all the five faculties of the University of Lapland. The distribution between women and men is the same in the whole student population who started their studies at the University in fall 2004. The mean age of the respondents is 24 years. The youngest respondent is 19 years and the oldest 58 years old. The size of the response rate can be affected by the fact that the questionnaire was rather long even though it was shortened before it was delivered to students. It was handed out to students at the student orientation arranged by the faculties, this may well have influenced the response rate because it is a time when students are typically inundated with information and the schedule during those first days of the autumn term is quite hectic, so there was not a lot of time to answer the questions. It would have been possible to try to increase the response rate by repeating the inquiry, but that might have twisted the results because the laptop computers were delivered to students from the first week on.

4 Results

4.1 Students' expectations

The first research question was: What kinds of expectations do students have concerning data security, mobility and computer-supported collaborative learning on a wireless campus?

Firstly, four items describing students' expectations of data security were selected from the questionnaire and transformed into sum variable through reliability test. These four items are 1) "Using a laptop and networks is confidential (data security)", 2) "It is possible to use a laptop and networks to search for and save information from networks privately", 3) "When using a laptop and networks I can store my files in a way that others don't have access on them" and 4) "When using a laptop and networks virus protection and firewall software protect my information". Cronbachs' alpha of the sum variable is 0.80 (α=0.80), which indicates that the variable is reliable and can be used as descriptive of students' expectations of data security.

Secondly, five items describing students' expectations of mobility were selected and transformed into sum variable. These five items are 1) "By using a laptop and networks studying becomes more independent of time and place", 2) "Using a laptop and networks changes the time management of studying", 3) "Using a laptop and networks makes studying flexible", 4) "Using a laptop and networks changes time management and the amount of spare time" and 5) "With the help of a laptop and networks it is possible to study in more versatile locations than before". Cronbachs' alpha of the sum variable is 0.75 (α=0.75), which indicates reliability that enables further analysis.

Finally, five items describing students' expectations of CSCL were selected and transformed into sum variable. These items are 1) "With the help of laptops and networks it is possible to do group assignments with other students in the same classroom", 2) "With the help of laptops and networks it is possible to do group assignments via email or in a network-based learning environment", 3) "With the help of laptops and networks it is possible to work on the same document on a synchronous distance connection", 4) "With the help of a laptop and networks it is possible to publish and forward

information to others" and 5) "With the help of a laptop and networks it is possible to work on ideas with other students". Cronbachs alpha of the sum variable is 0.85 (α=0.85), which shows that variable can be reliably used as descriptive of students' expectations of computer-supported collaborative learning.

The frequencies of students' expectations of data security, mobility and CSCL are presented in Table 1.

Table 1. Students' expectations of data security, mobility and CSCL

Expectations / Likert scale	Data Security	Mobility	Computer Supported Collaborative Learning
1 (Not at all)	1%	0.5%	0.5%
2 (A little)	3.6%	12.5%	16.2%
3 (Some)	16.7%	40.8%	45.0%
4 (Quite a lot)	49.0%	40.8%	29.3%
5 (A lot)	29.7%	5.4%	8.9%

Almost half of the students, 49% expect quite a lot that studying and learning on a wireless campus is data secure. However, data security was not mentioned in open answers about expectations of teaching, studying and learning. It might be that data security is perceived as a ubiquitous part of studying and learning on a wireless campus since data security issues were the most mentioned threat or weakness in the SWOT analysis, which means that data security is not insignificant.

> *Laptop may be stolen or someone might hack into my laptop or misuse my information.* (Student 157)

Of the respondents, 40.8% expect some or quite a lot to be able to be mobile when studying. High expectations regarding mobility can also be seen in written answers concerning expectations of teaching, studying and learning and also in the 'strengths and opportunities' section of the SWOT analysis. Students' embrace the fact that they have the opportunity to study more personally and flexibly regarding time and place and combine studying with work and family-life more effectively. Students also envision their laptops to become a seamless part of their studying and learning.

> *In practice studying becomes easier and the laptop proceeds my studies remarkably (I have a family, children are 4 and 6 years old, no computer at home). I can study at the time it suits me the best (towards midnight).* (Student 108)

> *I believe that the laptop will become a part of me.* (Student 071)

On the other hand, some students realized also the responsibility that increased freedom brings about, which can be seen in some answers in the 'weaknesses and threats' section of the SWOT analysis. It also noted that when "the University comes home with you" it is more difficult to relax and separate studying from free time.

> *The illusion that studying can take place whenever brings about the danger that studying doesn't happen at all since one can imagine being able to postpone the work forever...* (Student 073)

> *Studying is always with you. One might not be able to relax as should.* (Student 183)

Of the respondents, 45% have some expectations concerning CSCL. This quite neutral standing could also be seen in open answers and in SWOT analysis. The ability to receive materials and information through the laptop and WLAN was perceived positively and also the ability to interact in a more flexible manner with teachers and other students. However, studying and learning in computer-supported communities was not perceived totally positive, some students also mentioned fearing that studying and learning through networks might hinder social interaction and communality.

> *The WLAN opens doors to a wider community.* (Student 119)

It is possible to have studying material in electronic form […] interactions become more effective and assessment accelerates. (Student 070)

It is possible to recede from other students and have lesser contacts with other people. (Student 142)

4.2 Features of students' background that correlate with their expectations

The second research question was: Which features of students' background information correlate with their expectations? In the questionnaire, students were asked for some background information about their age, gender, faculty, previous experience of desktops, laptops and different kinds of software and also previous experience of network-based studying and learning. Students were also asked if they work in parallel with their studies, about their marital status and if they had children or not. In addition to these variables there were also several items concerning students' skills in using different kinds of hardware, software and networks. According to Osika and Sharp (2003) students should have skills to be able to use computer operations and utilities, file management, word processing, the Internet, presentation graphics, spreadsheet and databases.

When reviewing the correlation ratios that describe the connections between the expectations and background information, there are three factors of students' background information that have an effect on their expectations: 1) positive images of using computers, software and the Internet, 2) age and 3) previously gained basic computer skills. When comparing these results to the study of Saunders and Quirke (2001), there was a difference in that gender did not play an influencing role in students' expectations. One might have hypothesized that the faculty where students begin their studies could have had an impact on their expectations, but according to these results this was not the case.

In the questionnaire, there were eight items concerning students' feelings towards using computers, software and the Internet: 1) "Computers and software are easy to use", 2) "I like using computers", 3) "I like using the Internet", 4) "Using a laptop computer and networks is easy", 5) "Using a laptop and networks brings me joy", 6) "Using a laptop and networks makes studying more interesting", 7) "Using a laptop and networks makes me satisfied" and 8) "Using a laptop and networks in studying motivates me". These items were transformed through reliability test into a sum variable describing students' general positive images of using computers, software and the Internet. Cronbach's alpha of the sum variable is 0.83 (α=0.83).

There were five items describing students' basic computer skills in the questionnaire: 1) "I have used word processor software", 2) "I have used presentation graphics software", 3) "I have used spread sheet software", 4) "I have used an Internet browser" and 5) "I have searched information on databases". These items were transformed through reliability test into a sum variable describing students' previously gained computer skills; Cronbach's alpha being 0.73 (α=0.73).

As mentioned earlier, the mean age of the respondents is 24 years. The frequencies of the other two features effecting background are presented in Table 2 below.

Table 2. Frequencies of students' previously gained basic computer skills and positive images of using computers, software and the Internet

Background information / Likert scale	Previously gained basic computer skills	Positive images of using computers, software and the Internet
1 (Not at all)	0.0%	0.5%
2 (A little)	13.1%	4.1%
3 (Some)	41.4%	22.2%
4 (Quite a lot)	38.2%	57.7%
5 (A lot)	7.3%	15.5%

Less than a half, 41.4%, of the students have some basic skills that are needed when using typical office software or common network services. This result confirms the results presented by Osika and Sharp (2003). They state that although students are introduced to technology at an early age, they still do not necessarily have all of the skills required to be successful with network-based education. Here it needs to be noted that particularly older students have not necessarily had lots of experiences with computers and networks, which may influence these results even though ICTs are commonly used also in working life. But even though the level of respondents' skills is not very high, 57.7% of them have quite a lot positive images of using computers, software and the Internet.

The results of the analysis describing which features of students' background information correlate with their expectations are presented in Table 3 below.

Table 3. Correlations with students' background information and their expectations

		Expectations of data security	Expectations of mobility	Expectations of CSCL
Positive images	Pearson Correlation	,465(**)	,461(**)	,394(**)
	Sig. (2-tailed)	,000	,000	,000
Previously gained basic computer skills	Pearson Correlation	,307(**)	,103	,346(**)
	Sig. (2-tailed)	,000	,180	,000
Age	Pearson Correlation	,157(*)	,205(**)	,191(*)
	Sig. (2-tailed)	,040	,007	,013

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

According to this study, expectations of data security may be explained by positive images (*r=0.465, p=0.01*), previously gained basic computer skills (*r=0.307, p=0.01*) and age (*r=0.157, p=0.05*). Positive images have a moderate, positive and statistically significant correlation with expectations of data security. Previously gained basic computer skills have a weak, positive and statistically significant correlation with expectations of data security. Age has a weak, positive and statistically almost significant correlation with expectations of data security. Having positive images and previous basic computer skills seems to increase the expectations of the data security of studying and learning on a wireless campus. Also, the older the students are, the more they expect data security.

Expectations of mobility may be explained by the students' positive images of using computers, software and the Internet (*r=0.461, p=0.01*) and by the students' age (*r=0.205, p=0.01*). It can be said that both these background features have a weak, positive and statistically significant correlation with expectations of mobility. The more positive images the students have or the older they are, the more they expect studying and learning on a wireless campus to be mobile.

Expectations of computer-supported collaborative learning may be explained by positive images (*r=0.394, p=0.01*), previously gained basic computer skills (*r=0.346, p=0.01*) and age (*r=0.191, p=0.05*). Positive images have a moderate, positive and statistically significant correlation with expectations of CSCL. Previously gained basic computer skills have a weak, positive and statistically significant correlation with expectations of CSCL. Age has a weak, positive and statistically almost significant correlation with expectations of CSCL. Though according to these results it seems again, that having positive images and previous basic computer skills evoke expectations of CSCL. Furthermore, the older students are, the more they expect from CSCL.

5 Discussion

The purpose of this article was to describe students' expectations of data security, mobility and CSCL on a wireless campus. The aim was also to scrutinize which students' background features might explain their expectations. When reading the results it needs to be remembered that these can be generalized with caution because of the small response rate.

From the empirical data it is possible to identify that students expect quite a lot that studying will be data secure. Data security is mostly mentioned through data security threats, such as viruses and hackers, not so much as a positive feature that enables the creation of the sense of community and secure computer-supported collaborative learning. Students also have some or quite a lot of expectations that they will benefit from the mobility enabled by laptop computers and the wireless network. In students' minds mobility relates to the movability of devices, such as it is seen in the article by Luff & Heath (1998). Hoppe et al. (2003) anticipated that wireless handhelds might promote setting the focus of studying and learning on interpersonal relations and the task as the technology moves to the background. These kinds of expectations can be seen also in this study as students expect the laptop to become an embedded part of their studying and to be able to study in various locations and at various times in a way that suits their individual habits and situation in life. Finally, students have some expectations of computer-supported collaborative learning. These expectations were the most neutral of the three. The most mentioned benefits were being able to interact and do group assignments through laptops and WLAN more flexibly with a possibility to access a wider student community, which follows the basic idea of CSCL (Stahl et al., 2006). Teaching, studying and learning through networks was seen as a positive opportunity but also as a possible threat that might lessen social contacts with other students, professors and teachers.

There were three background factors that stand out as influencing students' expectations: 1) general positive images of using computers, software and the Internet, 2) previously gained basic computer skills and 3) age. The most influential factor of these three is general positive images, which is a slight surprise. Then again, it has already been acknowledged in previous research that emotional factors have an influence on studying, learning and on the creation of community (Hyvönen, Lehtonen, Ruokamo, & Tella 2005; Jones & Issroff 2005).

Another important factor behind students' expectations is having previously gained basic computer skills. The more skills a student has, the more positive expectations she or he has about data security and CSCL. This seems logical since having computer skills may also diminish possible fears a student might have of computers and technology in general and thus is able to have positive expectations. Age also seems to have an effect on expectations. One reason for this might be that many students work besides their studies and some also have families. Network-based courses and mobility enable them to create their own schedules and help them divide their time between studying, working and family-life. Also, the mean age of the respondents enrolling in the University was 24 years which indicates that many of them have previous studies that they have taken since graduating from high school. Thus they may have additional personal studying skills which help them to be more active and independent during their studies.

In this case, questionnaire was selected as means to acquire knowledge about students' background information and expectations. As the population was quite wide, using statistical data collection and analyzing methods was justified but it turned out that using also written answers to open questions was beneficial to the analysis since it enabled gaining the kind of knowledge that would have been otherwise missing from the analysis.

The results help planning future laptop or other mobile technology initiatives taking place in higher education. Studies that precede higher education should ensure that students have the skills needed when enrolling in studies using mobile technology. In addition to having basic skills in using computers and networks, gaining positive experiences of success with computers and networks is important. This might contribute to positive images of using computers, software and the Internet and thus help in diminishing fears and prejudices towards computers and networks.

This article is a part of a larger investigation of the laptop initiative in the University of Lapland and it should be considered as an opening for future research. Following, students' experiences of mobility, data security and computer-supported collaborative learning on a wireless campus will be examined in the second case study of the MobIT project. Of particular interest is the role of data security in CSCL, which needs further investigation.

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Study II

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Domestication of a laptop on a wireless university campus: A case study

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This study reports how university students domesticate their personal laptops at the beginning of studies on a wireless campus. The aim was to examine how students integrate the laptop into their personal education experience, what sort of processes were experienced to render the laptop useful and meaningful, and how gender and IT proficiency influenced this process. Qualitative interview data with twenty students (identified and selected by quantitative survey) was analysed using the grounded theory approach during which a multi-aspect domestication process was identified. Results highlight the importance of a structured way of organising laptop initiatives in universities. It is important that students have the kind of support available that best suits their needs. Pedagogically, successful domestication enables students to integrate the computer into their learning experience. However, we argue that successful domestication allows the artefact to become more than just a tool for learning, but also an integral part of an individual's existing media environment. In effect, comfort of use and IT capability is regarded as only one way of expressing successful domestication. This article adds to the growing number of studies using domestication as an analytical and theoretical framework and considers the phenomenon in an under-researched area.

Introduction

In recent years, educational organisations have been taking courageous steps in the ways they aim to apply information and communication technologies (ICTs) in teaching and learning processes. One example of such an initiative is that taken at the University of Lapland, Finland, where all entering students since autumn 2004 have been given an opportunity to acquire a laptop through the university. In practice, this means that a student pays one-third of the cost of the laptop and the university covers the remainder. Additionally, a wireless local area network (WLAN) has been launched on campus. The original idea to take such an initiative was purely administrative and it has aimed among other things to give students an opportunity to organise studies flexibly regarding schedules and physical places, and to decrease maintenance costs for computer classes (Vuojärvi, Lehtonen & Ruokamo, 2008; Räisänen, Lehtonen, Ruokamo & Isomäki, 2005.)

Along with these administrative and economic implications, such an initiative can have a deeper impact on the pedagogical practices. Mobility afforded by wireless laptops makes it possible to study flexibly regarding times and places (Eriksson, Vuojärvi & Ruokamo, 2009). It provides a convenient way for students to store and carry their own study histories and facilitates collaboration with other students. Many keys to pedagogically successful use of ICTs have been identified in previous research, which has also yielded practical recommendations. The most mentioned include long-term strategic pedagogical planning of implementing technology in education (Jonassen, Lee, Yang & Laffey, 2005; Nicol & McLeod, 2005); high quality of faculty utilisation of the technology for teaching and students having choices as regards technology (Demb, Erickson & Hawkins-Wilding, 2004); engagement of students in active learning and problem solving through ICTs (Barak, Lipson & Lerman, 2006); and support for the development of network based communities and feelings of trust (McInnerney & Roberts, 2004).

The concepts of ambient intelligence and ubiquitous computing foresee a future where technologies embed themselves and disappear into the fabric of everyday life (Punie, 2003). This shift brings about the possibility of laptops fulfilling increased everyday functions and increasing their value and worth to the user. The emphasis is on user friendliness, user empowerment and support for human interactions encompassing a number of dimensions: technical, economical and social. Although campus-wide technology programs utilising laptop computers have been executed worldwide, research papers discussing how students experience the process in an educational setting are practically absent. What remains unclear are the mechanisms through which students become familiar with their laptops, and start using them in learning as well as in everyday life settings.

This article reports a study which sought to find out how university students put their laptops into use and domesticated them before entering teaching and learning processes utilising the laptops on a wireless campus. This case study investigates how the domestication process is manifested and what students do during that process. We were also interested in the gender dimension and differences between ICT novices and ICT experienced students in their actions. We use the term 'ICT experienced' here to describe a student who has versatile ICT skills and can apply those skills creatively. We did not want to use the traditional concept of 'expert' that is usually coupled with the concept of 'novice', because expertise is its own acknowledged research area, and this research does not aim to contribute towards expertise research.

The data for this study of students' domestication of laptop computers were collected by qualitative interviews with twenty students who were selected as interviewees through explorative sampling. The article is structured in the following manner: firstly the topic is delineated through a theoretical background presenting the idea of technology domestication, and the related research questions are presented. Secondly, data collection and grounded theory analysis procedures are described, and finally, results are presented and discussed.

Domestication explained

Jones, Dirkinck-Holmfeld and Lindström (2006) emphasise that in education, ICT adoption should be considered in relation to their later use in learning. According to Cretchley (2006), computer confidence has an impact on how motivated students are to learn in an ICT-enhanced learning environment. Since confidence is usually gained

through successful use and problem solving, students should have positive experiences of using their laptops right from the start. Still, it remains unclear as to what exactly happens *before* students participate in courses on a wireless campus where mobile technologies such as laptops are exploited, and *before* they use their laptops in everyday life. How do students get acquainted with their new tool? Before learning with technology, students need to learn how to use technological tools. The term 'tool' here is appropriate, as laptops bought for educational purposes are usually conceptualised as educational tools and mindtools (Lehtonen, Ruokamo & Tella, 2004) which refer to mobile tools that support thought and activity and are well suited to a particular situation and activity – in this case laptop computers. However, we are sensitively aware that computers can achieve deeper meanings which go beyond mere functional attributes as they progress through their lifecycle, in other words, as they become domesticated.

In this case study, the phase that takes place before entering courses on a wireless campus is explored by applying the concept of domestication (Hynes, 2003, 2005; Silverstone, Morley, Dahlberg & Livingstone, 1989; Silverstone & Hirsch, 1994). Domestication is a concept widely used by researchers to explain how technologies and in particular, media and computing technologies become part of our everyday life. As Silverstone explains "by domestication I mean something quite akin to the domestication of the wild animal… a process of taming or bringing under control. Technologies, television and television programmes must be domesticated if they are to find a space or place for themselves in the home" (Silverstone, 1994: 83). It is used to help explain patterns of ICT usage and non-usage; and adoption and experience (see Haddon, 2006, for a valuable overview of the concept and related studies). Domestication has typically been associated with media technologies and the household. The original formulation of the concept was developed by Silverstone and researchers (1989) in the CRICT project in 1989. Further development of the concept continued both in the UK and in Scandinavia. In the UK, Silverstone, with Hirsch, collaborated to co-edit a book on technologies in domestic spaces, while in Norway, Lie and Sørensen (1996) edited a collection of papers with the focus of making technology our own.

The domestication of technology approach has been applied not only to household media technologies (such as televisions and radio) but also to smart homes, cars, and working environments (Pierson, 2006). The domestication approach moves beyond linear adoption models (Rogers' S-curve (1995), for instance) and allows for a more embracing analytical methodology taking in a wider range of variables and contexts. The value of the domestication approach in contrast to more technologically focused or technologically deterministic adoption models is that the user and the social conditions and environment of use is privileged (see Hynes & Richardson, 2009), While Habib (2005) attempts to apply domestication to learning environments, it is noticeable that any consideration of domestication of technologies within educational settings is lacking. It is within this context that we use domestication to help us understand how educational technologies become part of students' everyday life.

The concept of domestication catches the practical, temporal and spatial place, but most importantly, it underlines how this is mixed with the cultural as an expression of lifestyles and values. Silverstone et al. (1989) describe four aspects, or non-discrete elements, identified to analyse this process of how technologies become part of everyday life: 1) appropriation, 2) objectification, 3) incorporation, and 4) conversion. In the *appropriation* phase, possession and ownership are central. The acquisition of the

technology is the main activity or concern. A technology gets appropriated as it is sold, and then owned or possessed by an individual or household. That is the point at which a commodity crosses the threshold between public and private, beginning its new life as a domestic or owned object. *Objectification* tries to capture how values, tastes or styles are expressed through the display of the new technology. It involves both a spatial aspect (where it is placed in the house), and a temporal aspect (how it is fitted in the time structure of the daily routines and habits of the owner). However, the spatial aspect is more central in this phase. The *incorporation* phase emphasises how ICTs are used, and the temporal aspect is more central in the incorporation phase. Silverstone and Hirsch (1994) suggest that for an artefact to be incorporated it has to be actively used, such as in the performance of a task. The *conversion* phase is concerned with the relations between the households or individuals' internal/personal affairs and the public domain or outside world.

Domestication is not a fixed or linear process (Hynes, 2009). We have described the four phases above in a fractured sense, but in reality, individuals can experience aspects of domestication without necessarily doing so in the order explained above. Silverstone et al. (1989) have separated the phases in order make sense of the processes experienced by individuals and households. In this sense, domestication, both as a metaphor (i.e., the taming of wild animals can be used to described the process of how individual's react to and tame new, wild and strange technologies), and as an analytical concept, is used to find the crossover where technologies and people adjust to each other and find (or do not find) a way to co-exist. Central to the domestication process is the attempt to make technologies fit into their surroundings in a way that makes them invisible or taken for granted. Domestication is about giving technology a place in everyday life. It is important to notice that even though we, in this paper, consider domestication in a study related setting where the main goal of domestication is to put it into use in studying and learning, the technology at hand adjusts itself to students' lives in a more profound way.

Hynes and Rommes (2005) have used the concept of domestication to argue that policy makers, course designers, and educators need to pay attention not only to material resources (such as hardware provision and tuition), but also to the symbolic resources students bring with them (such as motivations, reasons to learn and attend, and the importance and meaning the artefact holds for the individual). By addressing both material and symbolic resources, the likelihood of successful domestication is enhanced.

There are some aspects that make the situation at the University of Lapland special. In this case study, the focus is on students who put their laptops into operation in learning processes for the first time. There were not any organisationally established and structured practices that the students could have followed during their domestication process. We are particularly interested in the early phases of domestication – specifically, how the students assigned early meanings, how they engaged with the artefact individually and in groups, and how they set about making the technology their own. The university arranged some introductory sessions on the use of laptops, but the students did not find them at all useful. Recent research (Osika & Sharp, 2003) has, however, identified that students should have some knowledge of how to use computer operations and utilities, to manage files, and the skills to use some basic office software. We would also highlight the importance of having knowledge of features related to the aspect of mobility afforded by laptops and WLAN that might bring about the additional need for new skills. Mobility and mobile learning

implies the possibility of learning in various locations at various times with the help of mobile tools – in this case, laptop computers. Technology has an important role in learning processes as a mediator of thoughts, interactions, and activity. (Ruokamo & Tella, 2005.)

The main research question of this case study was formulated as follows: *How do university students domesticate laptop computers at the beginning of their studies on a wireless campus?* This question can be expressed in terms of two sub-questions:

a. *What kinds of actions do students take when domesticating laptops, and are there differences between female and male students, or ICT novices and ICT experienced students in this?*
b. *How is the domestication process manifested in this case study?*

Data collection and analysis methods

Participants were selected through exploratory sampling performed in order to find a representative subsection (Gilbert, 1993) of ICT experienced students and ICT novice students in the student population. Sampling started by sending a questionnaire to all 682 students who entered the university in the autumn of 2004, before the laptops and WLAN were adopted for their use. In the questionnaire, students were asked for background information and queried about their previous experiences and expectations regarding the use of computers and networks and how they reconciled the demands of studying and family life. Married students and students with children were asked about their housing arrangements and their family situation as well as about their expectations regarding the demands of studying and family life. (Räisänen et al., 2005). Most of the questions were Likert scaled items on a scale from 1 to 5, but also open ended questions were included as well as a SWOT (strengths, weaknesses, opportunities, threats) analysis of using laptops and networks in learning. With the questionnaire was also sent a letter, in which the research topic was introduced, and in which students were also asked for their informed consent (cf. Sieber, 1992). A total of 197 students returned questionnaires, which is 29% of the whole population.

Next, a K-means cluster analysis of the statistical data was performed on the basis of the answers students gave to 18 five-point Likert scaled questions (end points from "Not at all" to "A lot") concerning their own perceptions of their skills and previous experiences in using computers, different kinds of hardware and software, as well as networks and network services. In the K-means cluster analysis method, the amount of final clusters is decided beforehand (Aldenderfer & Blashfield, 1987), and the goal was to divide the students into two groups of ICT experienced students and ICT novice students. After performing the K-means cluster analysis the goal was to find ICT experienced students and ICT novice students in the groups of female and male students. Thus, the two clusters were cross-tabulated with a question about the respondents' gender. The results of the K-means cluster analysis and the cross-tabulation are presented in Table 1 below.

On the basis of the cluster analysis, students distributed quite evenly into a group of ICT experienced students who are marked with number one in Table 1, and ICT novice students, who are marked with number two. Out of the total number of respondents, 47% (n = 84) of the students were ICT experienced students, and 53% (n = 96) were ICT novice students. The difference between ICT experienced students and ICT novice students was statistically significant in all variables that were included in the cluster analysis at a *p-value* < 0.05. Cross-tabulation shows that 45% (n = 63) of women are ICT

experienced students, and 55% (n = 78) of women are ICT novice students. Out of the group of men, 54% (n = 21) are ICT experienced students and 46% (n = 18) are ICT novice students.

Table 1: Clusters of ICT experienced and novice students, and gender distribution in the clusters

		Male		Female		Total	
		No.	%	No.	%	No.	%
Cluster number of cases	1. ICT experienced students	21	54%	63	45%	84	47%
	2. ICT novice students	18	46%	78	55%	96	53%
Total		39	100%	141	100%	180	100%

After cross-tabulation, twenty students were randomly chosen as interviewees on the basis of the previous analysis. Ten from each cluster, and an equal number of male and female students representing all faculties of the university were chosen. These students were contacted by phone and asked for their consent to be interviewed. All the students were already familiar with the research topic, since they had responded to the questionnaire sent to them in the autumn of 2004, but the main points of the research were still reiterated. If they did not want to participate, another student representing the same cluster was selected and contacted. If they were willing to take part, an appointment was scheduled. The interviewees comprised of twenty first year Finnish university students between the ages of 21 and 53 years. There were 10 female and 10 male students. All five faculties in the University of Lapland were represented, as in this group of twenty students, there were three Arts and Design majors, two Social Science majors, six Education majors, four Business and Tourism majors and five Law majors.

Interviews took place during the summer and autumn of 2005. By the time of the interviews students had been using their laptops for one year after receiving them in September and October 2004. Interviews were conducted by using a qualitative interviewing method (Kvale, 1996; Clemmensen, 2004). Interviews took place at the university in a negotiation room or an office. Before the actual interview questions, the interviewees were asked if it would suit them if the interviewer was to tape the interview and write notes on a laptop computer. Also, the issues of maintaining confidentiality and interviewees' anonymity were discussed. Every interview included the following themes: 1) experiences of taking the laptop and wireless network into use, 2) data security and usability issues, and 3) issues related to studying and learning. According to the chosen interview method (Kvale, 1996), the interviewer wrote notes during the interview on a laptop and presented her own interpretations to the interviewee as the discussion forwarded. The interviewee corrected the researcher's interpretations if needed. One interviewee sent an email to the interviewer after the meeting and added some things that he had forgotten to say during his interview. These points were added to the transcription of the interview.

The analysis of the interview data was carried out using the grounded theory approach (Glaser & Strauss, 1967; Corbin, 1997; Strauss & Corbin, 1998; Suddaby, 2006) with the aid of the *AtlasTi* qualitative analysis software. Grounded theory process consists of three steps of coding. These steps are: a) open coding, b) axial coding, and c) selective coding. It is typical for grounded theory research that data collection, analysis, and interpretation are interwoven. The data does not have to be collected in its entirety before the analysis, but the coding can start as soon as some data is collected. New data is constantly compared to existing codes and categories.

The reliability of the interviews was strengthened through the discussions. The chosen qualitative interviewing method (Kvale, 1996) included discussing the researcher's interpretations of the interviewees' answers; interviewees had the possibility to correct and fill in the interpretations, even though the selected interviewing method was not carried out as it was originally decided, but the interpretation phase was gone through during the interviews. The questions were designed to be simple and understandable so that the risk of misperceptions on the part of interviewee would be minimised (Cohen, Manion & Morrison, 2007). The analysis process carried out in this study and the resulting categories are presented in the following section.

Results and discussion

The three phases of the grounded theory analysis and resulting categories are presented below in Figure 1. The analysis is described in detail in the sections that follow. There are also quotations from the interviews; students' names are changed to protect their anonymity.

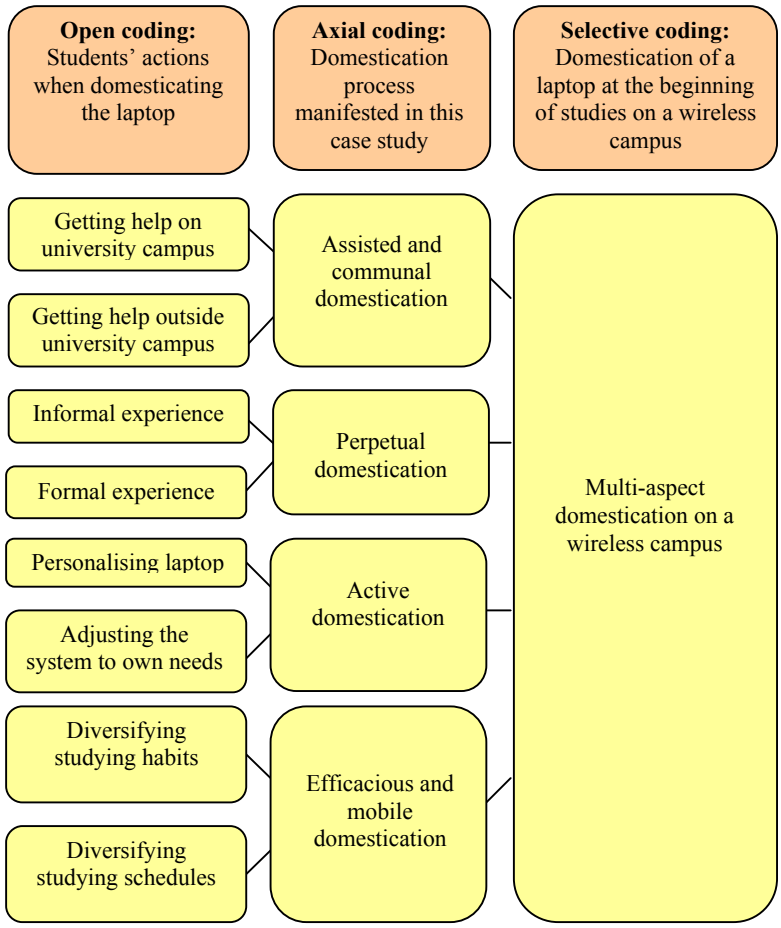

Figure 1: Phases of grounded theory and the resulting categories

Open coding: Students' actions during the domestication process

The first step, *open coding*, started simultaneously with the interviews by reading through the transcribed interviews and identifying and naming concepts relevant to the focus of the study, that is, how university students domesticate laptops at the beginning of their studies on a wireless campus, students' actions during the domestication process, possible differences between female and male students, and between ICT novices and ICT experienced students, and also domestication process' manifestation in this case study. We initially found seventeen concepts which were placed in eight categories: a) getting help on the university campus, b) getting help outside the university campus, c) informal experience, d) formal experience, e) personalising, f) adjusting the system to their own needs, g) diversifying studying habits, and h) diversifying studying schedules.

The first category – getting help on the university campus – was created from two concepts: help from peer students and help from university personnel. It was these two concepts students used when describing how they had help in the domestication process when they were present on the university campus. As the students of the class of 2004 were the first who had the opportunity to acquire laptops, there were not any older students who could have been of assistance in this matter. Hence, they had to deliberate about laptop problems with their peer students. Some of the students also had help from staff members, mainly from the help desk at the university's ICT services. Also, some training lectures were organised at the University by the laptop deliverer, but students did not find these lectures helpful. They said that they would have needed deeper knowledge about the functions of the laptop and of the WLAN. They also thought that it would have been more beneficial if the training was organised by university personnel, since they have detailed information about the campus and the university's information systems.

> After we got the laptops I participated in the training session, but I didn't find it useful. Mainly we were instructed on how the keyboard works and what components the laptop comprises of, what's inside of it, how one can load the battery and what kinds of ports there are. […] I would have needed more instructions concerning data security issues. Now we were just told that we should update the virus protection software, but the practical 'where', 'when' and 'from who' were left unanswered. Also issues regarding WLAN installation and use were missed. (Jonathan, ICT experienced)

The second category – getting help outside the university – was created from two concepts: help from a family member and help from a friend. Help gained outside the university campus had a significant influence on how the domestication process succeeded, especially for female students.

> Taking the laptop into use has been easy, all the software I needed was already installed. I live with my boyfriend, who works in the IT field and he has given me a lot of support, so it wasn't scary to turn the laptop on for the first time. I think that taking the laptop into use probably wouldn't have been difficult, but the help made it easier anyway. (Katie, ICT experienced)

The third category – informal experience – was created from two concepts: previous own computer and previous computer in the family. Students used these two concepts to describe what kinds of previous experiences they relied on during domestication. Some of them had their own computer before, and some had used their parents' computers. Dividing previous experiences into these two concepts was relevant, because the students identified the responsibility that came through actually owning a

laptop. When one uses a computer that is not in their possession, responsibility is not perceived to be as great as if it were one's own. The fourth category – formal experience – was created from two concepts: ICT studies and ICT work. This category was created to describe past experience students had gained through ICT studies or ICT work. This category differs from the third category in that the skills acquired through formal experience were gained trough training that was designed according to some educational standards, or to match the demands of working life.

> Putting the laptop into use has been easy. I work as a PC advisor, so that has undoubtedly affected the easiness. (Sarah, ICT experienced)

The fifth category – personalising the laptop – was created from two concepts: editing exterior features and making their own laptop unique. It seems that students appreciated the fact that the laptops were their personal tools, and they did not have to share them with anyone. This, of course, enables personalising the laptop to their taste by, for example, changing the wallpaper on their desktop, or changing or even creating their own screen savers. Also, organising the directory was one important way to make the laptop more personal, and make it feel as if it was one's own.

The sixth category – adjusting the system to one's own needs – was created from three concepts: installing hardware, installing software, and installing Internet access (WLAN and/or other). This category is more about what kinds of tools the students assumed they would need during their studies. Most mentioned additional hardware installed being mice and scanners. One significant type of software that students wanted to adjust to their own needs seemed to be data security software. There was a firewall and virus protection already installed, up and running on the laptop, but many students said that they wanted to adjust their protocols to suit their own working habits, and some of them also changed the software to something that they perceived as better. Changing the software seemed to be a common strategy also regarding other types of software than just that of data security. Regardless of the fact that there were some office tools already installed, many students wanted to have software that was more familiar to them, and did not want to learn how to use unfamiliar software. Students said that it was important for them to find, for example, word processors, presentation graphics, spreadsheets, and Internet browsers that would support their individual studies the best way possible. They could then complete their assignments using only one computer, and did not have to use the computers in lecture rooms and then carry files back home on, for example, a memory stick or a disk.

> It is a joy and also very handy to take my laptop with me as I go home and continue working there. (Jack, ICT experienced)

> I uninstalled the *Star Office* software totally and installed the *Microsoft Office* instead. It is easier for me to use than this software that was on the laptop. (Joey, ICT experienced)

The seventh category – diversifying studying habits – was created from two concepts: altering previous studying strategies, and trying out new studying strategies. This category has to do with the choices students make when deciding how they want to use their laptops in studying and learning. For example, using the wireless local area network is not a certainty for every student. Beside the fact that some students had had difficulties when installing the WLAN, the reasons whether or not to use the WLAN had more to do with their own actions.

> I haven't used the wireless LAN at all. That is a totally conscious choice, because I think it's more than likely that I'd surf the Internet during lectures if I had the network installed. (Jonathan, ICT experienced)

The eighth and final category – diversifying studying schedules – was created from two concepts: studying in versatile environments, and studying at versatile times of the day. These two concepts describe the way students started to try out scheduling their daily life in a new way. Having a mobile laptop in their use enabled participation, even from a distance. It was very evident from the participants' narratives that the idea of wireless access and mobile access was an attractive option and an appealing feature of computer use within the university. Students spoke about their own individual experiences, and how it had made a difference to their lives, and how it had proven to be a useful tool when it came to studying outside the university.

> If we had only one computer in use at home, it would be in somebody's bedroom and when I had the time to study, that somebody would be sleeping in that room. Now I can go someplace else. Also when thinking about motivation it's good to be able to do things when I feel like it and wherever it's most peaceful. (Sarah, ICT experienced)

The first sub-question of this case study was: *What kinds of actions do students take when domesticating laptops, and are there differences between female and male students or between ICT novices and ICT experienced students in this?* The analysis revealed that the students use a great amount of time in adjusting the laptop to their own individual needs and their studies. This confirms the view presented by Jones and his colleagues (2006), according to which, technology adoption should be dissected in the light of the context in which it will be used. The domestication process is affected by the purpose for which, and the context in which the laptops are used. Social support is a critical feature that is used to assist the process; this was important especially to female students. Students reported that they had solved problems in collaboration with each other, which accentuates the social aspects of the domestication process. These social aspects could be considered and supported as a part of a forming stage suggested by McInnerney and Roberts (2004) that precedes network based learning. Students would have more opportunities to collaborate with each other during the early stages of domestication, in addition to getting to know each other.

Personalising the laptop is also important during domestication. This reminds us that students who invest in personal learning tools are, in a way, also consumers who want to have choices (Demb et al., 2004). In large initiatives such as this, it is practically impossible to provide, for example, a wide choice of laptop brands and types, software or hardware in order to maintain technical support for the laptops. In this case, students have administrator user rights to their own laptops, and therefore have a choice of, for example, software and hardware. According to our results, previous experiences are also important and are put to use when domesticating the laptop. As students become familiar with their tool, they start to diversify their studying habits as well as schedules, as the laptop affords mobility for them. Osika and Sharp (2003) reported the ability to use computer operations and utilities, to manage files, the skills to use word processors, presentation graphics, spreadsheets, databases and Internet browsers as the minimum technical competencies that students should have before entering network based education. Our analysis of domestication on a wireless campus revealed that in addition to these factors, students also perceive data security skills and Internet connection (WLAN or other) installation and maintenance skills as critical prerequisites for entering network based courses.

In addition to finding out what students actually do during the domestication process, it was also interesting to see whether there would be differences between female and male students, and also between ICT novices and ICT experienced students. According to our analysis, it seems that male students preferred to put the laptop into use single handed, with only a little bit of help from their friends, if at all. They also relied on the help provided by the university's organisational support services, and expected more that the training organised by the university would answer their questions. None of the men mentioned having help from family members. Women instead relied heavily on their social support networks, and had a lot of help from family members and friends, regardless of what their skill level was. Help was sought if there were concrete problems with the laptop computer, but social support was also used as a backup, just in case problems appeared.

ICT novice students did not have a similar opportunity to gain from previous experiences of using computers and networks at home, school or work, as ICT experienced students had, which is as expected. This is why the domestication process seems to have gone more smoothly for the ICT experienced students. When looking at the level of the skills of these two groups, it has to be noted that being an ICT novice student does not mean having no experience with using computers and networks. Only one novice interviewee said that she had been avoiding computers until now, but everyone else had had some experience with using computers. The differences between these two groups can be seen in the versatility of the actions students took during the first stages of the domestication process. ICT experienced students seemed to be more confident about what they would need in their studies and other areas of life already at the beginning, and thus, for example, installed more software and were braver in tuning their laptops more to meet their personal tastes. ICT novices seemed to be content with less, and started their studies with the basic tools only, and added features and software to their laptops as time went by.

Axial coding: The domestication process manifested in this case study

The second step of analysis, *axial coding*, means categorisation of related phenomena. We started to look for relations between individual concepts and form categories that were again labelled. During this process it was noticed that at the early stages of taking the laptop computer and WLAN into use, social support seemed to be an asset. Help was mostly needed when new software had to be installed and learned, or when the laptop had to be connected to the WLAN. The two categories that describe the social support are 'Getting help on the university campus' and 'Getting help outside the university campus'. The new category, formed on the basis of these two open coding categories, was labelled 'Assisted and communal domestication'.

As technologies progress through their life cycle, domestication can be interrupted, slowed, accelerated, or even stopped. We see that some students spoke of their past experiences and how that influenced their domestication process. These concepts can be found in the open coding categories 'informal experience' and 'formal experience'. These categories were reassembled to the axial coding category of 'perpetual domestication'.

The third axial coding category, 'active domestication', was formed on the basis of two open coding categories: 'personalising laptop' and 'adjusting the system to one's own needs'. Active domestication resembles objectification that was present in the

domestication process proposed by Silverstone et al. (1989). As the students move through the phases of getting to know their laptop computers, and overcoming the many teething problems, they begin to become more active in the process by assigning functions and meanings to the technological artefact. This is achieved by personalising the interface and adjusting the system to the needs that studies present to the use of the laptop.

The fourth and final axial coding category, 'efficacious and mobile domestication', was formed on the basis of two open coding categories: 'diversifying studying habits' and 'diversifying studying schedules'. This resembles the incorporation aspect presented earlier (Silverstone et al., 1989). Efficacious or successful domestication comes about when the technology is successfully embedded within the daily routine and habits. The participants spoke of their success in adapting the technology to fit their lives and their multiple purposes.

The second sub-question of this case study was: *How is the domestication process manifested in this case study?* The grounded theory analysis revealed the four aspects of the domestication process on a wireless campus. The first aspect is the assisted and communal domestication, which highlights the importance of social support during domestication. What seems to be characteristic to domestication taking place in a university setting is the help provided by families, friends, and peer students to those who need assistance at the early stages of domestication. Even for the ICT experienced, the knowledge that social support is available when needed can smooth the early stages of the process. Stewart (2002) uses the term local expert to describe the types of help such experts provide. He states that individuals provide trusted, if not always reliable, help for others making their steps in forming attitudes to innovations and adopting them. The local expert also provides on going support which is *local* and *relative*. Related to the notion of assisted domestication referred to above, it is also possible to identify a kind of communal domestication between friends and students, who found themselves in the same situation with regard to their own personal domestication of the laptop. We can see parallel domestication occurring between students who are in roughly the same stages of domestication.

> We have used peer support. […] I don't think that we would have collaborated as much as we have if we didn't have laptops. (Jack, ICT experienced)

The second aspect of the domestication process manifested in this case study is perpetual domestication, which describes how earlier experiences are used to assist the domestication process. Having previous skills and experiences has a positive influence on the fluency of taking the laptop into use and taking part in the community's activities. For example, if the operating system is already familiar, it is easier to get started even if the hardware is not so familiar.

> I have some experience in using laptop computers, which made things a little bit easier. I got my new laptop switched on and acted according to my previous experiences, so I succeeded. (Helen, ICT novice)

The third aspect is active domestication, in which students make their laptops look like their own. The fourth and final aspect is efficacious and mobile domestication, which describes the various situations and times students started to use their laptops in.

> I have tailored my computer to look more like me, for example, by creating icons of software and files that are important for me, installing a screen saver and desktop wallpaper. I have also organised folders and files so that they are easy for me to find. (Joanna, ICT novice)

> I can write for example in a bus, a hallway or when I'm waiting for something. At home, I don't have to share the computer with my wife and interrupt my task if she needs to use the computer. Currently I'm writing my masters thesis and I'm not dependent on the place I'm in, but I can take my books and laptop and go, for example, to a pier to write. […] I don't have to ask for quietness from anyone, but go to a quieter place myself. (Mark, ICT novice)

The domestication process revealed in this case study has some differences when compared to the domestication process described by Silverstone et al. (1989). During analysis, we encountered a scenario of forced domestication, or artificial domestication. This is because some of the work (end)-users and consumers traditionally have to do to bring about domestication is skipped over, or artificially supplied as the laptop, here the technological artefact, as it is already provided for by the university. This is particularly evident in the early stages of domestication where appropriation involves the social processes of obtaining the artefact and the kind of work that involves. This removes the processes of justification, purchase, research, choice and decision of the model. These early phases of domestication are crucial in the meaning generation process.

Selective coding: Domestication of a laptop on a wireless campus

Finally in the third step of the analysis, *selective coding*, the aim was to integrate categories created during the axial coding. This seems similar to the integration done when moving from open to axial coding, and actually it is, but the integration in the last phase of the analysis is done on a more abstract level. The central category for all the categories found during the previous steps, was created and labelled 'Multi-aspect domestication on a wireless campus'.

The main research question of this case study was: *How do university students domesticate laptop computers at the beginning of their studies on a wireless campus?* Grounded theory analysis of interview data revealed a multi-aspect domestication process consisting of: (a) assisted and communal domestication, (b) active domestication, (c) perpetual domestication, and (d) efficacious and mobile domestication. According to this study, students approached the domestication process from four aspects. The perceived value of each aspect for an individual student depends greatly on students' personal experience and needs. For example the need for social support is not so critical for everyone, some students approach the process on their own and some need closer guidance at the beginning. Further, for some students the laptop is only a tool for learning and they do not use it for any other purposes, but for others it is also a tool for making a living and more integral part of their everyday lives used for entertainment and running errands.

It is worth stating that even though we have introduced and analysed domestication from multiple aspects, in reality, the experience of domestication is never as simple as four easily managed and identifiable aspects. While it is useful for academic papers such as this one to explain the process in sections, the experience of domestication is ultimately a more fluid process with overlapping aspects, blurred boundaries, and is one which is unfixed in sequence and nature. Also, even though we present the

domestication process here as something that takes place at the beginning of the studies, it is a reality that the domestication and studies start somewhat at the same time, and students probably use their laptops already, even though they are still in the middle of the process. The amount and type of support students need changes as the time passes, the ways in which laptop is utilised become more diversified and in time, the tools start to look like their own for their users.

Conclusions

The aim of the study presented in this article was to find out how university students put their laptops into use and domesticated them before entering teaching and learning processes utilising the laptops on a wireless campus. This case study investigated how the domestication process is manifested and what students did during that process. We were also interested in the gender dimension, and differences between ICT novices and ICT experienced students in their actions. The data were collected by qualitative interviews with twenty students who were selected as interviewees through explorative sampling, and analysed by using grounded theory approach.

The analysis revealed a multi-aspect domestication process taking place at the beginning of studies on a wireless campus. Our findings suggest that in universities where similar laptop and wireless campus initiatives are taking place, a common 'one size fits all' approach to student engagement in ICT provision should be rejected. This can be seen as being beneficial to both teachers and students. Learning processes that involve students applying theoretical concepts to hands on practice with the help of ICTs, such as described by Barak et al. (2006), require students being familiar and confident with their tools. This enables both students and teachers to concentrate on the subject, instead of the technical aspects. Students call for broader training organised by the university, and hope to have more knowledge, especially about data security issues and of the WLAN installation and use. It seems that ICT novice students, and especially women – regardless what their level of ICT skills is – tend to rely on social support. This echoes the findings of Hynes and Rommes (2005).

It is known that the pedagogical use of ICTs requires careful planning, and best practices are often found through long-term development and repeated implementations (Jonassen et al., 2005; Nicol & McLeod, 2005). At present however, pedagogical planning seems to start from planning a single course's activities and interactions, whereas we suggest that strategic and long-term planning should also consider the multi-level and complex domestication process that precedes actual courses and learning processes. A single training session during which tools are introduced cannot answer all the needs that students have regarding their personal learning tools. In practice, based on the four aspects of domestication revealed in our analysis, we suggest first of all that institutions provide sufficient social support that is available to students who need hands on assistance with their laptops. This can be arranged for example through a help desk system, or if there is an existing student tutor system, the tutors could be trained also to help with laptop problems.

Perhaps it could be considered to arrange a special starting course for students with laptops during which the ICT infrastructure at the university would be thoroughly presented to students. Also, students' previous experience of using laptops and networks should be taken into consideration. For example having software that is already familiar to students installed to laptop can lower the threshold of starting to

use the new tool in learning. If students have to learn how to use all new software in addition to the subject that is under study, it may slow down the learning process remarkably. Being able to use tools that students themselves prefer, make the tool feel closer to them. Finally, we suggest that students should be carefully guided to use any mobile services that are provided by the institution. This way students could better maintain active also when they are off campus. Also network based help desk could help students dealing with laptop problems while they occur. This could be arranged for example by using *Skype* or similar communication software.

No study is without limitations. It needs to be carefully noted that the dividing line between ICT novices and ICT experienced students achieved through K-means cluster analysis, only gave the two groups from which the interviewees were selected. Having students distributed into two groups does not imply that all students in one group are identical in their ICT skills. There are differences among the skills of ICT novices, even though they all represent the same group. The students close to the limiting value on both sides of the dividing line are actually quite close to each other in terms of their skills, but there is some significant fact that determines to which group a student belongs to. The sampling of the interviewees may also have been affected by the fact that the survey's response rate was quite small.

However, we managed to get interviewees from all five faculties, both male and female students, and students of versatile age groups. The data was collected some five years ago, but the analysis and results can be safely reflected at present. Same kind of interview data could be collected from the student population that enrolled the university in fall 2009. Individual experiences are of course always unique, but both ICT novices and experts among the student population can yet be found. Even though we discussed the differences in domestication process between genders, we do not aim to generalise from these results but instead wanted to reach rich, in depth findings from a focused qualitative study.

To conclude, the results of this study highlight the importance of structuring and systematising the way in which laptop computer initiatives are organised in universities. It cannot be taken for granted that all enrolling students have good enough ICT skills to manage putting their laptops into use. Students are on different skill levels and have unique personal preferences, thus they need different kinds of support at the beginning. Successful domestication is nevertheless a critical phase of studies on a wireless campus, since students consider having a personal laptop computer in their use throughout their studies as a significant asset. It enables storing their whole studying history in one place in a form that, for example, essays, designs, reports and studying diaries can be accessed, read, edited and carried wherever. This article adds to the growing number of studies using domestication as an analytical and theoretical framework - it builds on the Silverstone foundations of media technology domestication and brings the concept of domestication into an under-researched area.

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Study III

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Designing and Implementing a CSCL-based Course on the Data Security of a Wireless Learning Environment

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Abstract

This article reports on a design-based research (DBR) process for designing and implementing a computer-supported collaborative learning (CSCL) course on the data security of wireless learning environments. The study focuses on examining how university students practice data security when learning on a wireless campus, how data security aspects appear in this study and how students perceive the role of data security in CSCL. The research subjects included six pilot students and eight students enrolled in the course. To promote the reliability of the findings, various kinds of data were used. The data was analysed following the grounded theory approach. The results suggest that data security should be considered an integral part of CSCL-based courses and that students need to be taught the basics of managing the data security of their information and communication technology (ICT) enhanced learning environment regardless of the main subject of their studies.

Keywords

Design-based research, Computer-supported collaborative learning, Data security, Higher education.

Introduction

At present, wireless technologies are increasingly used as promoters of flexible eLearning practices. The mobility of technological devices facilitated by wireless technologies gives educational institutions, such as universities, new opportunities to design the use of their pedagogical environments. In this redesign of pedagogical spaces, it is essential to prepare students for the implementation of new learning practices utilising wireless technology. In order to study in wireless virtual communities, students must be able to trust the mediating technologies. This requires increasing students' awareness of data security, particularly because the potential insecurity of Wireless Local Area Networks (WLANs) has been criticised quite heavily in recent years (Furnell & Ghita, 2006). Further, as universities continue to organise their pedagogical practices to support a virtual presence on wireless campuses, the demands for data security, privacy protection and usability of mobile technologies should also be a focus (Isomäki, Päykkönen, & Räisänen, 2008).

This article reports on a design-based research (DBR) process for designing and implementing a computer-supported collaborative learning (CSCL) based course on the data security of wireless learning environments at the University of Lapland. DBR aims to improve educational practices through cycles that consist of analysis, design, development and implementation. All activities are based on tight collaboration between researchers and practitioners (Barab & Squire, 2004; Brown, 1992; Wang & Hannafin, 2005). A special feature of the process presented in this paper was that it took place at the university's wireless campus where all enrolling students had an opportunity to acquire a laptop computer through the university from 2004 to 2009 (Räisänen, Lehtonen, Ruokamo, & Isomäki, 2005). In practice, the university covered approximately two thirds of a laptop's total cost, and the student paid the rest. The laptops included an open-source office-software package, firewall and virus protection and statistical-analysis software. Arts students also had specific software they required during their studies pre-installed on their laptops. Furthermore, a WLAN covering all university premises was launched on the campus. This meant that all students that participated in the course had similar mobile tools and were able to benefit from the mobility afforded by them.

During the first stage of the DBR process, a course on the data security of wireless learning environments was designed and piloted by four teachers. The aim of the first stage was to (a) gather knowledge of current research on data security in academic environments, (b) arrange a pilot course on the data security of wireless learning environments and (c) use the experiences gathered during the pilot course in the *Data Security of Wireless Learning Environments* course design. During the second stage, the *Data Security of Wireless Learning Environments* course was implemented as a part of Information Technology subject studies and Media Education advanced studies. The first aim was to examine the role of data security in CSCL on a wireless campus, the manner in which university students sought to achieve and maintain data security and the manner in which data-security aspects were manifested in this study, while the second aim was to use the research results in refining the course.

The data for this study was collected during the DBR process and consisted of asynchronous network-based discussions students participated in during the course, user diaries that they wrote during and one month after the course and their feedback from the pilot course. The data was analysed using the grounded theory approach (Corbin, 1997).

This article is organised as follows: First, background and previous research are discussed. Then, a presentation of the design framework and research questions is given. Next, a description of the research methods is provided, and the results are presented and examined. Finally, conclusions are drawn and discussed.

Data Security in Higher Education

Information and communication technologies (ICTs) are an integral part of universities' everyday administrative operations, especially in the areas of teaching, learning and research. Increasingly, the ICTs in pedagogical use are mobile, such as in this case laptop computers and wireless networks, as it has been acknowledged that the mobility afforded by mobile tools offers flexibility in learning processes (Demb, Erickson, & Hawkins-Wilding, 2004; Moody & Schmidt, 2004). Mobility is here understood as a wider concept describing not only the mobility of tools but also students' physical mobility, mobility in social and conceptual space, and thus learning is dispersed in time. This promotes students' engagement in their learning and helps them to organise learning activities in a more convenient manner

(Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009.) As the pedagogical use of mobile ICTs develops, it is not only pedagogical decisions that influence the fluency and effectiveness of the teaching and learning processes; technological aspects, such as data security, are also significant.

The data security of academic environments was addressed in a recent research study by querying university staff's perceptions of data security (Drevin, Kruder, & Steyn, 2007) and attempting to determine how to prevent students from cheating on electronic tests (Graf, 2002). It has been outlined that carrying out network-based learning demands paying particular attention to authentication and accountability, access control, intrusion detection, protection of network communications and non-repudiation issues (Furnell et al., 1998). In addition, the viewpoint of end-users on online learning has been emphasised (Furnell & Karweni, 2001). Data security education has been developed concerning both contents and pedagogical practices, but it has mainly been aimed at either the staff of the university (Rezgui & Marks, 2008) or students who are majoring in information systems (Sharma & Sefchek, 2007). The development of data-security practices should, however, be widened to concern all university students, since it has been discovered that putting data-security software into use is one critical part of the domestication process university students undergo when starting their studies on a wireless campus (Vuojärvi, Isomäki, & Hynes, 2010).

The continuously increasing use of mobile ICTs in teaching and learning processes compels researchers to re-examine data security and its role in education. Traditionally, the nature of universities' operations has required public openness, but that should be balanced with data security. Personal laptops enable flexible learning activities, but students must also be responsible for their maintenance, including taking care of data security. From the organisation's point of view, this creates a need to ensure that students are aware of data-security risks and realise that they are key actors in maintaining not only their own but also the organisation's data security. From the students' point of view, data security also potentially affects the learning processes that take place in CSCL communities. Ideally, in CSCL-based courses, students actively participate in collaboration by interacting, sharing experiences and completing tasks together (Jonassen, Lee, Yang, & Laffey, 2005; Stahl, Koschmann, & Suthers, 2006). Reaching a level of productive interaction requires a safe

emotional environment; students need to feel accepted by their peers—to feel trust, respect, belonging and a sense of community (Allan & Lewis, 2006; McInnerney & Roberts, 2004). One way to promote this could be enriching users' awareness of and ability to manage the data security of their CSCL environment. If students trust that data-security solutions are working properly and know how to manage personal data security themselves, they can concentrate on learning without feeling the need to "hold back" just in case their data security might be compromised.

Recent research on information-security training in academia has been approached from various viewpoints of traditional pedagogy; for example, lab-based courses (Jensen, Cline, & Guynes, 2006), seminar-style teaching in classrooms, topic presentations and discussions and course projects for promoting hands-on learning (Li, Zhao, & Shi, 2009). Currently, research concerning university students' perceptions of the data security of their mobile CSCL environment is virtually non-existent. Moreover, most information-security research tends to focus on the technical context (Siponen & Oinas-Kukkonen, 2007). This can be considered a critical deficiency, because students are a significant group of users that use university ICT services every day, possibly with devices that are not organisationally maintained. It is often suggested that the members of organisations constitute a major data-security threat to those organisations (Furnell, 2008; Leach, 2003; Schultz, 2008). In an academic environment, this includes not only the staff but also the students. At a minimum, all users should have the ability to protect their computers against malicious software or other attacks with anti-virus and firewall programs and to control access to their computer or user account. Moreover, successfully implemented data-security solutions have the potential to bring about feelings of belonging and safety, thus supporting the forming of a secure community, which is seen as a critical feature promoting learning in computer-supported communities (Chapel, 2008; Jones & Issroff, 2005; Moody & Schmidt, 2004; Wegerif, 1998).

Design Framework

Course Design

The study reported in this article was conducted as a DBR process that generally aimed to improve educational practices and theoretical constructs through iterative stages of design, implementation, analysis and refinement (Brown, 1992; Cobb, Confrey, diSessa, Lehrer, &

Schauble, 2003; Design-Based Research Collective, 2003). It was based on a tight connection between theory and practice, in that all activities in the process were based on collaboration between researchers and practitioners (Collins, Joseph, & Bielaczyc, 2004; Edelson, 2002; Wang & Hannafin, 2005). Here, this was realised, in that the teachers on the course implementations were also the researchers who analysed the data and refined the course design. This tight connection between research and practice helped to fulfill DBR's dual goal. Firstly, it aims at producing new theories, artefacts and practices that may have an impact on learning. Secondly, it aims at examining these theories and investigating the changes they bring in on a local level. This dual goal brings DBR very close to a kind of learning that takes place in real-life naturalistic settings (Barab & Squire, 2004) such as the wireless university campus in this study.

The first stage of the DBR process involved designing a pilot course based on literature and previous research conducted in the areas of information security, human-computer interaction (HCI) and CSCL. This was done in collaboration between four teacher-researchers. The second stage of the DBR process—implementation of the pilot course—took place in October–November 2006. There were six pilot students, all of them female and aged between 20 and 26 years. They were majoring in either Media Education or Education.

The pilot course started with an introductory lecture that dealt with users' basic security actions, such as users' responsibilities of maintaining the organisation's data security, technical data security risks and protection from these risks. The second lecture concentrated on possible security issues with organising CSCL-type courses. The third lecture was an introduction to data security in wireless networks, and it concentrated on the technical hardware of wireless networks and data security. The fourth and final lecture focused on data security, law and informatics issues and user interfaces.

Between the lectures, students engaged in asynchronous network-based discussions in the Optima environment. After each lecture, students were given a discussion topic that was formulated as follows: (a) Have you used any data-security software? How self-explanatory was it? (b) Form a shared view about data security's role in CSCL-based education. (c) What is your perception of the security level of wireless networks? What kinds of problems or risks

do wireless networks bring about in using learning environments? and (d) How are usability criteria realised in the learning environment that you are using? As their course assignment, students wrote user diaries during and after the pilot course. In the diaries, they reflected on the topics of the lectures and discussions and deliberated on the role of data security in their learning as well as in other areas of life. They also described situations in which they encountered data-security problems and described how they managed those situations. After the pilot course, the students gave anonymous feedback through a learning-management system.

In the third stage of the DBR process, two of the teacher-researchers continued the work by designing the CSCL course on the data security of wireless learning environments. This was done by refining the original pilot course design based on pilot students and teachers' experiences.

Course Description

The course designed based on the pilot course experiences was entitled *Data Security of Wireless Learning Environments*. It was primarily aimed at media education undergraduates and students studying information technology as a secondary subject. The students received four ECTS (European Credit Transfer System) credits for completing the course, which was graded from 1 to 5 or fail. The goal of the course was that the students learn (1) to understand the meaning of data security in CSCL and (2) skills that enable taking care of data security.

Eight Finnish students (4 female, 4 male) between the ages of 20 and 31 years enrolled in the first course implementation in October–November 2007. The students were Media Education, Sociology or Accounting majors. During the seven-week course, students attended thematic lectures, participated in network-based discussions and completed a course assignment. The course started with a lecture that introduced the aims of data security. The second lecture concentrated on data security in practice (i.e., the students were taught skills to maintain data security). This practice-based second lecture was added to the course design on the grounds of students' feedback from the pilot course. According to the pilot students, they would have appreciated more concrete how-to guidance regarding, in particular, virus-protection and firewall software. The third lecture concentrated on security issues in CSCL, and during the

fourth lecture, the students learned about data security in wireless networks, as the lecture concentrated on the technical hardware of wireless networks and data security. The fifth and final lecture covered data security as well as law and informatics issues. The main points of the course were recapped through collaborative mind-map exercises.

Between the lectures, the students engaged in asynchronous network-based discussions in the Optima environment. After every lecture except the first one, they were given a discussion topic that was to be addressed in the discussions. The topics were formulated as follows: (a) Dissect your own computer use in light of the topics presented in the lectures. How do you acknowledge data security in your daily use? (b) Form a shared conception about data security in CSCL. (c) What is your perception of the security level of wireless networks? What kinds of problems or risks do wireless networks bring about in using learning environments? and (d) From a student to the designer of learning environments, what would an ideal and data-secure learning environment be like?

Course assignments were the same as in the first course implementation. Students wrote course diaries and deliberated on the topics handled during the course and their own data-security experiences.

Research Questions

Based on prior research on the topic and the principles of DBR, the research questions of this study were formulated as follows:

1) *What is the role of data security in CSCL on a wireless campus?*
    1.1) *How do university students seek to achieve and maintain data security in CSCL on a wireless campus?*
    1.2) *How are data-security aspects manifested in this study?*
2) *What implications do the results have for the course design and refinement of the course*?

Data-collection and Analysis Methods

Three kinds of data were collected for the analysis. Firstly, there were the network-based discussions that the participating students generated during the pilot and first course implementations. Altogether, there were 139 discussion messages. Secondly, there were 15

learning diaries that the students wrote during and after the course. Both the discussions and diaries were saved in the Optima environment. Thirdly, there was the feedback the students gave anonymously after the pilot course. However, no feedback was available from the first course implementation, because, to ensure students' anonymity, the learning management system through which the feedback was gathered did not allow the teacher to access feedback data if the number of students giving feedback was insufficient.

DBR welcomes the use of various types of data, which helps to achieve data triangulation (Cohen, Manion, & Morrison, 2007). The data was analysed using the grounded theory approach in which the central idea is to develop theoretical ideas and allow relevant issues to emerge from the area of interest; the aim is not to verify an existing theory that suits the goals of the DBR process (Glaser & Strauss, 1967). During the research, the processes of data collection, analysis and interpretation were interwoven (Corbin, 1997; Strauss & Corbin, 1998; Suddaby, 2006). The method included three phases of data coding: open, axial and selective coding. Even though these phases are presented here as individual phases of the analysis, they do not necessarily take place in stages; rather, a researcher may move between coding procedures (Strauss & Corbin, 1998).

Results

The open, axial and selective coding phases of grounded theory analysis and the resulting categories are presented in Figure 1.

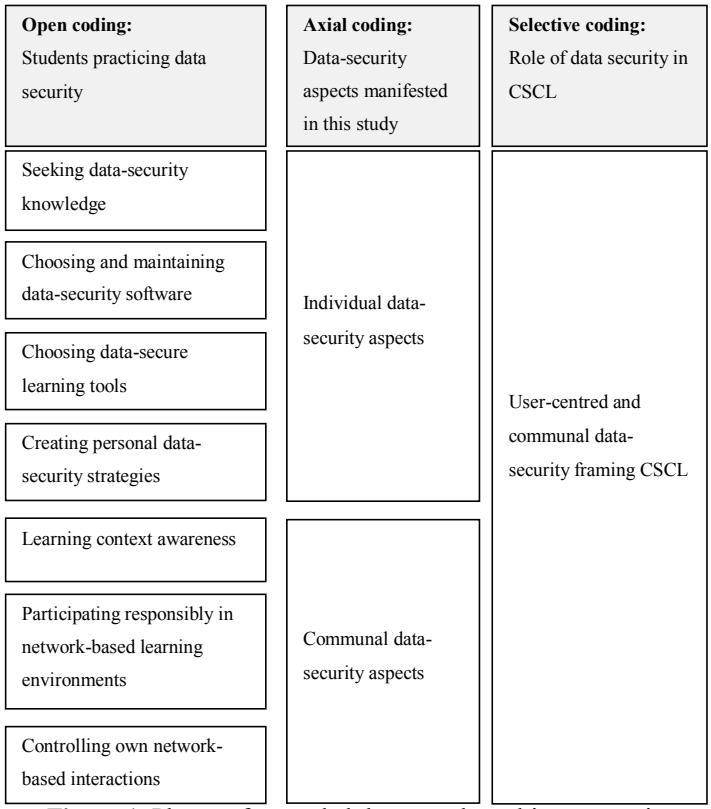

Figure 1. Phases of grounded theory and resulting categories.

The analysis is described in detail in the sections that follow. Empirical evidence is presented by referring to quotations from the discussions, feedback and students' diaries. Students' names have been changed to protect their identity. The justification of the analysis is facilitated by explicating the different levels of data in each phase of the analysis.

Open Coding – Students Practicing Data Security

The first phase—open coding—started by reading through all the diaries, threaded discussions and feedback and identifying concepts relevant to the focus of the study (i.e., the manner in which students seek to achieve and maintain data security in CSCL, the manner in

which data-security aspects are manifested in this study and the role of data security in CSCL). This phase was initiated simultaneously with the discussions, which is typical in grounded theory analysis. The data does not have to be collected in its entirety before the analysis, but the coding can start as soon as some data is collected. The first phase yielded 21 concepts, which were placed into seven categories: (a) seeking data-security knowledge, (b) choosing and maintaining data-security software, (c) choosing data-secure learning tools, (d) creating personal data-security strategies, (e) learning context awareness, (f) participating responsibly in network-based environments and (g) controlling own network-based interactions.

The first category—*seeking knowledge about data security*—was created from four concepts: learning from friends, attending data-security courses, reading IT magazines and learning from the university's help desk personnel. Nearly all the participating students mentioned that they had deliberated upon issues concerning laptops with their friends. The more experienced students had taught the less experienced students about the functionalities and best practices concerning the laptop. Some of them had also attended courses organised by the university, but for most, this was the first ICT course they had attended. In general, the students hoped that there would be more guidance concerning the use of laptops in learning. Some of the students had had help from the university's help desk personnel.

The second category—*choosing and maintaining data-security software*—was created from three concepts: setting up virus-protection software, setting up firewall software and creating software policies. The original laptop configuration included virus-protection and firewall software, but some of the students had changed them before the course started. Changing the software became topical for all students, since a few days before the first course implementation started, the university's ICT services announced that the firewall software that was installed on the students' laptops should be uninstalled, because the campus license would expire. The students were advised to independently choose and install new firewall software on their laptops. This presumably had an effect on the students' deliberations in their diaries and network-based discussions. In general, the students were pleased that it was possible to fit firewall-installation guidance into the course structure.

> *This course was arranged at a convenient time for me. University ICT services had announced that McAfee firewall was to be uninstalled and we had to find new software.* (Edith, diary)

The third category—*choosing data-secure learning tools*—was created from two concepts: selectiveness when loading software from the Internet and choosing proper software. The students seemed to be quite cautious about choosing software. As they had administration rights, they were able to install and uninstall their software of choice on their laptops. They wrote in their diaries and stated during network-based discussions that they did not want to upload anything extra from the Internet—only the software they truly needed and knew how to use. The most often mentioned software applications were Internet browsers and different kinds of office tools such as word processors and presentation graphics software. Data security played an important role, especially when deciding what Internet browser to use.

> *I am quite strict concerning what to allow on my laptop.* (Annie, discussions #4)

The fourth category—*creating personal data-security strategies*—was created from three concepts: managing own personal user identification, managing backup copies and defining access to laptop. Both in their diaries and in network-based discussions, the students deliberated the password issue from multiple standpoints. They all described having several passwords, each for a different kind of system. Topically, a piece of news was reported a few weeks before the course started according to which a long list of user-identification information was stolen and published on the Internet. This raised concerns and discussions among the students about having and storing passwords and possible future identification procedures (e.g., fingerprint technologies). The usual backup forms were copying files to a memory stick, copying files to an external hard drive and copying files to a folder on the university's server. Access to the laptop was controlled through defining usernames and passwords and restricting the availability of user accounts. The necessity of user identification to gain access to network-based services is common to every computer user nowadays, and this was also evidenced by the students' diaries and discussions. It was also a commonly used strategy to restrict the number of user accounts available on their laptops. Most of the students had created only one user account for their own use.

> *To cover my family's needs, I purchased a network hard drive to which it's possible to save files from multiple computers.* […] *I have also used my own folder on the university's server to store my backup files.* (Tom, diary)

The fifth category—*learning context awareness*—was created from three concepts: being aware of private and public spaces, adjusting own behaviour regarding the context and choosing the type of network in view of the activities involved. These three concepts came about when the students deliberated on how to set the boundaries between the private and public physical places where technology is used. Public places, such as the university, are perceived as critical places where all information-security functions must be up and running. Private and public considerations were also in focus when defining private and public network-based activities. According to the students, they did not want to pursue all their activities through wireless networks, because they perceived them as more risky than, for example, an ADSL (asymmetric digital subscriber line) or cable network connection. Having, for example, neighbours' WLAN Internet connections available in the network list in one's home environment was perceived as irritating. The students thoroughly deliberated on the characteristics of wireless and wired networks and the manner in which they might affect the user. In addition to the types of data-security mechanisms, they also thought about access issues.

> *Somehow, I have had an image that a wireless network would be more secure than [a] wired network. Perhaps this image is because wireless is "in the air" and invisible, harder to see.* (Rachel, discussions #34)

> *A laptop is surely as private as a desktop PC, but still, I perceive it [as being] more public. A desktop is always at home, inside four walls, whereas a laptop is with me everywhere among foreign crowds.* (Ally, diary)

The sixth category—*participating responsibly in network-based learning environments*—was created from four concepts: determining access rights to one's own materials, determining access rights to a group's outputs, protecting shared workspaces and taking care of personal

data security in a learning community. Students perceived the network-based learning environment they used during courses as a private area. All the files, discussions and exercises in that environment were meant for the group's eyes only and needed to be protected. They also realised that data-security procedures were there to support their learning processes. From an individual point of view, it was important to know who might read their texts. They identified several types of texts that they produced in network-based learning environments of differing degrees of sensitivity. Some contained more personal information, while others contained more report-type texts that were not highly sensitive. Students felt that through restricting access to documents and essays that included mostly personal deliberations on the subject of the study, they could maintain their privacy and protect their identity.

> *I think that data-security issues should be highlighted before accessing [a] network-based learning environment. At least I haven't had any guidance about data security relating [to] my network-based studies. […] Especially as the laptops are becoming more common, I think that it is everyone's responsibility to get the needed data security on their own computer. In a communal learning environment, responsibility is shared by everyone, as we are working together. So if one of us breaks the rules, everybody suffers.* (Ally, discussions #21)

The seventh and final category—*controlling network-based interactions*—was created from two concepts: being cautious with the use of MSN Messenger and maintaining several email accounts. Many of the students had several email accounts for different purposes. They did not want to share their "official" email address that they had received through the university with unofficial parties. One student had five different email accounts for studying, work, discussion forums, hobbies and e-shopping.

> *Because of trash mail, I have several email accounts. I'll share the not-so-important address for general use and accordingly receive about 20-30 trash mails every day*. (Adam, discussions #3)

The first follow-up question of this study was, *How do university students seek to achieve and maintain data security in CSCL on a wireless campus?* The analysis shows that students are oriented towards embedding data-security practices in their daily routines. This emphasises the importance of organising and developing data-security education for all students in the university, not only those majoring in information systems (e.g., Sharma & Sefchek, 2007). Firstly, it seems that students try to find out about data security and gather knowledge about topical issues. Secondly, they perceive it as important to play an active role in managing data security. Students are quite specific in terms of how they feel software should work, and they are prepared to try out multiple options and make comparisons before choosing. Thirdly, students try to be aware of the context in which they are using their laptops and networks, and they often create personal data-security strategies through which they can manage user-identification information, backup copies and laptop access. Fourthly, students perceive themselves as members of a learning community in which everyone has to assume responsibility for data security.

Axial Coding – Data-security Aspects Manifested in this Study

After the data was broken down in the open coding phase, it was reassembled in the second phase—*axial coding*. This was done by comparing categories in a way that reveals how two or more of them might be linked. During this process, it was noticed that the categories 'Seeking data-security knowledge', 'Choosing and maintaining data-security software', 'Choosing data-secure learning tools' and 'Creating personal data-security strategies' all described how students adjusted the laptop to meet their personal data-security demands. Therefore, the first axial coding category was labelled 'Individual data-security aspects'.

The second axial coding category 'Communal data-security aspects' was formed on the basis of the open coding categories 'Learning context awareness', 'Participating responsibly in network-based learning environments' and 'Controlling own network-based interactions'. Through these three categories, students were able to describe how they sought data security in the CSCL community of which they were a part.

The second follow-up question of this study was, *How are the aspects of data security manifested in this study?* As reported earlier, authentication and accountability, access

control, intrusion detection, protection of network communications and non-repudiation issues are the key data-security aspects that need to be considered when carrying out network-based teaching and learning (Furnell et al., 1998). The analysis revealed that the data-security aspects come about in terms of individual and communal points of view. When thinking about individual aspects, students pay close attention to choosing the right kind of data-security software and data-secure office software. This can be seen as considering authentication and accountability and intrusion detection. Access control came about in creating personal data-security strategies, particularly when defining access to the laptop. In communal aspects, authentication and accountability and access control were regarded as defining who has access to network-based communal learning environments. Protection of network communications was another communal data-security aspect.

Selective coding – Role of data security in CSCL

The third phase of the analysis was selective coding. This phase considered how the three categories that were formed during axial coding could be integrated into one central category. The core category that emerged as a result of selective coding was labelled 'User-centred and communal data-security framing CSCL'. This answered the first research question of this study: *What is the role of data security in CSCL?*

It was noticed that students described how data security, on the one hand, created rules and restrictions for their actions and, on the other hand, worked as a tool that they could use to protect learning outcomes and their privacy. For example, access is controlled on multiple levels. Students are asked for identification information when logging on the system, and inside the system, they have available only the workspaces of those courses in which they are enrolled. Inside one course's workspace, the teacher can restrict access to some information (e.g., between groups). The students were content with the way access control was handled in their network-based learning environment. They perceived it as a closed area that was available only to those participating in the course. This can be understood as their need for a safe place to study, where they could feel they belonged to a certain group while experiencing trust and respect (Allan & Lewis, 2006; McInnerney & Roberts, 2004).

Access issues also came about when the students described how they managed their laptop computers. They perceived very strongly that the laptop was their personal and individual learning tool that created a private space in which they could learn. That is why they wanted to restrict access to their own laptop by, for example, using only one user account protected by a password. Students were also very keen on selecting the tools that they used on their laptops. Office tools, such as word processors and Internet browsers, were selected in terms of usability and data security, which was highlighted especially when the students mentioned their selection of an Internet browser. Having specific data-security software was perceived as essential.

Concretely, the idea of a private learning space came about when students described the places in which they used their laptops. The awareness of private and public places played a very important role in deciding when and where to study. The data security of the WLAN and public spaces such as the university was perceived as weak, and that is why some activities were preferably performed in a home environment. In particular, the inconsistent availability and slowness of the WLAN were perceived as undermining students' perceptions of a secure learning environment.

Data security can also be seen as framing learning when thinking about the level of knowledge of data security that students possess. In their writings, all the students noted that they did not really have a clear idea about data security or possible threats or enough expertise to manage their own laptop and, thus, did not fully utilise their laptop. They mentioned that participating in this course had opened their eyes and given them knowledge they could fall back on when using their laptops.

Implications for Course Refinement

The second main research question of this study was, *What implications do the results have for the design and refinement of the course?* Three particular points need to be addressed in the next stage of the DBR process.

Firstly, students need practical how-to skills, and the course should include practical training sessions. Practical aspects played a larger role in the first course implementation, because the

pilot course feedback clearly indicated a need for that, but their role in course design could be emphasised. It would be beneficial to learn to evaluate different features of software and give reasons based on which tools they choose to use. Secondly, current data-security software needs to be considered when designing the course contents. Some preinstalled software applications are available on the laptop as students get them, and changes will occur in time due to changes in campus licences. This means that the course designers should collaborate more closely with the university's ICT services to gain knowledge about these changes as early as possible. Thirdly, more attention in the course design should be directed to the social aspects of data security. This is an emerging research area, which means that there is no extensive knowledge base on which the course design could be grounded, but students' responsibilities to the community can nevertheless be highlighted.

Conclusions and Discussion

In this article, a DBR process of designing and implementing the *Data Security of Wireless Learning Environments* course was presented. The results of the grounded theory analysis suggest that data-security training should be considered as a part of CSCL-based teaching and learning. The educational use of ICTs involves not only planning pedagogical aspects but also considering the technology and analysing how it can be used in such a manner that it supports students' collaborative actions, problem solving and interaction in a safe community. Generally, students must try out and learn to use their ICT tools in addition to the main subject of the courses in which they enrol. In this case, the main goals of the course were learning about technology and exploring data-security issues in particular, which was perceived as beneficial by students—not only regarding the completion of this particular course but also in terms of their studies in general. Even though today's university students are more computer savvy than those of the past, it seems that they need a deeper understanding of data-security issues in order to be able to consider their computer usage from a security point of view.

Teaching students about data security may have more far-reaching influences than just promoting their learning. Today's work environment relies heavily on information technology: Employees are assumed to have information technology skills, including skills related to data security, to manage their work. Additionally, technological solutions cover

other areas of life as well. Teaching students basic data-security knowledge and skills could very well be considered an opportunity to educate them not just for their degrees but for their future lives as well.

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Study IV

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The Added Pedagogical Value of Using Laptops in Computer-Supported Collaborative Learning on a Wireless Campus

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Abstract: The article reports the results of a case study focusing on the added pedagogical value that laptop computers can afford to students in computer-supported collaborative learning (CSCL) on a wireless campus, how the key elements of CSCL are manifested, and how university students use laptop computers in CSCL. Data were collected during Media Proficiency course with ten participants in a university where all entering students are given an opportunity to acquire a laptop computer through the university. Grounded theory analysis revealed that the students used laptops in interactions, in completing parts of their assignment and in organizing their learning. According to the students, in addition to mediating interactions, mobile tools made it easier to manage their study-related interaction in particular, and therefore facilitated attainment of their shared goal of completing the collaborative course assignment. The added pedagogical value is that the mobility afforded by such tools enables students to operate on the task-organizing and task completion levels of course activities.

Introduction

Information and communication technologies (ICTs) have become very popular in all areas of society, including education. The development of and positive attitudes toward ICTs, as well as many positive experiences of their pedagogical use, have encouraged educational organizations to move forward ambitiously in the ways they apply ICTs in teaching and learning processes. One example of such an extensive initiative is that taken at the University of Lapland, Finland, where since autumn 2004 all entering students have been given an opportunity to acquire a laptop computer through the university. In practice, a student pays some one-third of the cost of the laptop and the university the rest. One aim of this initiative was to compensate for the deficiencies in the numbers of computers available to student; the university has only several computer rooms, which are often crowded and used for teaching, and hence students cannot use the desktop computers in them to write assignments or access databases. Moreover, the computer rooms are not available in the evening or on weekends, because the university is closed. Another aim was to be able to discontinue the computer rooms after some time – as all students would be using laptops – and in this way substantially decrease maintenance costs.

In autumn 2004, a total of 682 students began their studies, of whom 582 – some 85 % of the entering student body – took advantage of the opportunity to buy a laptop. At the end of 2004, a wireless local area network (WLAN) was launched on campus. The students who entered the university in 2004 were sent a questionnaire before the laptops were made available in autumn term. They were asked, among other things, about their expectations of mobility and computer-supported collaborative learning (CSCL) on a wireless campus (Räisänen, Lehtonen, Ruokamo & Isomäki 2005). A statistical analysis of the questionnaire data revealed highly positive expectations of being able to organize learning flexibly regarding time and place with the aid of mobile tools such as laptops and the WLAN. Students also expected to be able to apply their personal routines and preferences when using computers and networks in their learning. When it came to expectations of being able to take part in CSCL, students were positive but also realistic. They expected to be able to interact with each other and complete group assignments using the laptop computers and networks, but also acknowledged the possible threat of lessening social contacts with other students, professors and lecturers. (Räisänen 2007.) At this writing – three years after the first group of students acquired their laptops – it is time to ascertain whether students' expectations have been fulfilled, that is, how they and their teachers have used laptops and the university WLAN in CSCL.

This article reports the results of a study which sought to reveal how university students use laptop computers in CSCL on a wireless campus during their media education studies. The research analyzes the occurrence of key elements of CSCL, i.e., collaboration, interaction, strong social ties, shared goals, the role of ICTs as a mediator in collaboration and the contextualized and situated nature of learning. The ultimate aim of the study is to find out what added pedagogical value laptops can afford to university students. The study reported here is part of the MobIT Project (Developing Mobile Network-Based Teaching, Studying and Learning Processes), funded by the Finnish Ministry of Education for the years 2007–2009. The project explores what happens when mobile technology – in this case laptop computers and a WLAN – is introduced on an extensive scale in higher education. The data for this study of students' experiences of using laptops in CSCL on a wireless campus were collected during a media education course titled "Media Proficiency" in spring 2007. The course was organized in keeping with the principles of CSCL: in addition to participating in thematic lectures, students completed course assignments collaboratively in small groups of three. Course assignments were designed to correspond to the students' future work as media education professionals. The students were expected to collaboratively decide on their topic and to arrange and manage their group's work. During the course, the students also wrote personal learning diaries in which they described and reflected on learning in CSCL groups and described the ICT tools they used during their collaborative work. These course diaries were used as the data for this study and analyzed using grounded theory method. In addition to having laptops at their disposal, students used a network-based learning environment known as Optima during the course. Currently, Optima is the only such environment that is organizationally supported and maintained by the University of Lapland. Even though there are many other such learning environments available, the university has made a decision at the organizational level to support only this one.

In the sections to follow, we first present some previous research on the topic based on a literature review, then describe the theoretical background and the empirical part of the research. This is followed by a detailed account of the data collection and methods of analysis. The last section of the article then presents and discusses the results.

Laptops as Affordances for CSCL

There is already an increasing amount of research evidence on students' experiences of integrating mobile ICTs such as laptop computers into CSCL. Elements that are embodied in CSCL include collaboration, interaction, strong social ties, shared goals, the role of ICTs as a mediator, and the contextualized and situated nature of learning (Koschmann 1996; Jones, Dirckinck-Holmfed & Lindström 2006; Jonassen, Lee, Yang & Laffey 2005). A framework proposed by Kirschner, Martens and Strijbos (2004) dissects these elements in the context of a CSCL task. They suggest that three dimensions of task constraints should be taken into consideration when designing a CSCL-based course: task ownership, task character and task control. Task ownership concerns the responsibility of determining what each participant should do and who provides the social steering during CSCL. Task character describes whether the task is designed specifically to fit the content to be taught or if it is an imperfectly defined problem that students might encounter in working life. Task control describes the shift of control from the lecturer or professor teaching the course to the learner. An ideal CSCL task, one that features the key elements of CSCL, is an authentic and ill-defined assignment that creates a sense of ownership among the students, who become strongly tied together through mediated interaction. Students have a shared goal of completing the task and are collaboratively in

control of reaching that goal. They are individually accountable to and positively dependent on each other. (Kirschner et al. 2004).

Previous research on integrating laptops in CSCL has identified a number of advantages and disadvantages. Positive findings indicate that laptop computers can have a favorable impact on students' attitudes toward and motivation for their degree program and can diminish the digital divide between the genders and between different fields of study (Barak, Lipson & Lerman 2006; Weaver 2005; Finn & Inman 2004). It has also been discovered that providing laptop computers to students can have a positive effect on their collaboration and strengthen connections between disciplines (Kiaer, Mutchler & Froyd 1998). In addition, laptop computers can enhance students' academic performance, as well as their research and problem-solving skills (Mackinnon & Vibert 2002; Siegle & Foster 2001; Stevenson 1998). In general, students perceive that laptops can have a considerable influence on their academic and social life (Demb, Erickson & Hawkins-Wilding 2004; Nicol & McLeod 2005; Varvel & Thurston 2002). Fried (in press) states, however, that when students use laptop computers in lecture courses – where there is no particular need for a computer other than for taking notes – the tools can distract them and detract from learning. Moreover, participating in asynchronous discussions, which are common in CSCL-based courses, is sometimes perceived as frustrating, slow and difficult (Walther & Bunz 2005). According to Selwyn (2007), the use and application of computer technology in universities in general is still limited and modest.

None of the above-mentioned studies on the use of laptop computers in university-level teaching and learning reveal what added pedagogical value laptop computers and networks might afford to students attending a course based on a mobile CSCL design. Mobile learning implies the possibility of learning in various locations at various times with the help of mobile tools – in this case laptop computers. Technology has an important role in learning processes as a mediator of thoughts, interactions and activity, and as a tool and mindtool. Mobile technology enables flexibility regarding times and places, i.e., when and where one studies. (Ruokamo & Tella 2005; Lehtonen, Ruokamo & Tella 2004.)

Drawing on this theoretical framework the main research question of this case study was formulated as follows:
1) *What added pedagogical value do laptop computers afford to students in CSCL-based media proficiency studies on a wireless campus?* This question can be expressed in terms of two sub-questions:

1.1) *How are the key elements of CSCL manifested in this case study?*
1.2) *How do university students use laptop computers in CSCL?*

Course Description and Data Collection

The participants were ten Finnish students between the ages of 22 and 36 years. Eight of the students were female, and two male, and all were either Media Education or Graphic Design majors. This group of students was not sampled from a larger student population; it represented the number of students who participated in the optional course Media Proficiency in spring 2007 when the data were collected.

The aim of the Media Proficiency course was to teach the students to understand the special characteristics of presentations in different kinds of media and the ways of interpreting such presentations. The aim was also to get the students to understand the meaning of different components of their media skills in producing and interpreting audiovisual and web material.

In practice, the students were required to participate in seminars, thematic lectures and network-based group discussions and to complete a course assignment in groups of three. They were also required to present their completed assignments to the other students in accordance with the idea of jigsaw learning and reciprocal teaching methods. The fact that the students owned laptop computers was taken into account when designing the course. With the exception of conventional literature, all course material, guidelines for the course assignments, and diaries were delivered through the Optima environment. In addition to providing storage space, Optima functioned as a discussion area during the course: students used the discussion forum and the chat tool to share ideas and sources of reference material, organize the completion of the course assignments, discuss their assignment topics and arrange meetings at the university. Even though the working methods of the course were mainly network-based, no computer classes were booked for the students, as they were expected to use their laptops.

For their course assignments, the groups analyzed a media presentation of their choice, e.g., a movie, an advertisement or a web page, and documented their concerted analysis. This assignment reflects the three dimensions of a well-defined CSCL task as described by Kirschner et al. (2004). The first dimension, task ownership, was created by making the students independently accountable for the task and for managing the processes involved in the collaborative activities. The second dimension was task character. The media analysis that students completed is an example of a challenging and authentic task that they will have to carry out later in working life as media education professionals. As regards the third dimension, task control, the students were positively dependent on each other: they needed to work together to complete the task and they were assessed as a group.

In addition to attending lectures and completing the course assignment, students were required to complete a course diary, which they wrote independently during and after the course. These diaries were used as the data for this study. Students were asked to reflect on the topics dealt with during the course, to describe the technological tools they used while working on their group assignments, and to note what they perceived as good, bad, easy or difficult in their interactions. Students also wrote about their feelings of belonging to a computer-supported collaborative group and discussed their perceptions of CSCL in general.

Due to the small number of participants also the amount of data is thereby small. That is why it would be beneficial to repeat this course design in the future and find out if a new analysis reveals similar results as presented in following section.

Data Analysis and Results

The written data were analyzed using the grounded theory approach (Glaser & Strauss 1967; Corbin 1997; Strauss & Corbin 1998; Suddaby 2006) with aid of the *AtlasTi* qualitative analysis software. Grounded theory analysis consists of three steps of coding: a) open coding, b) axial coding and c) selective coding. These three phases are somewhat interwoven and analysis can start almost simultaneously with data collection, as was done in this research. The coding process started immediately after the first learning diaries were received. The three phases of the analysis in this study and the resulting concept categories are presented in Figure 1 below. The analysis is described in detail in the sections that follow.

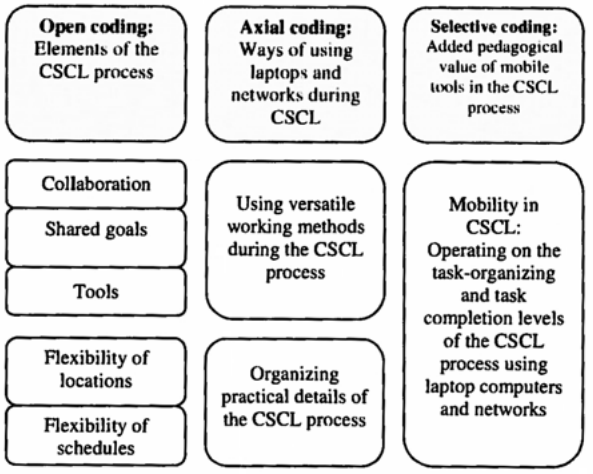

Figure 1: Grounded theory analysis of the added pedagogical value of mobile tools in CSCL processes

Open Coding – The Elements of CSCL

The *open coding* phase started with our reading through all the diaries and identifying concepts relevant to the focus of the study, i.e., the way elements of CSCL are manifested, how students used laptops during the CSCL-based media proficiency course on a wireless campus, and the added pedagogical value that laptop computers can afford. The first phase yielded sixteen concepts, which were placed into to five categories: a) collaboration, b) shared goals, c) tools, d) flexibility of locations and e) flexibility of schedules. The first category – collaboration – was created from two concepts: face-to-face collaboration and network-based collaboration. It was these concepts that students used to describe how they organized their collaborative work. All student groups used both types of collaboration during the course. Students appreciated the fact that they already knew each other before the course started, as this made it easier for them to start their collaboration; they did not have to spend time getting to know each other but could proceed to complete their assignment right from the start.

> The fact that we knew each other certainly made working together smoother. (Student 1)

The second category – shared goals – was created from four concepts: searching for references, writing the analysis, creating a presentation and accessing cases. The students used these concepts to describe different kinds of activities through which they pursued their shared goal of completing the assignment. During collaboration, it was essential for them to be able to assess each other's contribution and they found that their laptops made this possible.

> It [using laptops in CSCL] makes it possible to assess afterwards how the workload was divided and how everyone contributed. (Student 7)

The third category – tools – was also created from four concepts: instant messengers, asynchronous messengers, word processors and presentation graphics. These were the different kinds of tools students used during their collaborative learning. Instant messengers, such as MSN Messenger, Skype and Optima chat, were used mostly when organizing the assignment or groups' schedules, and asynchronous messengers when focusing more deeply on the assignment. The students used word processors to write their media analyses and presentation graphics to create their presentations, which they showed to the other groups and the lecturer at the end of the course.

> We used Instant Messenger a messenger to arrange schedules to meet at the university and share information about good references we had found and good ideas we had. We also shared files to keep track of where everyone was going with their work. (Student 9)

The fourth category – flexibility of locations – was based on three concepts: home, university and library. These were the locations that students mentioned in their diaries. They were able to freely decide where to work and their laptop computers enabled them to access the course material and interact with each other even when they were not present in the same physical location.

The fifth category – flexibility of schedules – comprised three concepts: day, evening and night. These described how students arranged their individual and group schedules during the day. The possibility to participate in asynchronous discussions was especially appreciated by the students who had families.

> When there aren't any specific schedules for discussions, everyone can participate at the most convenient time of the day and that is a good thing. For a stay-at-home mum it is helpful that one can study at night after the kids are in bed. (Student 6)

The first sub-question of this study was: *How are the key elements of CSCL manifested in this case study?* The key elements embodied in CSCL include collaboration, interaction, strong social ties, shared goals, the role of ICTs as a mediator, and the contextualized and situated nature of learning (Koschmann 1996; Jones et al. 2006; Jonassen et al. 2005). The analysis revealed that, according to students, mobile tools not only enabled and mediated interactions but also, and in particular, made it easier for them to maintain their study-related interactions and thus to attain their shared goal of completing their collaborative course assignment.

> Working through the Internet seemed to differ from working face to face in that we accomplished more. Matters that had nothing to do with task itself did not take up our time or at least gossiping and such was easier to cut off. (Student 8)

The students wrote in their diaries that they already knew each other before the course started and felt that this made working in the network-based environment smoother than it would have been had they not known each other. They were able to fill in the gaps in the network-based interaction based on what they knew about one another. The students reported that they were able to maintain strong social ties and did not report that their interactions or social relations had suffered from being mediated or that social ties had lessened; rather, they pointed to the special character of interacting through network-based interaction tools. The analysis of this case study indicates that laptops also enabled flexibility in terms of the times when and the places where one could study. This can be seen as promoting the situatedness and contextuality of learning, as students are able to move from place to place during their collaborative learning if needed.

When analyzing the manifestations of the key elements of CSCL in this study in terms of the task design presented by Kirschner et al. (2004), it can be seen that the three dimensions of a CSCL task – task ownership, task control and task character – can be enhanced through the mobility afforded by tools such as laptop computers. The first dimension, *task ownership*, concerns the responsibility of determining what each participant should do and who provides the social steering during CSCL. According to the present analysis, the mobility afforded by the laptops allows students to have greater responsibility when it comes to dividing up parts of the task and steering the collaboration. It also helps in holding each participant individually accountable for the group's work and later checking how everyone has contributed. Positive interdependence was created in this case through the practice of assessing individuals on the basis of group performance. The second dimension – *task control* – concerns the shift of control from the lecturer or professor teaching the course to the learner. In the case of Media Proficiency this meant that the students had to negotiate in their group the learning activities, schedules of learning and range of content according to their needs and preferences. The third dimension – *task character* – is not so much dependent on the students in the course as it is on the teacher. Then again, students' mobile tools and the mobility they afforded enable the teacher to design assignments in a way that supports the students' professional development as well as possible. The teacher can encourage students to seek and use resources outside the university and also give the students free hands when it comes to scheduling their work. In the present case, one advantage was that neither the teacher nor the students were dependent on the availability of the university's computer rooms.

Axial Coding – The Use of Laptop Computers

After the data were broken down in the open coding phase, they were reassembled in the second step – *axial coding*. This was done by comparing categories in a way that reveals how two or more of them might be linked. During this process it was noticed that the categories 'Collaboration', 'Shared goals' and 'Tools' all described how the laptops and different kinds of software and network-based tools were used in individual and group work, in face-to-face and network-based interaction, and in carrying out different parts of the course assignment, which involved seeking material, writing the media analysis, creating a presentation about the media analysis and accessing the object of the analysis. The new category formed on the basis of these three open coding categories was labeled 'Using versatile methods during the CSCL process'. The second axial coding category 'Organizing the practical details of the CSCL process' was formed on the basis of the open coding categories 'Flexibility of locations' and 'Flexibility of schedules'. It was noticed that the students described in detail how they organized their group and individual work during the course with the help of the interaction tools that they accessed using the laptops. They arranged meetings, kept up with how they were proceeding with their assignment, and delegated subtasks among themselves that would further the completion of the assignment.

The second sub-question of this study was: *How do university students use laptop computers in CSCL?* The grounded theory analysis revealed first that the students used their laptops to participate in interaction with each other and the lecturer. In their interactions, the students used both synchronous tools such as messenger, Skype and Optima chat, and asynchronous tools such as email and Optima forum. Second, the students used the laptops to complete different parts of the assignment on their way to achieving their shared goals. Finally, the students used laptops to organize their studies flexibly with regard to time and place. These results confirm findings regarding the potential of laptop computers to enhance academic performance (Mackinnon & Vibert 2002; Siegle & Foster 2001;

Stevenson 1998). However, the present analysis suggests that the possibilities of enhancement can be realized on multiple levels of actions: laptops can support CSCL not only in task-related actions but also when organizing the practicalities of CSCL.

Selective coding – The Added Pedagogical Value of Laptop Computers

The third phase of the analysis was *selective coding*. In this phase, we considered how the two categories that were formed during axial coding could be integrated to a one central category. It was noticed that students operated on two levels of activities during CSCL process: task-organizing and the task completion. The two are tightly interwoven and interact with each other. The first level concerns managing practical details and schedules relating to the completion of the course and dividing the work between the group members. The second pertains to activities involving the substance of the course and completing the assignment. The students felt that more profound responsibility for their learning enabled them to choose learning strategies according to their individual needs and in this way achieve their goals effectively.

The core category that emerged as a result of selective coding was labeled "Mobility in CSCL: Operating on the task-organizing and task completion levels of activities in the CSCL process using laptop computers and networks". This answers the main research question of this case study: *What added pedagogical value do laptop computers afford to students in CSCL-based media proficiency studies on a wireless campus?* Previous studies have claimed that mobility enables students to participate even from a distance since mobile tools afford the added pedagogical value of flexibility of time and place (Ruokamo & Tella 2005; Lehtonen et al. 2004). The analysis carried out in this case study confirms these findings and adds that laptop computers afford students participating in CSCL the added pedagogical value of a possibility to operate on two levels of the learning activities involved, namely, the task-organizing and the task completion levels. Students inevitably become involved in organizing their studies when they are assigned an ill-structured task that they cannot complete on their own. Managing the practicalities of learning along with focusing on the substance issues of the course strongly ties students to CSCL processes and to one other.

Discussion

This case study suffers from the small amount of data. However, it was not possible to get more participants for the study, as there were ten participants in the course Media Proficiency, which is optional in the students' degree program. The results of this study nonetheless suggest recommendations for designing future CSCL-based courses in which students have laptops of their own. Students ought to be more deeply involved in the course design and made responsible for their work on both the task-organizing and the task completion levels. When students are responsible for dividing up and managing the group's work, for the social steering of the group and for the control of their interactions, they become more involved in CSCL processes in general, which benefits their group and individual performance.

Allowing students to schedule their work and to choose their location freely makes it possible for them to use resources outside the university. Among other things, it can be seen that mobility enables collaboration with partners in working life, which makes it possible to design assignments that are closely related to the students' future professional work. For example, students may interview an expert in their field to further completion of the group assignment, record the interview using their own equipment, transcribe the interview collaboratively and use the information during learning processes.

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Study V

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Laptop computers and wireless university campus networks: Is flexibility and effectiveness improved?

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This study explores whether university students find that laptop computers and networks increase flexibility and effectiveness of studying. Special attention has been paid to non-traditional students who have extra commitments, such as taking care of children or term-time employment. Questionnaire data was collected from students who had the opportunity to acquire a laptop partly sponsored by the university. The data was analysed quantitatively. Results show that students with children particularly benefited from the support the laptops and networks provided. However, term-time employment did not influence students' experiences of flexibility or effectiveness in studying. Since it is increasingly common for university students to have other commitments along with their studies, this information can be utilised when planning teaching and student support practices.

Introduction

Employment and family responsibilities are commitments that limit the time spent on studying. In this article students with children or students who are working during term-time are referred to as non-traditional students, as opposed to traditional students who are studying full time without being committed to working and do not have children. Depending on the individual case, commitments might affect the number of available classes, impede participation in group work, restrict access to school facilities and limit interactions with faculty and fellow students. However, many students must work to finance their studies and living expenses, and having children should not be an obstacle to one's education either. According to a recent Eurostudent report (2005), 4 to 11% of university students have children and 20 to 91% are employed during term-time. In North America adult students over the age of 25, who often have these extra commitments, are actually one of the fastest growing groups of undergraduates (Carney-Crompton & Tan, 2002). In the USA, almost 80% of undergraduate students identified themselves as being employed (Horn & Malizio, 1998). Accordingly, Riggert, Boyle, Petrosko, Ash and Rude-Parkins (2006, p. 63) stated that "colleges and universities can no longer assume that the majority of students will be able to give their full time attention to academic endeavors".

The introduction of network based learning environments (NBLE) has increased the possibilities of distance learning, and therefore also the flexibility of higher education. Along with the development in NBLEs, numerous colleges and universities have initiated technology programs that introduce different mobile technologies (laptop computers, personal digital assistants, mobile phones) to further increase the flexibility of studying. A popular solution for higher education institutions has been the implementation of laptop programs that include personal laptop computers for

students and, recently, also wireless local area networks (WLAN) that cover campus areas. Personal laptops are thought to increase the flexibility of studying by enabling computing anywhere and anytime, within the limitations set by batteries or availability of electricity. Laptops also provide storage space for students' personal files and study history. WLAN laptops increase also the availability of information and provide a wide range of communication tools that can be used to increase the effectiveness of studying. Despite the popularity of laptop programs among colleges and universities, articles exploring student experiences of laptop computers as studying tools are still scarce. This article aims to increase the knowledge of the ability of laptops and networks to increase the flexibility and effectiveness of studying and to find out whether student characteristics affect these experiences.

Theoretical framework

Students with commitments, like taking care of children or employment, often struggle with their schedules to integrate studies with their every day lives. Jacobs and Berkowitz-King (2002) argue that the tendency of older college students to enrol part time reflects the presence of competing social roles, and part time enrolment is the principal reason for lower completion rates at older ages. They also found that both full time and part time employment inhibited the chances of getting a degree. However, the literature provides inconsistent results concerning the effects of term-time employment on the progress of studies (reviewed in Riggert et al., 2006). Instead, having young children at home has been found to suppress the ability of women (Jacobs and Berkowitz-King, 2002) and divorced parents, regardless of gender, to complete their degree (Taniguchi & Kaufman, 2005). Scott, Burns and Cooney (1996) also found that family responsibilities were the primary reason for female Australian university students with children for interrupting their studies. Therefore, it is probable that most students with commitments have a stronger need than other students for studying tools that increase flexibility and effectiveness. This is also supported by the results of Eriksson, Vuojärvi and Ruokamo (2008), as a study on university students' expectations showed that in particular students with commitments (taking care of children, employment during term-time) expected laptop computers and networks to facilitate the integration of learning with their everyday lives.

The definitions of flexible learning usually include the possibility of choosing study modes, the opportunity to access learning materials and instructors, and student responsibility for learning (Honey, 2004). It is obvious that laptops, together with networks, can increase the availability of learning materials and other information sources, but laptops also make a significant difference in study habits and in students' academic and social lives, and are also valuable studying tools in terms of helping students with classroom assignments, communication, and research (Demb, Erickson & Hawkins-Wilding, 2004). In addition, Barak, Lipson and Lerman (2006) report positive perceptions of wireless laptops, as they enhance student centred, hands on, and exploratory learning. In the same research, students perceived laptops "as most useful and efficient for their learning". Newhouse, Williams and Pearson (2006) discuss that although the outcomes of their exploratory studies on the use of laptops in teacher education were generally positive, students still were reluctant to carry a relatively heavy device when they were unlikely to be asked to use it in lectures and tutorials. Some studies have also found laptops to be a distraction to both users and fellow students (Barak et al., 2006; Fried, 2008) and to interfere with students' abilities to pay attention to and understand the lecture material (Fried, 2008). However, despite

some negative results, mainly related to laptop use during lectures, laptops and networks have the potential to improve students' time management efficiency by transforming former dead-time, e.g., in trains or while children are sleeping, into productive time. The flexibility that students experience as a result of their increased studying possibilities may also improve the results of their studying efforts, e.g. by speeding up graduation, and therefore also increasing the effectiveness of studying.

Based on the needs and expectations of non-traditional students and the mainly positive experiences of laptop use, it is hypothesised that these students consider personal laptops and networks as tools that increase the flexibility and effectiveness of studying more than traditional students. This hypothesis is also supported by the results of Donaldson (1999) who suggests that mature students, who usually have these commitments, are more able than younger ones to use different skills and strategies to compensate for their inability to partake all activities on campus. In addition, Hoskins and van Hooff (2005) propose that older students have a deeper approach to studying and a higher intrinsic motivation, which could prepare the way for a more effective use of available studying tools such as laptops and associated learning environments. Laptops thus afford the potential for self regulation and particularly the environmental aspect of it. Self regulation in education is understood as taking responsibility in learning through setting learning goals, and being aware of one's own actions and different factors that affect the process of achieving those goals. Environmental self regulation implies creating a suitable environment for studying and learning, for example by choosing a quiet place to study (Zimmerman, 1989). Mobile information and communication technologies can facilitate environmental regulation by affording flexibility regarding when and where to study. Being able to take charge of one's own learning and controlling the factors that have an influence on the learning process – such as management of time and place – may contribute significantly to study motivation (Zimmerman, 1998).

Research questions

Student opinions of the laptop initiative were surveyed at the University of Lapland with the objective of determining whether students consider laptop computers and networks as studying tools that increase the flexibility and effectiveness of studying. In addition, the question was studied whether commitments, such as taking care of children, term-time employment and being in a steady relationship, or characteristics like gender or age affect students' experiences with laptops. The study focused on university students who have access to a laptop and are actively using computers and networks. The specific research questions were:

1. Do students actively using computers and networks experience personal laptop computers and networks as study tools that increase flexibility and effectiveness?
2. Do commitments like having children, being employed during term-time and being in a steady relationship or characteristics like gender or age affect students' experiences with laptops and networks as studying tools that increase flexibility and effectiveness of studying?

Context

The University of Lapland is situated in the city of Rovaniemi, in northern Finland, and has about 4,500 students with about 550 to 700 new students enrolling each year.

More than half of the students come from northern Finland. In the autumn of 2004 the university initiated a laptop program where new students where able to purchase a laptop computer partly sponsored by the university. Until spring 2008, four incoming classes have been able to purchase these laptops. Costs for students have been between 360 to 840 €, depending on the year of purchase and the field of study – art students for example need faster computers for 3D-modelling and graphic design than other students. In 2004, 85% of new students purchased the university laptop. However, as laptop computer prices have gone down more and more, many students already have their own laptop when entering university. Thus only 35% of new students purchased a university laptop in 2007. All university laptops were equipped with a standard open source office software package, software for statistical analysis, and basic data security software such as a firewall and virus protection. In the Faculty of Art and Design, laptops for students were also equipped with some special software suitable for those students' needs.

Laptops also had a readiness for networking in wireless local area networks (WLANs). To support the use of laptops, a WLAN, covering all buildings at the campus area was launched, enabling students and faculty outside computer classes to access the Internet. For Internet access outside the campus area, for example at home, students needed some other Internet service provider. The inquiry showed that more than 95% of respondents had the possibility to access the Internet also at home in spring 2008. University of Lapland provides all students enrolled a free email account and a remote access to university network also outside campus area. Student laptop use is supported through a helpdesk where students are able to get help in all computer related problems, like connecting the laptop to the university WLAN or problems with the university email. In addition, the university provides several computer rooms with desktop computers for student use.

The ways how laptop use is encouraged and facilitated vary greatly between disciplines and courses, and is very dependent on teachers' own initiatives. For example art students use laptops on a regular basis for 3D-modelling, graphic designing and audio-visual productions whereas social sciences students attend courses that include more lecture based teaching than hands on training and do not necessarily need laptops all the time. Teaching personnel have not been provided with training on how to take advantage of mobile technology in teaching. Some teachers are very interested in trying out different ways to conduct the courses they are responsible for, but some prefer doing things the way they are used to. All students have access to learning management system *Oodi* that enables registering to courses, giving feedback and following own records of completed studies. In addition, *Optima Campus* provides a network based learning environment where teachers can create working spaces to their courses, deliver material and receive course assignments from students.

Methods

Data collection

An online questionnaire was selected as an instrument for data collection. It is acknowledged that online questionnaires might be 'self selecting' by being unapproachable for participants who suffer from computer anxiety (Chua, Chen & Wong, 1999 and references therein) or are otherwise infrequent users of computers. Therefore, it is supposed that students who are more likely to use the computers and

networks are also more likely to complete an online survey. As the purpose of this study was to survey student experiences of the flexibility and effectiveness that laptops and networks provide, and to find out which student characteristics affect these experiences, it is important that respondents are actively using computers in their studies. In addition, only respondents who owned a university sponsored laptop or had access to some other laptop were allowed to answer the items related to experiences of laptop and network use.

The questionnaire was generated using the *Webropol* (http://www.webropol.com/). In April 2008, an email that included an introduction to the research, an invitation to participate in the survey, and a personal link to the questionnaire was sent to all 2,888 students who entered the University of Lapland in the fall of 2004 or later and who had agreed that their email address could be used for learning related polls. In addition, some students who had entered the University before the fall of 2004, but had later changed their major, were included. Reminder emails were sent a week later. The questionnaire was tested before delivery to students; overlapping questions were removed and the questionnaire was shortened. In the questionnaire, students were asked for background information (e.g. number of children, whether they worked during term-time, marital status, gender, age and faculty). The survey inquired into experiences and knowledge of using computers and the Internet, experiences of laptops and networks in teaching, studying and learning. Most of the questions were multiple choice, but some open ended questions were used also.

Data analysis

All data was analysed quantitatively using *SPSS Version 15.0 (SPSS for Windows)*. Ten preselected items were exposed to factor analysis (principal component analysis; varimax rotation) to sort out the items that best describe flexibility and effectiveness of studying. Two factors with eigenvalues over 1.0 emerged (Table 1). To analyse the data further, individual questionnaire items, grouped by the factor analysis, were used to create two scales. The internal consistency of the created scales was tested by calculating Cronbach's alpha (Cronbach, 1951). Cronbach's alpha takes values from 0 (indicating no correlation) to 1 (indicating identical results) and an alpha value of about 0.7 or above is considered as evidence of acceptable internal consistency (Nunnally, 1978). The alpha value of 0.7 was exceeded in both scales, named "Flexibility" (alpha = 0.84) and "Effectiveness" (alpha = 0.85). Both scales were recoded into 5-point scales for contingency table analysis.

We applied the Kruskal-Wallis chi square test to analyse the association between the two scales and background information (contingencies). If possible, the exact significance was computed. Otherwise, a Monte Carlo estimation of the significance based on 10,000 samples was used (Mehta & Patel, 1996). Because chi square test is sensitive to sample size, the strength of the relationship between variables was also calculated using Goodman and Kruskal's tau – an additional measure of association (Goodman & Kruskal, 1954). The benefit of this index is that it measures the predictability of one categorical variable given the presence of another. Goodman and Kruskal's tau takes values between 0 (no association) and 1 (completely related). Statistical differences were deemed significant at $p = 0.05$. In the results section only results deemed significant by both tests are mentioned as significant results.

Table 1: Factor analysis (principal components; varimax rotation) results of ten preselected items describing student experiences of the ability of laptop computers and networks to enhance flexibility and effectiveness of learning

Items	Factors	
	1	2
The use of laptop computer and networks has changed studying so that it is more independent of time and place	.856	
The use of laptop computers and networks has changed the routines of time expenditure in studying	.811	
The use of laptop computer and networks has made studying more flexible	.846	
The use of laptop computer and networks has made the integration of studying and everyday life easier (e.g., concerning scheduling)	.625	
The use of laptop computer and networks has made studying more effective		.607
The use of laptop computer and networks has speeded up your graduation		.596
With the help of laptop computers and networks, you have studied more actively		.711
With the help of laptop computer and networks, you have achieved your learning goals		.689
With the help of laptop computer and networks, your learning results have improved		.885
With the help of laptop computer and networks, you have learned quickly		.811

Respondents

The questionnaire was sent to 2,888 students and was returned by 392 respondents, representing 13.6% of the student population. Altogether, 575 students opened the link to the questionnaire, which means that 183 students either only checked the questionnaire or quit before reaching the last question. The proportion of male (25.8%) and female (74.2%) respondents, as well as the number of respondents from each faculty, represented the student population enrolled between 2004 and 2007 well. All four classes between 2004 and 2007 were also well represented, as their proportion varied between 0.20 and 0.26. Respondents' mean age was 28.5 years (median = 25), while the youngest students were 20 and the oldest was 59 years of age. Of the total 392 respondents, 22.2% had children, 48.5% were married or cohabiting, 19.1% were going steady and 32.4% were single. A majority of students worked during term-time, either regularly (34.4%) or occasionally (39.3%), while 26.3% of respondents did not work at all. A majority (74.2%) of respondents had acquired a university sponsored laptop, 20.7% had a laptop from another source and 36.0% had a desktop. Almost all respondents (96.7%) had access to the Internet at their apartment.

Results

The results show that although most respondents consider that personal laptops and networks increase the flexibility of studying, it does not automatically mean that the effectiveness of studying would also increase. Overall, 79.9% of respondents agreed or strongly agreed (later referred to as agreed) that laptops and networks increased flexibility of studying (mean = 4.06, SD = 0.82; Table 2), while only 38.8% agreed that this technology increased effectiveness of studying (mean = 3.28, SD = 0.81; Table 3). However, only 16.3% of respondents strongly disagreed or disagreed with the "effectiveness" scale while 47.7% responded "undecided".

Table 2: Frequency (%) of "Flexibility" and student background data including whether or not students have children, term-time employment, gender, age and marital status. Measures of association (Kruskal-Wallis chi square = chi square, Goodman-Kruskal's tau = tau) and their significance are also presented

	1 Strongly disagree	2 Disagree	3 Undecided	4 Agree	5 Strongly agree	Totals (n)
Have children						chi square = 8.700, $p = 0.003$[a]; tau = 0.014, $p = 0.007$[a]
Yes	2.7%	1.3%	9.3%	41.3%	45.3%	100.0% (75)
No	0.7%	3.1%	18.1%	51.4%	26.7%	100.0% (288)
Term-time employment						chi square = 0.794, $p = 0.421$[b]; tau = 0.002, $p = 0.911$[b]
Regularly	0.8%	3.3%	18.3%	46.7%	30.8%	100.0% (120)
Occasionally	0.7%	2.0%	14.3%	52.4%	30.6%	100.0% (147)
Not at all	2.1%	3.1%	16.7%	47.9%	30.2%	100.0% (96)
Gender						chi square = 12.691, $p < 0.001$[a]; tau = 0.010, $p = 0.025$[a]
Male	3.3%	4.3%	23.9%	48.9%	19.6%	100.0% (92)
Female	0.4%	2.2%	13.7%	49.4%	34.3%	100.0% (271)
Age						chi square = 1.675, $p = 0.645$[b]; tau = 0.006, $p = 0.630$[b]
< 24	0.0%	2.7%	19.5%	52.2%	25.7%	100.0% (113)
24-25	1.3%	1.3%	17.7%	49.4%	30.4%	100.0% (79)
26-29	1.2%	3.6%	12.0%	51.8%	31.3%	100% (83)
> 29	2.3%	3.4%	14.8%	43.2%	36.4%	100.0% (88)
Marital status						chi square = 1.294, $p = 0.528$[b]; tau = 0.003, $p = 0.699$[b]
Married or cohabiting	1.2%	2.3%	14.6%	49.1%	32.7%	100.0% (171)
Going steady	1.4%	0.0%	16.4%	54.8%	27.4%	100% (73)
Single	0.8%	5.0%	18.5%	46.2%	29.4%	100% (119)
Totals	1.1%	2.8%	16.3%	49.3%	30.6%	100.0% (363)

[a] Exact significance; [b] Monte Carlo Significance based on 10,000 samples

Cross-tabular analyses (Kruskal-Wallis chi square and Goodman and Kruskal's tau) were performed to find out the significant associations between experiences of both flexibility and effectiveness and student commitments like having children, being employed during term-time, and being in a steady relationship and characteristics like gender and age. Results show that of the tested commitments, only having children was significantly associated with both flexibility and effectiveness of studying. A significantly greater number of students with than without children reported that laptops and networks had increased both the flexibility (86.6 and 78.3%, respectively; Table 2) and the effectiveness (54.0 and 35.0%, respectively; Table 3) of studying. However, experiences of flexibility or effectiveness were not associated with employment. The only association found concerning marital status was the association with effectiveness of studying, based on chi square test, but Goodman and Kruskal's tau did not support this conclusion. If students with children were excluded from the analysis, even the chi square test indicated that marital status was not a significant factor.

In addition to commitments, also the association of gender, age, marital status and faculty with flexibility and effectiveness of studying was tested. Association between gender and flexibility was significant, as a greater number of women (83.7%) than men

(68.5%) agreed that laptops and networks have increased the flexibility of studying (Table 2). If students with children were excluded from analysis, the difference between genders still remained significant based on chi square analysis (chi square = 9.685, $p = 0.002$), but not quite with Goodman and Kruskal's tau (tau = 0.009, $p = 0.065$). Gender, however, did not affect experiences of technology's ability to enhance the effectiveness of studying. Students' age was significantly associated with experiences of effectiveness (Table 3), as 55.2% of the oldest students (> 29 years) and 29.1 to 37.7% of younger students (≤ 29 years) agreed with the effectiveness scale. Experiences of flexibility, however, were not associated with students' age (Table 2). Faculty did not effect experiences of flexibility, but Goodman and Kruskal's tau indicated an association between faculty and effectiveness of learning (chi square = 4.729, $p = 0.307$; tau = 0.032, $p = 0.004$). Students from the Faculty of Education, the Faculty of Business and Tourism, and the Faculty of Social Sciences seemed to have more positive experiences of laptops' and networks' ability to increase effectiveness of studying as 45.4, 46.1 and 41.5%, respectively, of students agreed with the 'effectiveness' scale, while only 31.8 and 25.5% of students from the Faculty of Law and the Faculty of Art and Design, respectively, agreed with this scale.

Table 3: Frequency (%) of "Effectiveness" and student background data including whether or not students have children, term-time employment, gender, age and marital status. Measures of association (Kruskal-Wallis Chi square = chi square, Goodman-Kruskal's tau = tau) and their significance are also presented

	1 Strongly disagree	2 Disagree	3 Undecided	4 Agree	5 Strongly agree	Totals (n)
Have children			chi square = 9.501, $p = 0.002$[a]; tau = 0.011, $p = 0.017$[a]			
Yes	2.7%	5.4%	37.8%	45.9%	8.1%	100.0% (74)
No	2.1%	12.8%	50.2%	31.5%	3.5%	100.0% (289)
Term-time employment			chi square = 0.993, $p = 0.606$[b]; tau = 0.005, $p = 0.456$[b]			
Regularly	3.4%	9.2%	47.1%	35.3%	5.0%	100.0% (119)
Occasionally	1.3%	8.7%	51.7%	34.2%	4.0%	100.0% (149)
Not at all	2.1%	17.9%	42.1%	33.7%	4.2%	100.0% (95)
Gender			chi square = 0.259, $p = 0.611$; tau = 0.002, $p = 0.413$[a]			
Male	3.3%	15.2%	42.4%	33.7%	5.4%	100% (92)
Female	1.8%	10.0%	49.4%	34.7%	4.1%	100% (271)
Age			chi square = 8.795, $p = 0.033$[b]; tau = 0.030, $p = 0.002$[b]			
< 24	0.9%	14.3%	50.9%	30.4%	3.6%	100.0% (112)
24-25	2.5%	7.6%	60.8%	22.8%	6.3%	100.0% (79)
26-29	2.4%	12.9%	47.1%	36.5%	1.2%	100.0% (85)
> 29	3.4%	9.2%	32.2%	48.3%	6.9%	100.0% (87)
Marital status			chi square = 10,023, $p = 0.007$[b]; tau = 0.010, $p = 0.102$[b]			
Married or cohabiting	1.8%	8.8%	42.7%	39.8%	7.0%	100% (171)
Going steady	2.8%	12.5%	55.6%	26.4%	2.8%	100% (72)
Single	2.5%	14.2%	50.0%	31.7%	1.7%	100% (120)
Totals	2.2%	11.3%	47.7%	34.4%	4.4%	100% (363)

[a] Exact significance; [b] Monte Carlo Significance based on 10,000 samples

Discussion

This study indicates that particularly those students with children considered personal laptops and networks as studying tools that increase the flexibility and effectiveness of their studying. Although it was hypothesised that all non-traditional students (students with children and students working part or full time during term-time) would consider that these tools increase flexibility and effectiveness of studying more than traditional students, employment during term-time did not influence these experiences. A prior survey inquiring into students' expectations showed that both commitments, whether or not students have children and whether or not they work during term-time, affected students' expectations of the way in which laptops and networks could support the integration of studying in their everyday lives (Eriksson, Vuojärvi & Ruokamo, 2008). This suggests that both groups need flexible studying and that they think technology supported learning can at least partly solve their scheduling problems. The large proportion (22.2%) of students with children among respondents, compared to the 10% of students with children among all university students in Finland (Viuhko, 2006), shows that students with children were over-represented among respondents. This suggests that they set great store by the theme of this questionnaire.

The difference in experiences between students with children and employed students might stem from the differing nature of these two commitments. Employment ties the worker to his/her place of work only for a certain period of time, leaving for example evenings or weekends free for studying. When most of the studying activities take place at home, a laptop does not provide much additional flexibility compared to a desktop – maybe just the possibility of choosing one's place of study between desk and couch. Taking care of children, however, is more of a twenty-four/seven job where the opportunities for studying cannot always be predicted. It is possible that because of their 'unpredictable learning environments' students with children have a greater need for flexible studying tools than working students. They have, therefore, benefited more from laptops and networks that allow learning where and when it best suits the student, which consequently improves the possibilities for efficient time management – one of the self-regulatory processes suggested by Zimmerman (1998).

Laptops also allow students to self regulate their studying environments (cf. Zimmerman, 1998), for example, by seeking a quiet place for studying while the other parent is taking care of children or by enabling studying in the backyard while children are taking their afternoon nap or playing under their parents' surveillance. The possibilities of taking charge of one's own studying may contribute significantly to study motivation, which is necessary for students' proactive efforts, personal initiative, resourcefulness, persistence, and sense of responsibility, to learn on their own (Zimmerman, 1998). As self regulation is not considered a fixed characteristic of students but rather a context specific process that is selectively used to succeed in school (Zimmerman, 1998), it is possible that students with children are more eager to take advantage of the self regulatory capacity that laptops and networks offer. This could consequently lead to experiences of more effective learning. The difference between these two commitments is also evident from previous studies that show that having children has mostly negative effects on the progress of studies (e.g., Jacobs & Berkowitz-King, 2002; Taniguchi & Kaufman, 2005), while the results of studies that evaluate student employment and higher education are at times inconsistent or even contradictory (reviewed in Riggert et al., 2006).

In the present research, gender was found to affect experiences of flexibility significantly, as 83.7% of women and 68.5% of men considered that laptops and networks enhance the flexibility of learning. Differences between genders in experiences of the effectiveness of studying were, however, not found. The result concerning the flexibility of learning is quite the opposite to many studies published during the last decades, which report a digital divide between genders from elementary school to higher education, with females expressing greater computer anxiety and more negative attitudes than males (reviewed by Cooper, 2006). Partly, the result is explained by the selective data collection method, that could have excluded students who either suffer from computer anxiety or are otherwise infrequent users of computers and the Internet. However, some recent studies have also shown that the gender gap is decreasing, at least in attitudes towards computers (Link & Marz, 2006; Teo, 2008) and online abilities (Hargittai & Shafer, 2006). However, despite women's actual abilities, women still self assessed their skill level significantly lower than men (Hargittai & Shafer, 2006).

Although age did not significantly affect experiences of flexibility, it did however have a significant effect on experiences of effectiveness, with older students (> 29) in particular experiencing laptops and networks as enhancing effectiveness of their studies. One explanation for the result could be older students' deeper approach to studying and higher intrinsic motivation (Hoskins & Hooff, 2005) that prepare the way for a more effective use of available tools such as laptops and associated learning environments. In an earlier study Barak et al. (2006; p. 257) reported that senior students valued active learning through the use of laptop computers more than other students, and suggested that "the more mature and ready for scholarly pursuits the students are, the better they understand the importance and effectiveness of being active in their learning". Actually, a closer look at the responses to the individual item 'With the help of laptop computers and networks, you have studied more actively' show that a significantly larger part of older (48.3%) than younger students (30.4-36.0%) agreed or strongly agreed with the statement.

Although most definitions of flexible studying include the possibility of choosing study modes, the opportunity to access learning materials and staff, and student responsibility for learning (Honey, 2004), our 'flexibility' scale has more to do with the possibility of using laptops for studying when and where it best suits the student. This independence of time and place consequently leads to changes in the routines of time expenditure, and also makes the integration of studies with everyday life easier. 'Effectiveness' scale, instead, mainly describes how laptops and networks have affected the progress of studies. Overall, almost 80% of respondents thought that laptops and networks increased flexibility, while less than 40% thought that the effectiveness of learning increased with the use of these tools. When interpreting these results, one must remember that the respondents do not represent all students of the University of Lapland, but focuses on those actively using computers and networks. Keeping the study method in mind, the results suggest that experiences of flexibility do not automatically lead to more effective studying and that a large part of the supportive value of laptops and networks for students consists of the opportunity to do their assignments at home, on campus or wherever the opportunity arises. The result that only 39% of respondents thought that laptops and networks increase effectiveness of studying could be an indication of a failure to integrate laptops into faculties' curricula.

According to Demb et al. (2004), students' perceptions of the value of their laptops in relation to their academic success have been found to correlate tightly with their perceptions of how successful the faculty has been in terms of integrating laptops into teaching and classroom activities. This is probably also the case in the University of Lapland as there were significant differences between faculties in students' experiences concerning the effectiveness of studying. In practice, this could mean that there are currently, at least in some faculties, insufficient possibilities for distance learning and/or too much of a focus on mandatory attendance at lectures. Experiences at Winona State University show that "access to laptops is not sufficient to support and transform pedagogy. Successful implementation depends on support from administration, technology staff, and individual departments" (McVay et al., 2005; p. 514). It therefore seems that the faculties and technology staff at the University of Lapland still have much work to do to integrate laptops and wireless networks successfully into the curriculum and teaching practices.

Results indicate clearly that laptops and networks can increase flexibility of studying for both traditional and non-traditional students but also that a considerably lower proportion of students experienced an improvement in effectiveness of studying. The key for improving also the effectiveness of studying is careful planning of teaching and student support practices. It seems to be beneficial for students if they have more choice on how they want to study the courses they are enrolling in (e.g. Honey, 2004), for example a possibility to choose whether they want to take an exam or write an essay. This would increase both flexibility and students responsibility for their own learning and probably also their motivation, which has been found to be positively related with several aspects of successful self regulated learning (Zimmerman, 1998). Mandatory attendance at lectures can rule out enrolling in some course entirely if, for example, a student has to take care of children at the same times. It could be contemplated if lectures could be recorded and saved in network based learning environments, in which students could watch them at a more convenient time. With the help of video conferencing hardware and software, lectures can also be broadcast in real time if recording is out of question, for example due to material rights issues that are now topical in education because of fast growth of the amount of digital material provided for students.

Effectiveness of studying can also be promoted by careful planning of students' own personal studying paths. Currently, students in the University of Lapland have both student and teacher tutors who help them in planning their studies. It is however presumable that these tutors have a deep knowledge only of their own discipline, which is problematic because it is common for students to take courses in other faculties also. Perhaps student guidance could be carried out in multi-disciplinary teams that have knowledge on the completion possibilities in different faculties. This would help students to plan their academic year in more detail, taking into account how they may benefit from mobile technology in different courses they are planning to take. It needs to be borne in mind that commitments such as having children are the starting point that dictates how other activities take place in students' lives. Detailed plans and schedules provide predictability that helps students' planning of their everyday lives in general, and not just their studies.

Conclusion

It is increasingly common for university students to have other commitments alongside their studies. Therefore, it is of the utmost importance that this is acknowledged by universities as they plan their teaching practices and student support structures in particular. Failing to do so may result in lengthening studying spans or increasing the drop out rate – these are consequences that today's efficiency focused university strategies aim to avoid. As almost 80% of all respondents and over 85% of students with children agreed that laptops and networks increase the flexibility of studying, and more than half of the students with children and older students also experienced that laptops and networks increased the effectiveness of studying, the practical implication of this research is that the use of laptops should be encouraged and that the laptop program should continue.

However, the low overall percentage of respondents (39%) agreeing with the effectiveness scale suggest that most of the students are not taking full advantage of the possibilities these learning tools offer. It is probable that some of these students simply do not need more effective studying tools, but it is also possible that a significant proportion of students do not have such self regulation skills that enable these supportive mobile technologies efficiently. Training for self regulative skills like goal setting, self monitoring, time management or environmental structuring (e.g. Zimmerman, 1998) should be part of each student's education. In addition, teachers should be given opportunities to develop their skills as instructors who can promote the use of laptop and WLAN technologies. Development of one's own work requires time to deliberate upon different possibilities and to think what, for example, would be the best way to support collaborative discourses, deliver material or give feedback for students. If there is not enough time for course development in a teachers' work plan, it is easier to continue the same way as earlier than make hasty alterations in course design.

Because of the low response rate, which is typical for email surveys (eg, Kaplowitz, Hadlock & Levine, 2004), and the possible bias in respondents towards those actively using computers and networks, these results should not be generalised to represent all students at the university. The possible bias amongst responding students should not, however, be taken as a weakness in the data, as students actively using computers and networks are exactly the group that can best estimate the possible benefits these studying tools can offer. This paper adds to the still limited literature concerning laptop computers and networks as tools that afford flexibility and effectiveness for non-traditional students. Our results demonstrate the need for further research to determine the special concerns and needs of non-traditional students, and how those needs can be addressed.

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Study VI

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Different Backgrounds—Different Priorities? Student Perceptions of a Technology Initiative

Miikka J. Eriksson & Hanna Vuojärvi

Abstract

A multitude of studies has assessed the success of different technology initiatives but rarely the focus has been on special groups. We studied whether university students with and without children have different perceptions of a technology initiative, where students were given a chance to acquire university sponsored laptops and provided with a wireless local area network around campus. The division of students into these two groups is based on earlier research suggesting that the studies of students with children are heavily restricted by their multiple commitments and might, therefore, have quite different priorities, than ordinary students, when comparing the pros and cons of the initiative. The results acquired by the combined use of SWOT (strengths, weaknesses, opportunities and threats) analysis and analytic hierarchy process (AHP) suggest that both students with and without children consider the increased "effectiveness of studying" the most important strength of the laptop initiative. It, however, seems that students with children appreciate especially the mobility and flexibility that laptops and networks offer, while other students value more the functionality of the university infrastructure and are more concerned about the deteriorative effects of technology on communality within the university. Results, therefore, indicate that students' background really affect their priorities when assessing technology initiatives. Noticing also the differing needs may prevent dropouts and prolonged graduation.

Keywords: laptops; student experience; SWOT; analytical hierarchy process; students with children

Introduction

Universities around the world have undertaken initiatives to integrate information and communication technologies (ICTs) into teaching and learning. One such initiative was

carried out at the *[name deleted to maintain the integrity of the review process]*, Finland, where students had an opportunity to acquire university sponsored laptops through the university from 2004 to 2009. Additionally, a wireless local area network (WLAN) was launched on campus. The practically motivated initiative aimed mainly to compensate for the small number of computer classes available to students. It was thought that after a few years, students would use laptops exclusively, enabling the computer rooms to be discontinued to decrease their maintenance costs (*[names deleted to maintain the integrity of the review process]*, 2008). Such an initiative can, however, also deeply affect teaching and learning at the university. Wireless laptops enable flexible studying in terms of time and place, but they also provide a convenient way to store documents providing an easy access to one's personal study history, and enable collaboration with other students either online or face-to-face, on or off campus.

A number of studies concerning ICT implementations have already provided critical knowledge; however, studies concerning special student groups are scarce. Stensaker, Maassen, Borgan, Oftebro, and Karseth (2007, p. 431) emphasize the importance of noticing the differences between user groups:

> *Without a focus on the personal needs of those who actually are to use and integrate new technology on the "working floor" of the higher education institutions, one can imagine that many institutions will have great difficulties getting beyond the first phase.*

Technology initiatives should be based on students' needs and preferences regarding the use of ICTs in learning (e.g., creating personal learning environments) (Luckin, 2010). In order to develop current initiatives and plan future implementations, strategic knowledge — especially links between purpose, people, and pedagogy inside institutions (Stensaker et al., 2007) — is required, and both positive and negative perceptions must be identified.

This study was motivated by the differences in the commitments of students with and without children. Family responsibilities limit the time spent on studying, and possible employment may add to these problems (Jacobs & Berkowitz-King, 2002). The tendency of older students to enroll part-time indicates the presence of competing social roles and having young children at home suppresses the ability of parents to graduate (Jacobs & Berkowitz-King, 2002; Taniguchi & Kaufman, 2005). As family life can sometimes be

somewhat unpredictable, these students may experience difficulties in preparing for higher education that requires careful planning (Bolam & Dodgson, 2003). Our interviews with university students with children (N = 14) confirms most of the above results and adds that for them successful studying is largely dependent on the support of their spouses or relatives – those without these support structures are struggling with their responsibilities (*[name deleted to maintain the integrity of the review process]*). The commitments of students with children also affect their possibilities to spend time at the university and, as a consequence, to connect with their peers. Therefore, they hardly ever communicated with their peers outside classrooms and also had quite negative attitudes towards out-off-class group work. Most students with children preferred to study alone, instead of group work, as they perceived the scheduling of sessions with other students so challenging. ICTs might ease some of these problems by increasing flexibility in organising of studies. Earlier results also indicate that students, particularly those with children, benefited from the support laptops and networks afforded in their studies (Eriksson et al., 2009).

This paper describes student perceptions of using laptops and WLAN in university-level teaching and learning with particular interest paid to the preferences of two groups of students: those with and without children. The data was gathered and analysed in two phases. First, students were asked about their perceptions of the strengths, weaknesses, opportunities, and threats (SWOT) of laptops and WLAN in teaching and learning through an online questionnaire (N=392). Second, after SWOT data was analysed students (N=24) went through an analytical hierarchy process (AHP) to determine their preferences of the selected SWOT themes. This paper reports and discusses the found differences between the two student groups and considers the effects of student background for these results. In addition, we discuss how the combined use of SWOT and AHP fits in assessing similar educational initiatives.

Previous research on students' experiences

University students perceive that having access to a WLAN, a sufficient number of plug-ins, printer availability, and on-site maintenance are all critical to the success of laptop initiatives (Cutshall, Changchit, & Elwood, 2006). They also prefer low costs and having a say in choosing the laptop (Demb, Erickson, & Hawkins-Wilding, 2004). Students have

expressed that using laptops positively affects their studying habits, academic success, and perceptions of their technological readiness (Demb et al., 2004; Finn & Inman, 2004). Potentially, they enhance student-centred, practical, and exploratory learning as well as meaningful interactions with peers and teachers (Weaver, 2005). In particular, students with children have found laptops important, as they increase the flexibility and effectiveness of their studying (Eriksson, Vuojärvi, and Ruokamo, 2009).

On a negative note, students have said that network and hardware problems related to laptops hinder their use for personal or social purposes (Demb et al., 2004). Using laptops in teaching also requires careful pedagogical planning, and the manner in which laptops are utilised affects students' perceptions of their usefulness. If proper planning is neglected, laptops can even disturb teaching and learning (Fried, 2008; Hembrooke & Gay, 2003). However, students are motivated to use wireless technologies if they have a clear need for it (Lee, 2007).

In order to continue developing laptop initiatives, more strategic knowledge is needed. Students who have actively used laptops in their studies and everyday lives are an irreplaceable source of information when evaluating the pros and cons of the current initiative but also when thinking about the future. Previous studies also indicate that students' views about the possible pros and cons might differ quite a bit depending on each student's background.

This study aims to reveal university students' perceptions of using laptops and networks in learning using SWOT and AHP processes. The research questions of this study are as follows:

> (1) What are the perceived strengths, weaknesses, opportunities, and threats of using laptop computers and wireless networks in teaching and learning, according to university students?
>
> (2) What is the order of significance of identified strengths, weaknesses, opportunities, and threats, according to students with and without children?

Methods of data collection and analysis

SWOT

SWOT is an acronym of four components: strengths, weaknesses, opportunities, and threats. It has been perceived as an analytical and development tool for business, but lately, its use has widened to other areas where strategic planning is needed (e.g., Jackson & Helms, 2008). Here, it was thought as an effective way to gather large amounts of ideas and thoughts that could be further processed with other methods. Traditionally, strengths and weaknesses are seen as connected with the internal environment of an organisation, and opportunities and threats with the external environment, but in this case SWOT's four components describe the students' views of how things are now and how they see the future of using laptops and networks in teaching and learning. This opened up possibilities to identify areas that are or are not functioning and areas that are seen as the biggest opportunities or threats for the development.

SWOT data was collected using an online questionnaire in April 2008. Participants (N = 392) were students that entered the University between 2004 and 2007. It is assumed that students who are frequent users of ICTs are more likely to complete an online survey than students who use computers less frequently (e.g., students suffering from computer anxiety) (Chua, Chen & Wong, 1999). As the purpose of this study was to survey students' perceptions of laptops and wireless networks in teaching and learning, it was important that all respondents were active computer users. Therefore, the use of somewhat "self-selecting" online questionnaires as a data-collection method was well argued. Consequently, the results should be interpreted as representing active computer users rather than all students of the university.

SWOT analysis has been criticised of sometimes being carried out at too simplistic a level (Panagiotou, 2003). Therefore, in this study, a more detailed thematic content analysis (Gray, 2004) was carried out by coding and theming students' answers in the four SWOT categories by two authors to enhance the credibility of interpretation. SWOT analysis offered knowledge about students' perceptions and hence a basis for composing the questions for AHP interviews. Thus all of the themes discussed in AHP interviews came

from the students themselves. Those that were often mentioned were regarded as important but also some themes that were rarely mentioned offered valuable insights of students' experiences. It was the researchers' responsibility to deliberate the knowledge gained in the SWOT analysis and carry out the final pruning of what themes would be further analysed in AHP interviews.

AHP

The second phase of data collection—interviews based on AHP—was carried out in 2009 to find out which themes in each SWOT category students considered most important. Because previous studies have implied that students with children are clearly a distinct group among students (Eriksson et al., 2009; Jacobs & Berkowitz-King, 2002; Taniguchi & Kaufman, 2005), it was reasonable to expect that students with and without children would also have significantly different views about the role and importance of technology in their studies. Therefore, the first set of interviewees was selected from students who responded to an electronic questionnaire in 2008 and who had one or more children under the age of 10. All (N = 59) such students were contacted by email to ask if they would volunteer for an interview. Fourteen students with children agreed to participate. The interviewees (11 females and 3 males) were 24 to 45 years of age.

The second set of AHP interviewees was selected from students who responded to the electronic questionnaire in 2008 and did not have any children. One hundred randomly selected students were contacted by email to ask if they would volunteer for an interview. Ten students agreed to be interviewed. The interviewees (six female and four male) were 23 to 32 years of age.

AHP is a general theory of ratio scale measurement based on mathematical and psychological foundations (Kangas, 1993). Saaty (1977, 1980) developed AHP originally as a decision tool for complex individual decision-making problems, but it is also amendable to group decision-making. This method has been predominantly used in the area of selection and evaluation in several fields (Vaidya & Kumar, 2006). The combined SWOT-AHP approach was first introduced by Kurttila, Pesonen, Kangas, and Kajanus (2000) to produce quantitative values for the SWOT factors or themes.

When AHP is applied, a hierarchical model for decision-making or assessment is constructed by dividing the problem into its decision elements. In this study, these decision elements are the themes acquired from the SWOT analysis. Most of the selected themes (Tables 4–7) were the ones that came up most frequently in students' SWOT analyses. Some themes were also included based on the researchers' considerations of their importance to the success or future of the laptop program. More specific reasons for the selection of themes for the AHP interviews are presented in the results section. In practice, each student made pairwise comparisons between the selected five themes within each SWOT category considering the following: 1) which of the two themes compared is a greater strength (weakness, opportunity, or threat) for university studies when using laptops and WLAN and 2) how much greater? The content of each theme was further clarified for each interviewee. The quantitative values, on a scale from 1 to 9, were derived from the verbal comparisons shown in Table 1 and were marked on an appropriate AHP matrix table. Table 2 presents an example of an AHP matrix. Similar matrices were composed of all four SWOT categories.

Table 1. The AHP scale

Number	Meaning	Explanation
1	equal importance	both items are equally important in terms of studying
3	a little bit more important	based on experiences and assessment, the first item is a little bit more important than the second item
5	a lot more important	based on experiences and assessment, the first item is a lot more important than the second item
7	very much more important	based on experiences and assessment, the first item is very much more important than the second item
9	extremely much more important	based on experiences and assessment, the first item is extremely much more important than the second item
2, 4, 6, and 8	compromises on the numbers above	
Inverse numbers	selected if the second item is more important than the first	

Table 2. An AHP matrix of the strengths category

	Mobility	Availability of networks	Easiness of Studying	Effectiveness of studying	Availability of laptop
Mobility	1				
Availability of networks		1			
Easiness of studying			1		
Effectiveness of studying				1	
Availability of laptop					1

The matrix of pair-wise comparisons is constructed as shown below. In this matrix, the element $a_{ij} = 1/a_{ij}$, and thus, when i = j, aij = 1. As shown in Table 2, the value of w_i may vary from one to nine, and 1/1 indicates equal importance and 9/1 extreme importance.

$$A = (a_{ij}) = \begin{bmatrix} 1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & 1 & \cdots & w_2/w_n \\ \vdots & \vdots & \cdots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & 1 \end{bmatrix}$$

The relative local priorities of the themes being compared are computed using the eigenvalue technique (Saaty, 1977). In this study, the priorities were calculated using free web-based AHP calculation software (http://www.isc.senshu-u.ac.jp/~thc0456/EAHP/AHPweb.html). Comparison matrices, both individual and grouped, can be expected, and accepted, to have some inconsistencies. The consistency of judgments is tested by computing the consistency index (CI).

$$\mathrm{CI} = (\lambda_{\max} - n)/(n - 1)$$

Where λ_{max} is the largest eigenfactor of the matrix. Because CI is dependent on the number of rows (*n*) in the matrix, the consistency ratio (CR) is also estimated. To estimate CR, the

average CI of randomly generated comparisons (ACI) is used. ACI varies functionally according to the size of the matrix (Saaty, 1980). For matrices of $n = 5$, ACI is 1.1.

$$CR = 100(CI/ACI)$$

According to Saaty (1980), CR values of 10% or less are considered acceptable. Inconsistencies in individual judgments were examined, and if inconsistencies were found, those individuals were given a chance to reconsider their judgments.

Here, we are mainly concerned with the preferences of two groups of students: those with and without children. Therefore, the "decision makers" were actually two groups of survey respondents that participated in an AHP interview to determine their order of significance for five themes in each SWOT group. As both of these groups became new "individuals," and were expected to behave as individuals, the reciprocity requirement was satisfied by using a geometric mean to aggregate individual judgments for both groups (Forman & Peniwati, 1998). The geometric mean was calculated using SPSS 15.0. As our main concern was the aggregated priorities, inconsistent individual judgments were also included. Duke and Aull-Hyde (2002) used a similar process to group individual judgments of respondents from four different locations, although an overwhelming majority of the 129 individual comparison matrices were not of acceptable consistency (Aull-Hyde, Erdogan, & Duke, 2006). The final CI and CR were computed to find out the aggregated values of both student groups.

Unlike Kurttila et al. (2000), we did not compare the importance of the four SWOT categories, as our main objective was the evaluation of the laptop program success and future opportunities and threats perceived by students rather than direct decision-making. Compared to the SWOT-AHP approach by Kurttila et al. (2000) our process differed mainly in two aspects. First, in this study the SWOT analysis was made by aggregating the results of the SWOT analyses made by individual students, while Kurttila et al. (2000) used an organized planning session to conduct the SWOT analysis. Second, in our study individual students conducted pairwise comparisons between the selected SWOT themes within every SWOT category and these results were later aggregated. Instead, in Kurttila et al. (2000) one decision maker made similar pairwise comparisons within each SWOT

category but additionally also made pairwise comparisons between the four SWOT categories to select the best strategy for their purposes.

Because AHP processes can be conducted with one person, and no statistical testing was involved, the sample size in both interview groups was adequate. AHP studies usually survey a relatively small number of experts—five participants in Peterson, Silsbee, and Schmoldt (1994) and 12 participants in Alho and Kangas (1997)—but when stakeholder preferences were identified, we found as many as 106 participants in Ananda and Herath (2008) and 129 in Duke and Aull-Hyde (2002). There are no guidelines for determining the adequate sample size for group decision processes, and, therefore, the key issue is whether there are enough observations for our sample to be an adequate observation of both student groups at the University of *[name deleted to maintain the integrity of the review process]*. Because AHP interviews and the following of contacts to check for inconsistencies are quite time consuming, we did not aim to use a high number of participants. Instead, our objective was to obtain a representative sample (Cook, Heath, & Thompson, 2000) of both student groups within the group of students that responded to the earlier online questionnaire. Due to their active ICT use, these students were regarded as expert computer and network users in learning at the University of *[name deleted to maintain the integrity of the review process]*. The sample used should give at least a rough estimate of students' priorities.

Results

Table 3 presents students' perceptions of the strengths, weaknesses, opportunities, and threats of using laptop computers and wireless networks in teaching and learning. In each SWOT category, one theme was clearly most frequently suggested, although in the strength category, two other themes were also quite popular among respondents. Students were asked to write down, into the four spaces below, those strengths, weaknesses, opportunities and threats (SWOT) that they think result from the use of laptops and wireless networks for university studies.

Table 3. Results of the SWOT analysis. *Note.* The percentage in parenthesis shows the percentage of students suggesting an answer within this theme. Bolded themes were included in the AHP analysis.

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
1. Mobility and flexibility of studying (33.4%) • independence of time and place • flexibility of working methods	**1. Technical problems** (35.7%) • WLAN blackouts • usability problems • computer vulnerability	**1. Versatility of teaching and learning** (37.5%) • distance learning • interactivity	**1. Data security** (41.8%) • viruses • hackers • information privacy
2. Availability of networks (24.2%) • computer-mediated communication • collaboration • information	**2. Ineffectiveness of studying** (11.2%) • lack of concentration • distraction by other users	**2. Mobility and flexibility of studying** (14.3%) • independence of time and place	**2. Ineffectiveness of studying** (10.5%) • lack of concentration • distraction by other users • information overflow
3. Easiness of studying (23.2%) • writing notes • collaboration • course registration	**3. Infrastructural deficiencies** (6.6%) • not enough plug points, lockers, or workspaces	**3. Availability of networks** (12.5%) • information and information exchange • computer-mediated communication	**3. Deficiencies in teaching and learning (**7.7%) • lack of planning • one-sided teaching methods • less face-to-face (f2f) teaching
4. Effectiveness of studying (16.1%) • writing essays • information seeking • time use, quickness	4. Data security (5.4%)	4. Effectiveness of studying (7.9%)	**4. Lack of communality** (7.4%) • less social interaction • facelessness
5. Availability of laptop (13.8%) • data storage space	**5. Negative aspects of increasing computer use** (5.1%) • technology dependence • less f2f-communication	5. Availability of computer (5.9%) • availability of data storage space	5. Technical problems (6.6%) • WLAN blackouts • maintenance, vulnerability
6. Pedagogical strengths (8.4%) • versatility of teaching methods	6. Lack of communality (4.6%) • less social or f2f interaction	6. Easiness of studying (3.6%)	**6. Negative aspects of increasing computer use** (5.6%) • health problems

• availability of distance learning and course material			• technology dependence
7. Equality (3.3%)	**6. Deficiencies in teaching** (4.6%) • staff's lack of ICT skills • laptops not integrated into teaching practices	7. Equality (2.3%)	7. Inequality (2.3%)
8. Paperlessness (1.0%)	8. Immobility (2.6%) • laptops too heavy to carry	**8. Technology development** (2.0%) • WLAN reliability • usability	8. Plagiarism (1.8%)
	9. Unavailability of software (2.3%)	9. Paperlessness (1.5%)	9. Infrastructural deficiencies (1.5%)
	10. Inequality (2.0%) • not everyone can afford a laptop	9. Advancement of students' skills (1.5%) • ICT skills	10. Lack of skills (1.0%)
	11. Lack of ICT skills (1.5%)	**11. Infrastructural development** (1.0%)	

To find out the order of significance of identified strengths, weaknesses, opportunities, and threats, according to students with and without children—hence to answer the second research question—five of the themes within each SWOT category were selected for AHP analysis. These themes are written in bold in Table 3. In addition to the most frequent themes in SWOT answers, some themes were included, because they were considered very important for the development of the technology initiative. One such example was "deficiencies in teaching" within weaknesses, which was suggested by only 4.6% of respondents. As the lack of integration of laptops into teaching practices—one subtheme within the theme 'deficiencies in teaching'—might be one of the most important factors affecting the success of the whole technology initiative, we thought that this point of view should be considered more thoroughly. Consequently, the slightly more frequently suggested theme "data security" was left out of the AHP interviews as the data security issues were already taken into account very seriously at the University. In addition, if a theme came up frequently in a category, such as "technical problems" within weaknesses, then this theme was ("technology development" was) included in the AHP analysis within the opportunities category, as it was seen as a major opportunity for development.

Many of the matrices produced by individual students were not consistent (CR > 10%) even after students were given a chance to reconsider their judgments. However, the CRs calculated for grouped judgments in each category and for both groups were all well under the acceptable level of 10%. The number of students interviewed was also reasonably high when compared with the majority of AHP literature and, therefore, the potential for any individual bias to significantly affect the aggregated preferences was therefore reduced. Results of the SWOT (Table 3) and AHP (Tables 4–7) analyses show that there are considerable differences between these two methods. In some categories themes frequently suggested in SWOT analyses were clearly not that important when directly compared with other, less frequently suggested, themes. "Technical problems" in the weaknesses category and "data security" in the threats category being the best examples.

Table 4. Results of the AHP — strengths category

	Students with children (n = 13, CR = 2.03%)		Students without children (n = 10, CR = 2.13%)	
Theme	Theme weight	Rank	Theme weight	Rank
Effectiveness of studying	0.31	1	0.30	1
Mobility and flexibility of studying	0.26	2	0.18	3
Easiness of studying	0.18	3	0.23	2
Availability of networks	0.13	4	0.16	4
Availability of laptop	0.13	5	0.13	5

Table 5. Results of the AHP — weaknesses category

	Students with children (n = 13, CR = 4.94%)		Students without children (n = 10, CR = 3.44%)	
Theme	Theme weight	Rank	Theme weight	Rank
Deficiencies in teaching	0.28	1	0.27	2
Infrastructural deficiencies	0.22	2	0.28	1
Technical problems	0.20	3	0.23	3
Ineffectiveness of studying	0.19	4	0.10	5
Negative aspects of increased	0.11	5	0.11	4

computer use				

Table 6. Results of the AHP — opportunities category

	Students with children (n = 13, CR = 3.20%)		Students without children (n = 10, CR = 0.43%)	
Theme	Theme weight	Rank	Theme weight	Rank
Mobility and flexibility of studying	0.39	1	0.23	2
Versatility of teaching and learning	0.28	2	0.28	1
Availability of networks	0.16	3	0.16	4
Infrastructural development	0.10	4	0.20	3
Technological development	0.07	5	0.13	5

Table 7. Results of the AHP — threats category

	Students with children (n = 13, CR = 1.59%)		Students without children (n = 10, CR = 2.26%)	
Theme	Theme weight	Rank	Theme weight	Rank
Deficiencies in teaching	0.39	1	0.29	1
Lack of communality	0.18	2	0.26	2
Ineffectiveness of studying	0.17	3	0.10	5
Data security	0.16	4	0.16	4
Negative aspects of increased computer use	0.11	5	0.19	3

Discussion

The aim of this study was to collect students' perceptions of using laptops and WLAN in university teaching and learning using SWOT analysis and to discover the order of significance for the themes that came up in SWOT analysis by using AHP. A special focus was on the differences between students with and without children. This division was motivated by the results of previous studies (Bolam & Dodgson, 2003; Eriksson et al., 2009; Jacobs & Berkowitz-King, 2002; Taniguchi & Kaufman, 2005).

The results indicate that although the laptop initiative had positive effects on studying, there are weaknesses that need more attention. According to the AHP students with and without children considered increased "effectiveness of studying" the most important strength. This means that laptops and WLAN enable effective performance of study-related activities like writing essays or information seeking, but also incorporates the effectiveness of time use (e.g., checking e-mail during short brakes). "Deficiencies in teaching" or in other words, insufficient integration of laptops into teaching practices, was perceived as a very important weakness of the laptop initiative. This confirms the information gained in previous studies that much more could be achieved if technology was truly integrated into university teaching and learning practices (Demb et al., 2004; Finn & Inman, 2004). As it has already been examined, poor pedagogical planning may lead to practices that at worst may harm learning (e.g. Hembrooke & Gay, 2003; Fried, 2008).

A functional university infrastructure is a key factor when pursuing a successful laptop initiative (Demb et al., 2004; Cutshall et al., 2006)—at least for most students. This study revealed the preference for "mobility and flexibility" of students with children and the obvious dissatisfaction with the "old-fashioned" university infrastructure of students without children. Students with children indicated that their lives and studies are heavily dictated by their commitments to their families and (for some) employers. Therefore effective studying may be dependent on the mobility and flexibility afforded by laptops. Instead, students without children have more freedom in scheduling their studies, and they can spend much more time at the university. Hence, a functional learning environment at the university is more important for these students.

Regarding future teaching and learning practices, students think that there are great opportunities to improve the mobility, flexibility, and versatility of practices. "Pedagogical versatility" in this study refers to, for example, increasing the use of laptops and networks in lectures to support f2f teaching, increasing interactivity and extending distance learning opportunities. Students with children accentuate the mobile and flexible side of learning, as they clearly have a need to manage and control their time, place, and mode of study. Investing time and money to improve the pedagogical practices, the university has the potential to develop all these aspects of studying. However, development that makes the integration of ICTs into teachers' practices possible, potentially resulting in more flexible

practices, requires that teachers are proficient with computers and that they are given the time and instruction needed to learn the pedagogical affordances of ICTs.

In line with the perceived opportunities, both student groups see the lack of pedagogical development as one of the biggest threats. The greatest difference between the two groups within the threats category was that students without children clearly ranked "lack of communality" second, while students with children gave this theme distinctly lower weight in their comparisons. This difference is likely related to the fact confirmed by our interviews with students with children (*[name deleted to maintain the integrity of the review process]*) that their social networks are strongly family oriented while those of the students without children are more university centred, and for them, f2f interaction and communality in the university context is much more valuable.

Methodologically the combined use of SWOT and AHP seemed appropriate for mapping and ranking both positive and negative aspects of the laptop initiative. When responding to a SWOT analysis, students may just list one or two things that come to mind without further consideration and, therefore, it is not suitable for estimating the importance of different themes. SWOT still offers a valid method for collecting a large sample of opinions and ideas that can be used for further analysis. Because of the above mentioned reasons, the themes selected for AHP should be considered carefully so that they would best serve the purpose of the particular decision making process. For example, in the present study it was clear that the most frequently suggested themes in the SWOT analysis should be included in AHP but most of the themes, below the popular ones, received quite similar low frequencies and concerning those objective consideration should be done to select e.g., those themes that actually can be improved. If e.g., the "deficiencies in teaching", in this study, would have been left out of the AHP the effect of teachers on this particular technology initiative would have been almost totally disregarded even the students actually thought this was an extremely important shortcoming.

AHP suited well for further processing of SWOT results, as it gave respondents clear alternatives between which judgments should be made—even if one would never have thought of the particular themes before. When students participated in an AHP interview, they had to consider their judgments very carefully, as each set of judgments was further

analysed for inconsistencies, and the participant was given a chance to reconsider. Because of the nature of the AHP method, no statistical testing was conducted, and therefore, ranking of the themes with close attribute weights should be treated with caution. However, the AHP application used in this study should provide rough estimates on the relative importance of the themes selected from each SWOT category.

Conclusion

To conclude, even though students find technology as supporting their learning, the results also indicate that so much more could be achieved if the institution concretely supports the use of ICTs and they were actively integrated into teaching and learning practices. This means that teachers should be given the possibility to improve their ICT skills and given the support needed to develop their teaching practices. Therefore, both time and money should be invested to make these changes possible for all willing instructors. While the integration of ICTs into the teaching and learning practices is an important topic it should also be noted that students still appreciate face-to-face teaching and the communality that the university environment and its' community provide. Therefore, ICTs should not be used just to substitute face-to-face teaching but to provide more variety and flexibility for learners to enable the better integration of their everyday lives, even with children, to the demands of university studies.

The facilities where these devices are used should also be updated to their standards; otherwise, usability will suffer, utilisation rates will remain low, and invested money will be wasted. The results gained here also show that students in different life situations have differing preferences when estimating the pros and cons of certain technologies. The approximate national percentage of students with children among university students for example in Finland is a sizeable 10 % (Virtala, Vilska, Huttunen, &Kunttu, 2011). This diversity in the student population should always be considered when planning investments in new technologies or the implementation of new courses, regardless of whether any technology is involved.

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