The Usefulness of ICT Support Systems for Thesis Courses

Learners' Perspectives at Bachelor and Master Level

Naghmeh Aghaee

The Usefulness of ICT Support Systems for Thesis Courses

Learners' Perspectives at Bachelor and Master Level

Naghmeh Aghaee

Dedicated to my dearest and beloved ones,
Linda, Kevin, and John

Human beings are members of a whole,

In creation of one essence and soul,

If one member is afflicted with pain,

Other members uneasy will remain,

If you have no empathy for human pain,

The name of human you cannot retain.

Saadi Shirazi, Persian poet

(This poem graces the entrance to the Hall of Nations of the UN building in New York)

Abstract

Doing a bachelor's or master's degree is a journey that leads to success or attrition (dropout). Previous research show the significance of considering learners' perspectives and their need for information and different types of interaction. This can be done through online ICTSS (information and communication technology support systems). The overall aim of this dissertation was to create knowledge about how the use of ICTSS can facilitate different types of interaction and support learners in order to reduce thesis problems and attrition and to enhance the quality of the thesis outcomes. The aim was operationalized by two research questions scrutinizing the interaction problems in the thesis process and investigating how the use of ICTSS can facilitate different types of interaction to reduce such problems and attrition, and to enhance the learning opportunities and quality of the thesis outcomes. To answer the research questions, five main studies were performed by applying different research methods on a case study. The empirical studies were performed at the Department of Computer and Systems Sciences (DSV) at Stockholm University, Sweden. The respondents were different learners (students) with active thesis projects at the bachelor or master level in different programs at DSV between 2012 and 2015. For the first two studies, conceptual and content analysis of the data collected from the case study was performed. For the three other studies, open-ended online questionnaires (survey) and interviews were conducted. On the basis of the findings, three main types of interaction issues were developed which related to the need for more learner-content, peer-to-peer, and learner-supervisor interaction in the thesis process. The hypothesis was that the interaction issues could be reduced by implementing a set of strategic suggestions through the use of an ICTSS including a set of functionalities and resources. The usefulness of these functionalities and resources was evaluated with regard to the learners' perception and experiences. The findings were categorized to facilitate learner-content, peer-to-peer, and learner-supervisor interaction, as well as management of the contents, supervision, and communication of the supervisory team. From these categories, a conceptual framework was developed in this dissertation to illustrate how the use of the ICTSS supports the thesis process. In conclusion, providing access to a set of structured e-resources and supporting educational communication through different types of interaction with peers and the supervisory team, enables learners' self-managed learning and facilitates similar learning opportunities for learners in thesis courses.

Keywords: Information and Communication Technologies (ICT), Support System, interaction, thesis, self-managed learning.

x

Sammanfattning (Abstract in Swedish)

Att göra en kandidat- eller magisterexamen är en resa som kan leda till framgång eller avbrutna studier. Tidigare forskning visar att det är viktigt att ta hänsyn till studenternas perspektiv och behov av information och olika typer av interaktion i högre utbildning. Detta kan underlättas av nätbaserade IKTSS (Information- och kommunikation TeknikStödSystem). Det övergripande syftet med avhandlingen var att skapa kunskap om hur användningen av IKTSS kan underlätta olika typer av interaktion och stödja studenter genom att minska svårigheterna i examensarbetesprocessen och förbättra examensarbetenas kvalitet. Avhandlingen är baserad på två forskningsfrågor kring vilka problem studenter har när det gäller interaktion i examensarbetesprocessen och 2) hur användningen av IKTSS kan underlätta olika typer av interaktion för att minska problem och avbrott i studierna bland studenterna. För att besvara forskningsfrågorna har fem huvudstudier med olika datainsamlings- och analysmetoder utförts inom ramen av en fallstudie, som följer användandet av ett IKTSS benämt SciPro. Datainsamlingen utfördes vid institutionen för data- och system vetenskap (DSV) vid Stockholms universitet, Sverige. Respondenterna var studenter som skrev examensarbeten på kandidat-, magister-, och masternivå i olika program på DSV, mellan 2012 och 2015. I de två inledande studierna analyserades data ur SciPro med hjälp av innehållsanalys. I de tre andra studier, användes webbaseradeenkäter och intervjuer. Resultaten visar att studenter har behov av tre huvudtyper av interaktion (student-student, kursinnehåll-student, samt handledare-student interaktion i examensarbetesprocessen). Ett strategiskt förslag ges kring hur dessa typer av interaktion i examensarbetesprocessen kan genomföras med stöd av ett IKTSS. Nyttan av dessa funktioner och resurser utvärderas utifrån studenters uppfattning och erfarenheter, och kategoriserades att underlätta studenters lärandeprocess och kommunikation under examensarbetesprocessen. Systemet stödjer både tillgång till och hantering av kursinnehåll och uppgifter, samt underlättar student-student och handledare-student kommunikation. Baserat på resultaten från avhandlingens fem artiklar, utvecklades ett begreppsmässigt ramverk för att illustrera och belysa viktiga delar av ett IKTSS. Sammanfattningsvis, tillgången till ett IKTSS, med strukturerade e-resurser och stöd av pedagogiska kommunikationer, underlättar examensarbetesprocessen för studenter och möjliggör likvärdiga möjligheter till lärandet samt stödjer kommunikation med andra studenter.

Nyckelord: Informations- och kommunikationsteknik (IKT), stödsystem, interaktion, examensarbete, uppsats, lärande.

List of Publications

This dissertation consists of the following original publications:

Paper I: Aghaee, N. (2015). Finding potential problems in the thesis process in higher education: Analysis of e-mails to develop a support system. *Education and Information Technologies, 20*(1), 21-36.

Paper II: Aghaee, N., & Hansson, H. (2013). Peer Portal: Quality enhancement in thesis writing using self-managed peer review on a mass scale. *The International Review of Research in Open and Distributed Learning, 14*(1), 186-203.

Paper III: Aghaee, N., Hansson, H., Tedre, M., & Drougge, U. (2014). Learners' perceptions on the structure and usefulness of e-Resources for the thesis courses. *European Journal of Open, Distance and E-Learning, 17*(1), 154-171.

Paper IV: Aghaee, N., & Larsson, K. (2013). Students' Perspectives on Utility of Mobile Applications in Higher Education. In *Trends in Mobile Web Information Systems* (pp. 44-56). Springer International Publishing.

Paper V: Aghaee, N., & Keller, C. (in press). ICT-supported Peer Interaction among Learners in Bachelor's and Master's Thesis Courses. Computers & Education Journal.

Contents

Figures

Tables

About the Author

I was born and raised in Tehran until my late teens. My journey then continued when I moved to Cyprus and thence to Sweden.

I started thinking about self-managed learning when I first decided not to continue going to school at my first grade of high school. I wondered why there was a need to go to school when I had the course books and supplementary materials and was sufficiently motivated to learn on my own. Why not study and learn in the way that I preferred and instead let teachers decide how I could learn and the details of my learning process. What was the point of education if I could not learn what I was most interested in?

After two months in the first grade of high school, I made up my mind, went home and said "I don't want to continue going to school, because I love studying and learning, and inappropriate teaching styles, poor teaching system, and insufficient teachers' knowledge will destroy my ambition." My parents did not understand the concept of "learning without teaching" until I demonstrated that even without going to school a person can learn things and even become highly educated and achieve good results! However, I've had great support from my sister and my brother-in-law, who have always guided me in my entire education.

Self-managed studying was immensely enjoyable and learning was a wonderful process. Without schools and teachers, I successfully finished my high school study and achieved good results in the field of "mathematics and physics. My learning process was completely on distance and by the help of the course materials. In the last year of my high school, I recognized that studying technical courses like mathematics, physics, geometrics, statistics, calculus, and computer sciences were all far easier for me than the history course, which was the only course I failed in my entire high school.

Direct entry to university before the fourth year of high school saw me start my bachelor's degree in computer engineering at the Eastern Mediterranean University in Cyprus. I did my second bachelor's degree at Jönköping University in business informatics, and a master's degree in computer and systems sciences at Uppsala University, followed by a PhD education at Stockholm University.

My self-managed achievements prompted me to think of facilitating students' self-managed learning. The concept of autonomous learning through the use of online information and communication technology systems helped me to develop my motivation to do research within this area.

During my education, I learned that life has a reflection; the more we give, the more we get back. The keys to my achievements were ambition, logical thinking and decision making, working hard, helping and supporting others, respect, and love. In addition, dancing and training karate helped me to strengthen my body and mind during this time.

In the following picture, my student cards show a summary of my higher education journey from 2003 to 2015.

Preface

I am for objection, if non-objection or agreement means refraining from divulging the unfairness.

In 2009, during my bachelor's thesis, I noticed that not all the students had similar chances of learning because of the differences in supervisors' knowledge, methods, supervision process, and other influential educational factors. I was ambitious and started my thesis before my fellow students and hence got the chance of choosing my supervisor. Hence, I obtained the appropriate support in doing research and scientific writing. I got relevant reading materials, references, instructions, and guidelines that not all other students might have had a chance to get. In 2011, when doing my master's thesis, a similar issue popped up. Many of my fellow students had personal supervision on campus, while I received the supervision completely at a distance via email and Skype. However, I had learning opportunities, provided by my supervisor, which again not all my fellow students might have had. I was always thinking about why not all students get similar learning opportunities, structured information resources, thesis instructions, and a set of general research guidelines. Some of my fellow students in both bachelor and master programs never finished their theses. Among those who did finish, some were not happy with the quality of their work and some finished their theses almost a year after the stipulated time.

I took this issue up with friends from other institutions in Sweden and abroad. It seemed that attrition, slow progress, and low quality of theses were a problem in many institutions in both bachelor's and master's degrees. What are the problems? How can these problems be reduced? How can online technology support the learning process in thesis courses? How can students be motivated to use an online support system? How can teachers be persuaded to use online technology as a support tool to complement their supervision and support students' learning process? Appropriate support by institutions and supervisors may make the thesis process more doable and efficient.

In the light of these issues, this dissertation addresses the following:

- The interaction problems in thesis courses which may lead to attrition or lack of motivation to finish the thesis on time.
- The use of online technology or blended learning to support the thesis process and make students more autonomous.

- The role of peer interaction among students, writing a thesis in a bachelor's or master's program.
- The importance of a set of structured e-resources and division of theses into phases with smaller milestones and opportunities for feedback.

Acknowledgments

I am so grateful for all the inspiring and helpful people, who I have got the chance to work with, during this process. Without you, it would have never been possible to accomplish my academic achievements and get to this stage.

Achieving a PhD degree is not only about the academic supports and not only during the few last years of the education. Coming to the stage of achieving the final goal on-time desires logical, mental, and emotional supports besides the educational guidelines. I would like to start giving my greatest and most honest appreciation to my lovely family in Sweden, who have always been a great source of love, concern, support, positive energy, and strength, in all these years.

First and foremost, I would like to express my greatest gratitude to my adorable sister, Linda: You always supported me in up and down, happiness, darkness and ambiguities, in hard, harder and the hardest situations, and always backed me up and spent time for me in my critical decision making. You were always there for me when I needed a hand. Thank you so much indeed from entire my soul and bottom of my heart for all your wonderful supports in my entire education from the first grade of my primary school until the last day of my PhD education (23 years non-stop). Thank you!

A very great and pure appreciation also goes to my endearing brother-in-law, Kevin: Thank you for all the priceless supports and guides in all these years. You always uplifted my enthusiasm, and motivated me to continue toward higher level. I also truly appreciate all supports in all the technical courses. You enlightened my way to achieve a better result at each step. Thanks!

I also would like to express my deepest feeling of thankfulness to my beloved partner, John: Thank you for everything! You have always supported me during these years and helped me to manage the situations in the best possible way. You helped me see the beauty of life and love even deeper. I appreciate it!

In line to my greatest supporters in education, I would like to express my sincere gratitude to my supervisors, Associate Professor Henrik Hansson, Associate Professor Christina Keller from Jönköping University, and Associate Professor Matti Tedre. Without your supports it would have been so hard to finish my PhD education on-time.

Thanks Henrik for all encouragements, sharing experiences, giving me self-confidence, providing me constructive comments, and for all the great philosophical, social, and scientific discussions. Thank you for helping me finding my abilities, enrich my ideas, learn how to present my work, and the way to implement my ideas.

Great thanks Christina for the continuous support and encouragement, excellent supervision, and the practical guidelines, not only during my PhD education, but also in my entire higher education in Sweden. You have enlightened my way and gave me the spiritual insights and supported me whenever I needed your valuable advices.

I am very grateful to you Matti for all supports for the research design and different aspects of the research methodology. I appreciate all your structured, useful, and caring guidance and supervision.

I would also like to thank Associate Professor Jimmy Jaldemark, from Mid Sweden University, who gave me very valuable and constructive feedback at the pre-doc seminar and provided me excellent guidance to improve the dissertation. My great appreciation also goes to my PhD dissertation opponent, Professor Ola Lindberg, and the committee members Professor Lars Svensson, Associate Professor Li Felländer-Tsai, Associate Professor Teresa Cerratto-Pargman to allocate their time to support the process of my biggest academic achievement.

I am indebted to Dr. William Jobe, dear Khalid Bencherifa, and dear Ranil Peiris Colombage for all the technical supports during the data collection process, thank you my friends! And thanks a lot William for all the language improvements as well. Also great appreciation goes to Associate Professor Rahim Rahmani, Professor Harald Kjellin, Professor Janis Stirna, Associate Professor Åsa Smedberg, and Dr. Thashmee Karunaratne, for giving me valuable and caring guidance during my PhD studies. Special thanks to Ulrika Drogge and Johanna Öberg, who always gave me the passion of work and lots of positive energy, and reminded me to breathe and think about my health.

An excessive thanks for all administration supports during these five years, especially to Fatima Ferreira, Irma Roovete, Birgitta Olsson, and Tuija Darvishi for all the concerns and great supports. I would also like to thank my dear colleagues Dr. Ulf Olsson, Ulf Larsson, Ken Larsson, Amin Jalali and Pooyeh Mobini for their additional inputs.

A special appreciation goes to Professor Stefan Hrastinski and Dr. Jonas Sjöström, who introduced me to this research area, helped me initiate my research interest and passion, and encouraged me to uplift my enthusiasm and continue my education toward PhD within this area of research.

Finally, thanks to all my fellow PhD students, respondents of the empirical studies, anonymous reviewers of the published papers. A great thanks also goes to the reviewers and editors of proof-reading-service.com for the great proof-reading of this dissertation.

Last but absolutely not least, a great gratitude to my parents for all the precious supports. Without you, your kindness, positive energy, supports, and specially the financial supports, it would have been so hard for me to get to this stage and achieve this academic success. Thank you deeply from the bottom of my heart!

Stockholm, November 2015
N. A.

1. Introduction

"*Education is the most powerful weapon which you can use to change the world.*"

Nelson Mandela

The focus of this dissertation is on learners' perspectives regarding educational interaction problems (lack of access to the required resources and learners' communications with supervisors and peers) in the thesis process and learners' perceived usefulness of a system developed to reduce these interaction problems. The research setting of this dissertation is a blended learning environment, which refers to the online facilitation of the thesis process through an online ICTSS as a complement to individual supervision.

In this section, first the research territory was established by showing the importance of the general area and introducing the basic concepts of this dissertation. The knowledge gap was introduced through a literature review and the aim and objective of the dissertation developed, followed by two research questions. At the end of the section, the delimitation is discussed to clarify the remit of the work and explain the specific focus on learners' perspectives in this dissertation.

1.1 Online Educational Technology

Educational technology is a broad research area which started with the introduction of mass media to higher education during the 1960s. Since the mid-1990s, the use of web technology (online technology) has created a foundation for online learning in higher education, which has been steadily increasing. Information and communication technology (ICT) is a developing concept with the potential to enhance educational quality. ICT in education has created discussions among educators in higher education institutions on how to support teaching and learning and facilitate interaction (types of interaction are discussed in section 2.2) through the use of technological tools (Jaldemark & Lindberg, 2013; Sarkar, 2012; Stacey, 2009; Kelly Garrett, 2006; Tinio, 2003; Moore & Kearsley, 1996).

ICT has a growing influence on educational practices and is becoming a strong means of educational changes in higher education (Sarkar, 2012). Online educational technology is used to improve teaching, learning, and creative inquiry, which have clear applications in the field, albeit much of such technology was not developed solely for educational purposes (Horizon Report, 2015). The prediction for the next 10 years is that ICT will become ubiquitous in the lives of learners in almost every country (Looi et al., 2010). According to the Horizon Report (2015), there are three categories of online technology planning and decision-making which are expected to enter mainstream education over the next five years; near-term technologies (within or less than one year), mid-term technologies (within two to three years) and far-term technologies (within four to five years). As discussed in different studies (e.g., Jaldemark & Lindberg, 2013; Sarkar, 2012; Stacey, 2009; Anderson, 2008; Kelly Garrett, 2006; Tinio, 2003), educational technology facilitates learning through access to information resources, synchronous, and asynchronous services and communication for educational, social, business, and other types of interaction.

Since the use of online educational technology is increasing, the role of ICT is becoming more important in education and learning (Sarkar, 2012). ICT in education increases learners' motivation by facilitating interaction with real people and even provides opportunities to participate in real-world events (Tinio, 2003). ICT supports achievement of good pedagogical results in education (Christie & Ferdos, 2004) and provides and maintains the acquisition of information (Tinio, 2003; Abbott, 2003). ICT has influenced the entire spectrum of education from early school development, primary, secondary, and high school levels to basic higher education at the undergraduate level and further graduate education and training (Sarkar, 2012). In this dissertation, ICT refers to the use of an online technological tool or platform to support generating, monitoring, distributing, collecting, and administering information and activities, to facilitate different types of interaction in education.

Doing a bachelor or master program is an educational journey that may lead to success or attrition (dropout). The high number of dropouts at different stages in higher education is an issue (Duque, 2014; Venuleo, Mossi, & Salvatore, 2014; Merrill, 2014; Witte, De Jonge, & Schoonman, 2014). In most bachelor and master degrees, the thesis course (discussed in section 2.7) is the final part of the degree. Hence, thesis attrition means leaving the education prior to completion of the degree. As noted by Boud and Lee (2005) and Kemp (1999), research education has become narrow, specialized, and theoretical, and in many cases there is a mismatch between the institution's research priorities and learners' interests and expectations, which has led to high attrition and slow completion rates.

According to a number of researchers, learners' attrition, lack of learners' satisfaction, and low productivity or fulfillment of learning outcomes are owed to issues such as: 1) poor supervision and instructor direction/contact (Dann, 2008; Ives & Rowley, 2005; Manathunga, 2005; McCormack, 2004; Benson & Blackman, 2003; Wegner, Holloway & Garton, 1999), 2) insufficient departmental support and opportunities for shared learning with peers (Boud & Lee, 2005; Kerry & Wilding, 2004; Bonk & Cunningham, 1998), 3) limited access to information, instructions, content, and prerequisites (Wegner, Holloway & Garton, 1999), further requirements for educational interaction (Anderson, 2008; Moore, 1989), and lack of academic and interpersonal skills (Kemp, 1999).

Nevertheless, despite a number of studies about these issues (as mentioned above), there is still a gap regarding how an ICT support system (ICTSS) can concretely address and support learners to reduce the educational interaction problems in specific courses such as thesis courses. In many institutions, there are different learning management systems (LMS) such as Moodle software applications and technology-enhanced learning (TEL) environments, which are used to provide e-learning through Web or online technology-based communication and interaction. However, there is no single developed system or study, which addresses different types of interaction problems in thesis courses from the learners' perspectives in order to develop strategic suggestions and solutions to reduce thesis attrition and low-quality thesis production. A common problem with ICTs in education is choices based on technological possibilities rather than educational needs (Sarkar, 2012). It is important to ensure that technological possibilities are viewed in the context of learners' educational needs and requirements in each specific course. One success factor in developing a learning support system in each course is the analysis of learners' requirements and perspectives (Singhal, Sehgal, & Singh, 2014; Sarkar, 2012).

In this dissertation, this gap is filled by considering the learners' perspectives regarding the educational interaction problems and requirements, besides evaluating learners' perception of the usefulness of an ICTSS in bachelor and master thesis courses. The several papers resulted in a set of strategic suggestions to facilitate different types of interaction and enhance thesis completion rate and quality.

1.2 Research Aim, Objective, and Questions

"If I had an hour to solve a problem, I would spend 55 minutes thinking about the problem and 5 minutes thinking about solutions." Albert Einstein

The overall aim of this dissertation was to create knowledge about how the use of ICTSS can facilitate different types of interaction (Moore, 1989; Anderson, 2008) and to support learners in order to reduce the thesis problems and to enhance the quality of thesis outcomes. The objective of this dissertation was to investigate learners' perspectives regarding interaction problems and evaluate learners' perception of the usefulness of an ICTSS in the thesis process. In order to shed some light on these issues, the following research questions were developed:

1. What are the common educational interaction problems that learners encounter in thesis courses at the bachelor and master degrees?

2. How can an ICTSS facilitate different types of interaction and support the thesis process in order to enhance the thesis completion rate and the quality of the thesis outcomes?

When it comes to the quality of the learning outcomes and thesis attrition, besides the educational factors and support systems, there are other potential factors (Bonk & Cunningham, 1998; Blanc et al., 1983; Bradburn, 2002) such as cognitive and metacognitive factors, motivational and affective factors, and social and individual (personal) issues in learners' private life. However, the focus in this dissertation was on learners' perspectives regarding the academic issues and ICT-based solutions to facilitate learners to communicate and get instructions, information, and guidelines in a more efficient way in the thesis process.

1.3 Abbreviations, Acronyms, and Key-terms

The abbreviations, acronyms, and the key-terms presented in Table 1 are used throughout this dissertation and in the papers included herein. Some of these terms or acronyms may refer to similar concepts; however, the definitions are based on the meaning specifically in this dissertation and the terms are described to facilitate understanding of their use in here. Further explanation, resources, and details about the use of these terms can be found in the papers included in this dissertation (Papers 1 to 5).

Table 1. Definition of Acronyms, abbreviations, and Key-terms

Abbreviation/ acronym	Full phrase	Definition
BSc	Bachelor of Science	A bachelor of science (BSc) or a bachelor degree in Sweden is generally a three-year undergraduate academic degree awarded by universities to students who complete the course and attain a certain number of credits (based on the Bologna credit system). In this dissertation BSc refers to undergraduate education at the Department of Computer and Systems Sciences at Stockholm University.
CMC	Computer-Mediated Communication	Any support from electronic devices and computer-based technology for human interaction and communication. In this dissertation CMC refers to ICTSS in some papers.
CMS	Content Management System	A system used to manage, prioritize, and present the content of a Web site, which normally consists of two elements of the content management application (CMA) and the content delivery application (CDA). In this dissertation CMS refers to ICTSS.
DSV	Swedish term: Data och System Vetenskap	Department of Computer and Systems Sciences at Stockholm University, Sweden.
ICTSS	Information and Communic	The application of technology to provide access to information and communication, and to store, retrieve, transfer and manipulate data and

Abbreviation/ acronym	Full phrase	Definition
	ation Technology Support System	information resources and support education and learning processes. In this dissertation ICTSS refers to a support system, such as SciPro, used to support and facilitate different types of interaction in the thesis process.
MSc	Master of Science	A master of science (MSc) or a master degree in Sweden is generally a two-year postgraduate academic degree, awarded by universities to students who complete advanced level courses and attain a certain number of credits (based on the Bologna credit system). In this dissertation MSc refers to graduate studies before PhD education at the Department of Computer and Systems Sciences at Stockholm University.
SciPro	Supporting the *Sci*entific *Pro*cess	An ICT-based support system to facilitate scientific process in the thesis courses in BSc and MSc programs at DSV.
TEL	Technology-Enhanced Learning	The usefulness of online technology in the learning context and education with the focus on learning for anyone, anytime, and anywhere. In this dissertation TEL describes the use of ICTSS as a general concept.
LMS	Learning Management Systems	Any electronic software application to support or facilitate education through online technology, which is also referred to as electronic learning (e-learning), including management of administration, learning/teaching, reporting and delivery of educational courses or training programs. In this dissertation LMS refers to e-learning and the use of ICTSS.

Key-terms	Definition
Learner	"Learner" refers to students at the Bachelor's and Master's levels at the Department of Computer and Systems Sciences at Stockholm University.
Online Technology	A set of online techniques, methods, and processes used to accomplish a specific purpose or task such as a scientific investigation or process through the Web. In this dissertation, technology is based on the Internet and online tools and hence is usually referred to as online technology.
Opposition	The process of providing a written report (called opposition report) followed by an oral discussion, critically discussing the important issues in the thesis, by a peer learner (called opponent) and the author of the thesis is called Opposition. Opposition is a part of the final module and peer interaction in the thesis process in the Swedish academic system and the thesis courses.
Peer review	In the thesis courses, peer review is the process of providing critical comments and feedback about the important issues prior to getting to the final module. Peer review is provided by a peer learner (called peer reviewer) on incomplete thesis manuscripts, written by the thesis author.
Thesis manuscript	A thesis manuscript refers to a draft of a thesis, written by the thesis author.
Active participant	Active participation is a part of the thesis process and tasks, which the system provides opportunities for learners to register as an active participant for another learner's final seminar to read final thesis manuscript and comment on it or ask questions in the final seminar.

1.4 Delimitations

This dissertation is written mainly from a learner perspective. Considering the perspective of supervisors as the second most frequent users of ICTSS for the thesis process was important in the system development process. Focusing on the two perspectives together would have created a more interesting result. Assessing the two perspectives and comparing their use of ICTSS might have added value to the study. However, it would have raised some discussion, since there were sometimes stark contrasts between the learning preferences of teachers and learners and things that may have positive impacts on learners' satisfaction and outcomes may not necessarily be acceptable to supervisors, or vice versa (Nunan, 1987; Islam & Azad, 2015). In some cases, supervisors did not like some of the functionalities that learners thought were useful and informative, such as documenting and monitoring the process and activities, availability of general information and resources for learners, and possibility of sending emails to and asking questions of the thesis support group.

There were challenges in preparing teachers to teach by means of ICT, since in many cases teachers still lack the knowledge and skills (Angeli, Valanides, Mavroudi, Christodoulou, & Georgiou, 2015; Dong et al., 2015; Tournaki & Lyublinskaya, 2014) and they refused to accept the interaction problems and that using an ICTSS would be a potential solution.

At the beginning of the ICTSS development, some supervisors appreciated its support of the thesis process and the learning process and others criticized the system; the latter's feedback and comments were rather a denial of the system's value than constructive remarks intended to help further development of the system. Reflecting both sets of attitudes would have consequences in terms of increasing the risk of the traceability of the supervisors, which would have been in breach of the ethical standard. Hence, the main focus was on the learners' perspectives and perceptions rather than the supervisors', not on the social and cultural aspects of learners' private life or individual problems, which could affect the thesis outcomes and the thesis production rate. The focus was purely on educational problems and ICT-based solutions.

The evaluation of the learners' perspectives regarding the ICTSS included both positive and negative aspects, which were considered and reflected in both the text and the number of respondents for each specific functionality of the ICTSS. In almost all studies the positive responses and satisfied learners outnumbered the negative ones. It would be interesting to deepen analysis of the negative reflections to find out what needs to be changed further. However, in order to respect the ethical issues and the anonymity and confidentiality of the respondents, provision of written contact information was entirely

voluntary. Of those who wrote their contact information, most refused to take part in the follow-up interviews, and the few who did take part, refused to be included in the publications. Therefore, the very negative comments without explanations and further clarifications were not the focus in any of the studies.

Gender (male/female/unknown) and education level differences (the bachelor or master level) were briefly considered, but were not the focus of the studies. In most of the studies the findings were not divided into different groups. This was mainly because in 2012 and 2013, when the studies were performed, the system had not divided the users by gender or education level. Hence the data collection focused on the learners' perspectives rather than their gender or education level. These issues were however considered in two of the published papers included in this dissertation, in which the gender and educational level did not have a significant correlation with the results of the papers. Slight differences between the two educational levels were discovered in Paper 5, which was discussed as a part of the paper.

2. Literature Review and Background

> *"Everybody is a genius. But if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid."*
>
> Albert Einstein

In this section, the nature of the research area is discussed and a background provided to the existing theories and principles, which were later used in developing the conceptual framework.

2.1 Educational Technology, Interaction, and Instruction

In the traditional view, learning only takes place when it is based on teaching and the various activities carried out by teachers and there is quite a small overlap between instruction and the learning process (Shuell, 1988). Schunk (2012) observes that in most of cases there is a direct connection between interaction and learning. As different studies state, ICT-based supports are effective and have positive impacts on education and learning (Abdullahi, 2014; Venkatesh, Croteau, & Rabah, 2014; Anthony, 2012; Roblyer, 2003; Pollock & Wilson, 2002; Spector & Anderson, 2000; Benbunan-Fich & Hiltz, 1999; Alavi, Wheeler, & Valacich. 1995; Alavi, 1994). Others suggest that providing instructions by using technology in education improves communication and access to the course materials or presented contents (Ness & Lin, 2015; Ratna & Mehra, 2015; Tarhini, Hassouna, Abbasi, & Orozco, 2015; Vong & Song, 2015).

Instructions on the learning objectives and how to study and use the online technology as a support tool for education are critical (Concannon, Flynn, & Campbell, 2005). Higher education institutions are investing in the use of ICTSSs to come across and fulfill the learners' needs and technological demands (Alavi & Leidner, 2001). In most of the institutions, different media or web-based tools are often used to facilitate delivering instructional materials such as presentation notes and assignments' instructions (Spector & Anderson, 2000), or to provide synchronous or/and asynchronous communication (Hrastinski, 2006, 2008; Hrastinski, Keller, & Carlsson, 2010;

Pargman, Hedin, & Hrastinski, 2013; Wendt, & Rockinson-Szapkiw, 2015). According to Schunk (2012), there are commonalities among diverse learning theories which share instructional principles that are predicted to enhance learning. There are commonalities among learning theories which share instructional principles that may enhance learning (Schunk, 2012). Table 2 shows four common instructional principles (inspired by Schunk, 2012), which are also discussed elsewhere (Shuell, 1988, 1990; Moore, 1993; Fox, 1983; Rosenshine, 1983).

Table 2. Instructional principles common to diverse learning theories (inspired by Schunk, 2012, p.19)

Instructional principles	Guidelines	Circumstances
Learning Structure	Learners progress through educational stages/phases	Structured materials (resources) presented in small steps
Requirements	Learners' requirement for practice, feedback, and review	Influential motivational and contextual factors on learning

These four principles are tightly interconnected. In the description of one principle, the others are automatically involved. Learners' progress through stages/phases means giving learners opportunities to understand important issues in each level, from the beginning to the end. This provides learners with opportunities to practice in each phase and get ready for the next phase based on the provided material and practices (Shuell, 1988). Learning through small steps influences student success rates and effective teaching (Rosenshine, 1983). In different stages of learning, learners may need to focus attention on different facts and struggle to understand material that later becomes part of a larger and more abstract conceptual framework (Shuell, 1988).

Organized materials presented in small steps include the organization and presentation of contents of the courses to be taught in small units in order to be cognitively processed in different phases (Schunk, 2012). An enormous amount of material which gives learners little time or opportunity to get the material into a meaningful context makes them feel constrained and frustrated (Fox, 1983). Small steps that are not too difficult for learners enable teachers to see that students practice new knowledge and skills until they are actually overlearned (Rosenshine, 1983). Learners' requirement for practice, feedback, and review is about the need of learners for provision of corrective feedback and frequent review sessions (Schunk, 2012). There are additional important

processes such as the need for practice, feedback, and counseling which need to be organized in education (Moore, 1993). Stimulating analysis and criticism and giving advice and counsel are two of the processes that must be structured in distance education (Moore, 1993) and similar campus-based courses such as thesis courses.

Influential motivational and contextual factors in learning are part of an enormous number of theories and discussions (Schunk, 2012). "*Motivation can affect all phases of learning and performance*" (Schunk, 2012, p.23). There are different aspects of the connection between motivation and learning from different theories (Schunk, 2012, pp.23, 357).This dissertation considers the notion that in order to get learners involved in learning, there is a need for learning motivation. Learners' motivation has two meanings; initiating learning, and maintaining engagement during learning (Biggs & Tang, 2011). This means motivation can affect learning initiation as well as the entire process of learning in a course. The achievement motivation is central to education and learning, which is sometimes challenging and requires learners' involvement (Schunk, 2012; Elliot & Church, 1997).

These instructional principles, discussed in Section 6.1, are based on the original discussions by Schunk (2012) and other connected references to this issue. Moreover, in order to show the importance of the issues mentioned in Table 2 specifically to the thesis process, the discussion reflects on each of these principles in connection with the different types of interaction (Section 2.2). These principles were also used as a base to establish the finding of this dissertation in order to develop the conceptual framework (Section 6.2) and the follow-up strategic suggestions (Section 6.3).

2.2 Types of Interaction

Interaction has various meanings tailored to different contexts and sciences which, according to Moore (1989), must be clearly defined to be meaningful in a context. In this dissertation, interaction is defined as any kind of connection, communication, transfer of information, or mutual or reciprocal action which has an effect on the learning process in thesis courses. As regards the learning process in distance education, Moore (1989) introduced the three most common types of educational interaction, between (1) learners and teachers (learner-instructor interaction), (2) learners and instructional/informative contents (learner-content interaction), and (3) peers (learner-learner or peer-to-peer interaction). These types of interaction were expanded by Anderson and Garrison (1988) to include instructor-instructor,

instructor-content, and content-content interaction (cited in Anderson, 2008, p.56).

In this dissertation, how the use of an ICTSS may facilitate supervision, the supervisor team (Pargman et al., 2013), and content management are also discussed. The following model (Figure 1), developed by Anderson (2008, p.58) illustrates the types of educational interaction and the connections between them. An appropriate and beneficial use of an ICT system advances all these types of interaction (Moore & Kearsley, 1996).
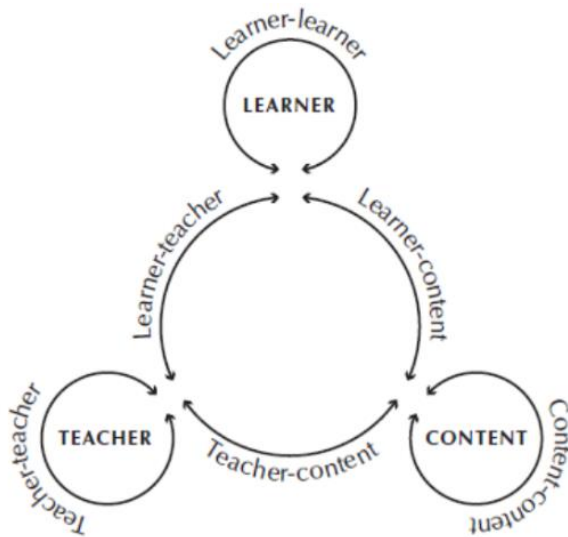
Figure 1 Three types of educational interaction (Anderson. 2008, p.58)

There is an assumption that learners taking part in thesis courses are in many respects facing similar challenges, opportunities and threats to learners in distance courses (Muilenburg & Berge, 2005; Aghaee & Larsson, 2013). Hence, these types of interaction can be used in the thesis process. However, the interaction in the thesis process does not necessarily have to be online or at a distance; it can be both face-to-face or in person and online through a support system. This theory is used as a general reference for the important types of interaction (Section 6.2).

2.3 ICT Support System in the Thesis Process

Each year, the department of Computer and Systems Sciences (DSV) at Stockholm University has more than three hundred students undertaking the thesis courses and this number of students is increasing year by year. Figures for 2008 show that thesis attrition and low-quality theses were quite common at DSV. At that time, many bachelor's and master's students never started writing a thesis and of those who did some never finished and some did not manage to achieve good quality or desired outcomes within the stipulated time. In 2009, the idea of an ICTSS was introduced by Associate Professor Henrik Hansson, as a solution, which has been developed to support both pedagogical and administrative aspects of the thesis process. The system was intended to facilitate different types of interaction (Section 2.2) to reduce the educational interaction problems and enhance the learning quality and thesis outcomes. The system was called SciPro. It began to be used in 2010 and has been iteratively developed until today.

SciPro was created to unify the basic information in the thesis process for all learners by providing information resources and instructions, better communication channels, and more possibilities of supporting learners throughout the entire thesis process. Moreover, the system was developed in order to enhance learners' autonomous learning (as described and discussed in Section 2.5) to access the basic and general information and instructions which make learners less dependent on their supervisors. Section 5.4 includes more information about the functionalities that are required and those which are already provided by SciPro.

2.4 E-learning and Blended Learning

"*The greatest incursion of e-learning in higher education is through the blended learning designs*"

Garrison (2011, p.75)

A core concept in educational models is that the essence of learning is educational interaction and communication, which can be supported by online technology to engage learners and educators (Garrison, 2011). E-learning is not about technology; it is rather about the true value of a higher education experience conveyed by the use of online technology (Garrison, 2011). E-learning is becoming increasingly important in the delivery of higher education (Penny, 2011). In higher education, e-learning is used to enhance

learning experiences and to facilitate education of learners through ICT, with or without instructors (Christie & Ferdos, 2004). E-learning delivers learning contents and activities through ICT via the Internet (Wang & Hwang, 2004). In most e-learning environments, such as the ICTSS in this dissertation, the focus is on facilitating learners' interaction (Moore, 1989) and supporting learning outcomes (Keller, 2007). The term e-learning is used interchangeably in different studies to refer to online learning, online education, internet-/web-based learning, educational technology, online technology-based learning, etc.

The concept of blended learning is defined as the combination of the traditional face-to-face lectures or supervisions and the web-based contents or structured online information and communication, as an educational complement (Concannon et al., 2005). In higher education, many institutions use technologies and Internet media to deliver information and instructions as a complement to the classroom teaching (Concannon et al., 2005). Based on the discussion by Bonk and Graham (2012), blended learning belongs to one of these three categories: a combination of face-to-face and computer-mediated instruction, involving different types of media, or combination of different instructional methods.

As discussed by Keller (2007), blended learning environments has influenced virtual learning environments and learning outcomes. Blended learning has highly affected the quality of educational interaction and learning by addressing learners' requirements and expectations, and facilitating the access to learning opportunities when a learning activity contains both face-to-face and computer-mediated elements (Bonk & Graham, 2012). In this dissertation, the use of ICTSSs in the thesis process relates to the first category of blended learning defined by Bonk and Graham (2012): a combination of face-to-face supervision and peer communications, and computer-mediated information, instruction and interaction (with content, peers, and supervisors) through the use of the system.

An ICTSS provides opportunities for learners to derive benefits from blended learning for interaction and supervision, by using online technology. In many cases, the ICTSS also facilitates the supervision process by enabling supervisors to send and receive materials through online technology or an online meeting with learners. Blended learning provides learners with communication opportunities to attend their peers' thesis final seminars at a distance as well as in person in the classroom (discussed in detail in Paper 5).

2.5 Autonomous Learning

As Federico (2000) noted, successful learning takes place when there is conformity between learners' requirements and the learning environment. A fundamental principle of autonomous learning is learner/learning-centeredness, where the locus of control is in the hand of individual learners (Nunan, 1996). As discussed by Moore (1972, 1993), providing autonomy in learning means facilitating and supporting learners to use teaching material, programs, and instructions in order to achieve their learning goals, in their own way and under their own control. According to Nunan (1987), there is a stark contrast between learning preferences of teachers and learners and teachers' preferences may not necessarily be learners' preferences. Hence, autonomous learning is a more learner-centered approach, which provides possibilities of learning under learners' own control and preferences. This is different from a teacher-based curriculum, which covers the topics that should be taught (Biggs & Tang, 2011) and learners have to learn what is decided and dictated by teachers. Moreover, as discussed by Moore (1993), peer support and peer interaction to generate knowledge have great potential in autonomous learning process, which also makes the learning process more learner-centered.

In this dissertation, autonomous learning in the thesis process does not mean that there is no or less supervision, guidelines, and instructions, or that learners have to manage the entire course on their own. Autonomy in the thesis process refers to enabling learners to learn on their own through accessing the structured resources, available guidelines and instructions, and communication. As discussed by Moore (1993), autonomy in learning processes enhances learners' self-management and self-directed learning by accessing the course contents, as well as collaborative learning with their peers. Moreover, providing support through the use of ICTSSs and developing autonomous learning is done in order to provide equal opportunities for all learners. However, supervisors still have the same responsibilities as before to support and guide learners in more detailed steps in the thesis phases (discussed in Paper 5).

Using an ICTSS in the thesis process would enable learners to derive benefits from different types of interaction anywhere and anytime. However, it is up to learners to decide how much and in which ways they use the functionalities of the ICTSS. Facilitating learning through using ICTSSs in the thesis process is in many aspects similar to playing a card game. However, they may be different in many fundamental ways. In a card game, there are rules that have to be followed by the players and all the players should have the possibility of learning about them. The dealer has to distribute the cards to the players equally, teach them how to play, and tell them about the tricks and clues of

the game. However, it is up to each player to decide and play. This is similar to the thesis process and producing a thesis with the help of an ICTSS. The ICTSS provides the requirements about the thesis process, accessing the structured resources, and all other types of interaction (which are the cards in the game), and describes the rules and regulations (which are the rules of the game) to all learners (who are the players in the game). The supervisors are the advisors who guide the learners in the thesis process and show the path for the learners to take the right decision and choose the right way (the dealer in the game). However, the learners autonomously decide what to learn, how to learn, and how to fulfill the requirements of the thesis course in order to achieve the outcomes (players' own decisions how to play). That is an important aspect in any investigation of learners' perspectives regarding the requirements and usefulness of the functionalities of the ICTSS to facilitate their autonomy in the thesis process.

2.6 Mobile Learning

In higher education, the ubiquitous use of computing devices, such as notebook computers, smart phones or wireless phones, and handheld devices with rapidly improving Internet capabilities is transforming the nature of education (Ally, 2009; Motiwalla, 2007). Mobile learning (m-learning) through the use of mobile technology and wireless devices intersecting with e-learning allows learners to access information and learning materials from anywhere and at any time (Ally, 2009; Motiwalla, 2007). Jaldemark (2013) noted five challenges to the understanding of learning and mobility, and concluded that learning and mobility can contribute to the development of educational research. As discussed by Motiwalla (2007), m-learning has the potential to provide or facilitate learners' interaction with their instructors and peers, and access to the course materials and information from wherever they have wireless connectivity. Motiwalla (2007) observed that m-learning connected to mobile applications enables users to control or filter the information flow and communication, improve real-time interactivity and collaboration, and access the services, regardless of time and location, which are useful for improving the learning environment.

In this dissertation, the concept of m-learning is used in the context of mobile applications in higher education. Paper 4 was performed in order to evaluate learners' perspectives about developing a specific mobile application as a complement to the ICTSS (SciPro) in the thesis process. The mobile application would provide specific functionalities, in order to facilitate access to the information resources, and getting updates and related notifications, in order to expedite and support the thesis process.

2.7 Thesis

The term "thesis" is used differently in different countries. For instance, in the Australian context, "thesis" refers to a document that students create to get degrees at all educational levels, i.e. bachelor, master, and doctoral levels (Evans, Gruba, & Zobel, 2011). In the United States and Canada (Evans et al., 2011) as well as in Italy (Eco, Farina, Farina, & Erspamer, 2015), Sweden, and other European countries, the "thesis" is mainly used for the two first educational levels (bachelor and master levels) and the term "dissertation" is more commonly used to refer to the document that is created to get a doctoral degree. However, in these countries a "dissertation" is sometimes also called a "doctoral thesis".

Obtaining an academic degree can be one of the most fulfilling achievements in a person's life. In most of the undergraduate (bachelor) and graduate (master) programs in higher education, the thesis is the core course of the final year (Zhao, 2015; Jaldemark & Lindberg, 2013; Hashim & Hashim, 2010; Todd, Smith, & Bannister, 2006; Todd, Bannister, & Clegg, 2004). The thesis is an opportunity for learners (students/thesis writers) to acquire knowledge and experience of project work which is designed to link their academic knowledge with their future careers (Zhao, 2015; Hashim & Hashim, 2010).

In general, in higher education, the risk of students' attrition is an important concern (McGaha & Fitzpatrick, 2005; Bradburn, 2002; Blanc, DeBuhr, & Martin, 1983). Some learners never complete their bachelor or master degrees because they fail to complete their theses. There are different problems in the thesis process, which may cause attrition or inability to finish the thesis within the stipulated time. Some of these problems comprise personal issues (McGaha & Fitzpatrick, 2005; Bradburn, 2002). The remainder relate to lack of information, instruction, interaction, supervision, and educational skills (Aghaee, 2015; Aghaee et al., 2014; Jaldemark & Lindberg, 2013; Benson & Blackman, 2003; Dong, 1998; Blanc et al., 1983). In most universities, different kinds of learning management systems (LMS) are developed to support thesis courses which are given on campus but are organized in the same way as distance-based courses. However, none of the researchers covered the learners' perspectives regarding the problems and solution in the thesis process, which would address the importance of the use of ICT to facilitate different types of interaction (Moore, 1989).

As mentioned above, in this dissertation, the term "thesis" refers to the final project or report produced by bachelor and master students (learners) at the Department of Computer and Systems Sciences (DSV), Stockholm University. The thesis courses are used to develop learners' understanding and critical thinking, provide opportunities for learners to produce new knowledge

in the research areas, and to demonstrate learners' writing abilities and scholarly ability in terms of carrying out academic research. Writing a thesis requires a great deal of autonomy, management, responsibility, discipline, and the ability to formulate and process scientific problems from the beginning to the end. At DSV, this is a different campus course from the other campus courses, since there are normally no lectures or seminars during the thesis courses. Learners must be their own driving forces and supervisors are only a support with limited time availability. There is, however, a certain amount of supervision, which is normally 15 and 30 hours respectively for bachelor and master theses, to provide guidance.

The Bologna Process is an attempt to define learning outcomes and quality assurance mechanisms, establish a national degree framework, and reflect on what is happening in institutions in 47 countries (Biggs & Tang, 2011). The grading of a thesis is based on the Bologna process, whereby each successful thesis gets a grade between A to E, and thesis close to a pass gets FX, which means more effort is required to reach the defined quality, and a failed thesis gets F.

In this dissertation, "learners" refers to students who are writing their thesis and learning from the thesis process. Supervision is provided by supervisors, who are the thesis advisors or leading teachers. However, referring to students as learners does not mean that students are the only ones who learn, and supervisors are the ones who only teach and never learn. It is important that supervisors also develop their understanding, skills, and competences in order to be up-to-date and able to supervise the new generation of learners in the best possible way.

3. Research Approach

Hot water makes potatoes soft; the same hot water makes eggs hard. It matters what is inside regardless of the surrounding. Any content can be shaped with appropriate tools. The choice of research approach guides and shapes the entire scientific process and research outcomes.

3.1 Case Study Strategy

Case study is a research strategy to provide opportunities for researchers to study a phenomenon or process more specific and in depth by considering different perspectives and collecting detailed data in time-boxes (Creswell, 2013). A case study, as defined by Robson (2002), is a strategic research tool for empirical investigation of a specific subject which exists in a real-life context. As suggested by Merriam (1988, 1998, 2002), a case study could be chosen when one is concentrating on a particular community or process to clarify the focus on a specific issue while considering the surrounding factors, which was the case in this dissertation. In a qualitative case study, questions can emerge and hence address the description of the themes, and be answered through different methods (Creswell, 2013). A multiple data collection method or a mixed-method approach can be used in a case study research to explore and understand the case and evaluate the outcomes (Creswell, 1994).

The case study was the core research strategy of this dissertation, since the aim of the study was to create knowledge about the use of an ICTSS to facilitate different types of interaction in order to support learners, to reduce thesis problems and attrition and to enhance the quality of thesis outcomes. For this evaluation we needed a case in a real-life context, which led to choosing SciPro, as the ICTSS in the thesis process. However, the focus of this dissertation was not on evaluating the ICTSS itself, but rather on the evaluating the learners' perspectives regarding the usefulness of the functionalities of the system on the thesis process and outcomes.

The strategy of this dissertation was inductive with a focus on the importance of the evaluation of individual perspectives and the complexity of the situations in order to render solutions. As noted by Yin (2013) and Creswell

(2013), in a case study, an inductive strategy offers additional promise, when the outcomes are evaluated by quantitative methods and the process and reasoning are explained and described critically by the findings from the qualitative methods. A case study with a mixed method was used in this dissertation to develop an inductive study.

As Stake (2000) observed, even though a case study can connect practical complex events to theoretical abstractions in many situations, it is normally quite specific and is more about what should be considered rather than about adopting a set of methodologies. In case study research, there are boundaries (Luck, Jackson, & Usher, 2006; Yin, 2013; Stake, 2000; Creswell, 1994) concerning the time, place, event or activity for each particular case, which may limit the data collection. Moreover, according to Yin (2013), the boundaries between the phenomenon and the contexts studied in a case study are not always apparent. Hence, choosing a case study may have limited the research findings in this dissertation, but since it was based on an inductive strategy in order to develop the conceptual framework, it allowed a focus on the core and aim of the study in order to answer the research questions by using different methods. Within the frame of this case study, the data collection methods and analysis methods were a combination of qualitative and quantitative research methods (details are shown in Table 3).

More specifically, in all the studies in this dissertation, the empirical data were collected by considering the use of SciPro in the thesis process at DSV. SciPro was used as a developing reference system, whereby the learners' perspectives were investigated and evaluated. The data, stored in SciPro, were subjected to content analysis in Papers 1 and 2. The surveys and interviews in Papers 3, 4, and 5 also referred to the functionalities of SciPro in order to collect learners' perspectives and evaluate the usefulness of the system in the thesis process. In Section 5.4 the basic functionalities of SciPro are shown in relation to the literature review's models and principles.

3.2 Methodological Consideration and Decisions

The choice of approaches and methodologies used in each individual paper was connected with this dissertation's research aim and question. It was an exploratory study with the use of different data collection methods in the research design, focusing on the learners' perspectives. Table 3 shows the research approach, method(s), and number of cases considered or participants in each paper.

Table 3. Research approach and choice of methods and analysis of the empirical data in different studies

Study	Research Approach	Number of items/ participants	Method
Paper 1	Qualitative data collection ➜ led to: 1- Quantitative results about the percentages of learners in each category. 2- Qualitative results by developing a set of strategic suggestions for further development of the learning process	Random sample (n) = 100 evaluated emails including 128 queries	Data analysis through a content analysis
Paper 2	Qualitative data analysis ➜ led to: 1- Quantitative result about the percentages of learners in each category. 2- Qualitative results by developing a set of strategic suggestions for development of collaborative learning process.	The entire population (N) = 260 evaluated peer reviews	Data analysis through a content analysis
Paper 3	A mixed method was applied: qualitative and quantitative data collection ➜ led to: 1- Quantitative result about the percentages of learners in each category. 2- Qualitative analysis of the open-ended questions and	Number of respondents (n) = 55 learners participated into the open- survey	Open and online surveys (Appendix A)

Study	Research Approach	Number of items/ participants	Method
	developing a strategic solution and a set of suggestions based on the learners' reflections and perception of the usefulness of the functionalities of the system.		
Paper 4	A mixed method was applied: qualitative and quantitative data collection ➔ led to: 1- Qualitative results from both open-ended and closed-ended questions, which reflected on the learners' perspectives, attitudes, and requirements.	Number of respondents (n) = 83 learners participated into the open-survey	Open and online surveys (Appendix B)
Paper 5	A mixed method was applied: qualitative and quantitative data collection through a survey and an interview study ➔ led to: 1- Qualitative results were developed from the quantitative (closed-ended questions) and qualitative (open-ended questions) parts of the survey study, which reflected learners' perspectives, requirements, and attitudes. 2- A second qualitative result to validate the findings from the first method and collect learners' perspectives in their own words to draw a qualitative conclusion based on the common findings from both methods.	Number of respondents (n) = 55 learners participated in the open survey Number of interviewees (maximum variation)= 6	1- Open and online surveys (Appendix C) 2- Interview (Appendix D)

In all five studies, the data were collected and analyzed between 2012 and 2015. However, some parts of the data could have been from theses which were started before 2012. When the data were analyzed by means of conceptual analysis, a second person checked and validated the results and the findings. In most cases, the data were controlled and confirmed by the thesis coordinator at DSV.

3.3 Data Collection Methods

3.3.1 Content Analysis of the Data

Content analysis, which has usually been considered in terms of conceptual analysis, is performed in order to analyze and compare data and specify the potential categories of events, and why, how and in which contexts they occur (Randolph, 2007). In conceptual analysis, the chosen concept is examined and analyzed according to certain criteria defined in advance. In line with the explorative aim of the dissertation, the content of the learners' emails to the thesis support group at DSV were analyzed in order to find the categories of the problems that learners encountered during the thesis process (Paper 1), in line with Randolph (2007). The content analysis quantified the number of the queries in each exhaustive category and identified the essential variables in each category (Randolph, 2007).

In this paper (Paper 1), content analysis was used to scrutinize interaction problems by reading and analyzing the core issues of the emails, dividing the separate enquiries (if there were any), and allocating queries to the relevant category. The six exhaustive and mutually exclusive categories were iteratively developed according to Krippendorff (2004), depending on the issues discussed in each email. When an email included more than one enquiry, they were put into separate categories. The result of this paper and the categories developed were validated by the result of Paper 3.

Moreover, in the second paper, content analysis was used to analyze the quality of the peer interaction and categorize each peer review according to its quality (Paper 2). Content analysis helped in analyzing the peer reviews on a mass scale, as suggested by Lombard, Snyder-Duch, and Bracken (2002). It was used to evaluate peers' asynchronous interaction and discussions in the peer portal in line with De Wever, Schellens, Valcke, and Van Keer (2006). The categories developed in this paper indicated the quality of the learners' peer reviews in the light of specific criteria that were developed for each category. Content analysis was used in order to evaluate and compare learners' performances and find the percentage of learners who provide high-quality

reviews of their peers' thesis manuscripts. A set of strategic suggestions was developed to enhance the quality of the peer interaction. The result was used as a base for Paper 5, which evaluated the users' perspectives regarding the usefulness of peer interaction.

3.3.2 Open-Ended Online Survey

Surveys (questionnaires) were used in order to ensure wide and inclusive coverage within the learner population and to reduce the turnaround time, to provide easy and immediate access to learners, and to evaluate the familiarity of the respondents with the system (Denscombe, 2010). In line with the dissertation's evaluative aims and research questions, the questionnaires included both closed- and open-ended questions to collect learners' perceptions of the usefulness of the online structured information resources. The closed-ended questions normally included four-/five-point ordinal rating scales designed according to Cohen, Manion, and Morrison (2007) and Denscombe (2010). The open-ended questions were used in order to let respondents write their opinions in their own words (Cohen et al., 2007).

The questionnaires were used for the data collection of Papers 3 and 4, and part of Paper 5, which were distributed through the university emails. A list of emails was available for the research population to allow the researcher to target the relevant group of learners (Denscombe, 2014). In Papers 3 and 5, the questionnaires were in two languages for different educational levels, Swedish for the learners at the bachelor level and English for learners at the master level. However, in Paper 4, the questionnaire was written in English for both educational levels. The surveys were designed by Google and were analyzed on the basis of the figures produced by Google for each closed-ended question. In Paper 3, the result file was exported as an Excel file to import the collected data into the SPSS for statistical and quantitative data analysis.

In all survey studies, the qualitative data from the open-ended questions were analyzed by following the data analysis spiral (Creswell, 2007, 2012) in three steps: coding data to pinpoint the issues and challenges; interpreting the codes to classify the data into categories; and situating the categories in their context in order to create a visualized account of the findings. The number of participants in the open-ended questions was more than expected and many learners formulated the issues and recommendations in detail and in most of the cases in a descriptive way in more than a few sentences for each open-ended question. This is a positive sign that the involved learners were motivated to take part in the study and help enhance the ICTSS by providing feedback and describing their perspectives on requirements and suggestions.

3.3.3 Interview Study and Connection of Papers

Interviews were used as purposeful conversations with a set of questions to reveal learners' personal opinions about problems and solutions (Kahn & Cannell, 1957; Creswell, 2013). Interviewing was a tool to find the personal thoughts, perceptions, feelings and individual perspectives in learners' own formulation, which could not be collected otherwise (Patton, 2002). The interview method was used to explore the learners' personal and individual experiences and to reveal their insights (Seidman, 2012). At the end of the interview, additional wrap-up or summary questions were posed (Creswell, 2013), as shown in Appendix D. In this dissertation, the interview was used to provide opportunities for collecting learners' perspectives in their own words and in order to strengthen the results of studies (Papers 1 to 5).

The conducted interviews were one-to-one and semi-structured. The interview questions (Appendix D) were based on the guidelines in Patton (2002, p. 342) with questions regarding opinions and values (p. 350). In each theme, two to four questions were used to guide the semi-structured interviews. The questions relating to each theme offered the interviewees the opportunity to express their personal perspectives in their own words (Patton, 2002) and talk about any aspects that they would like to. In order to maintain the focus and make the interview questions neutral but more systematic and comprehensive, an interview guide was developed from Patton (2002, pp. 341-342). However, when the interviewees gave the answers to a question before it was asked, then the question was not asked. At the end of the interview, there was a wrap-up or summarizing question, designed to obtain the general impression of the learners about the system and the five themes of the interview.

The target groups were learners at DSV at bachelor and master level who used the ICTSS in their thesis process and were in the last phases of their thesis (just before finishing or had recently finished). Maximum variation sampling was used in order to interview a diverse group of learners and identify important common patterns in any group (Miles & Huberman, 1994). The interview questions were tested by two master students, before the interviews were conducted. The interview request was sent to twenty students through the university emails. However, only six students volunteered to be interviewed. The interviews were conducted in English, at DSV, between January and February 2015. The interviews were based on the assumption that all the interviewees knew about the system and the different themes of the interview, and had used most of the functions of the system, which the interview questions were about. The findings were presented and analyzed qualitatively in a narrative summary based on narrative analysis (Miles & Huberman, 1994; Patton, 2002).

3.4 Research Ethics

"*Research ethics is not an option - it is the fundamental feature of all good research*".

<div align="right">Denscombe (2014, p.306)</div>

In this sub-section the ethical principles considered in the studies in this dissertation were described. These principles were discussed by many research method guides (e.g., Denscombe, 2014). The scrutiny of the following issues indented to ensure that no harm is caused by the investigation (Denscombe, 2014). The following ethical principles were discussed in different research guides (Denscombe, 2014).

Informed consent: in each study, informed consent was obtained at the beginning of the data collection. The students participated in the studies voluntarily and accepted the study conditions. The interviews were open and the learners could refuse to answer the questions if they wished. A summary of the informed consent of each study can be found in Appendices A to D.

Information provision: providing information for the participants is an important issue which was considered in all the studies. In the survey and interview studies, information about the purpose and structure of the studies were provided for the participants at the beginning of the data collection. Participation was completely voluntary and the participants were so informed.

Privacy of the respondents: learners' anonymity and information confidentiality. *Anonymity*: in the survey studies (Papers 3, 4, and 5), the data collection was completely anonymous which means that no one, not even the researcher, knew or could track who had made a specific response in a survey and no private information was used or connected with any response. The participants were informed about anonymity and asked to include their email addresses only if they would like to participate in related studies in the future. *Confidentiality*: in the first two papers (Papers 1 and 2) and the interview studies, the informants' confidentiality was considered and assured to protect the their identity, which means that only the researcher could see the private information (name, date of email, review, and the details of the problems), but chose to present the results in such a way that the responses could not be traced to any specific person. In a few cases, answers were removed from the study when there was a risk of identifying the learners or supervisors. To put all three studies in line with the confidentiality requirements, all personal information was removed from the data. For content analysis of the emails and peer reviews (Papers 1 and 2), the names of the learners were only used in order to find out the number of the learners in each gender and all the other

analyses were done totally anonymously after removal of names, dates, email addresses, and supervisors' information.

Benefits: in the interview study, the interviewees were offered light refreshments. However, in the survey studies there was no compensation for participation. At the beginning or at the end of each survey study or interview, the researcher thanked the participants for their time and voluntary contribution.

4. Summary of the Studies (5 Papers and 2 Further Studies)

The main theme of this dissertation is the learners' perspectives and hence the five published papers were chosen to fulfill this theme. Considering the learners' perspectives is important in both enhancing learners' education and developing the ICTSS. Other perspectives (supervisors', reviewers', or examiners' perspectives) could have been covered. However, the author tried to keep the focus on the learners' perspectives, in order to avoid complications and the risk of the study getting too broad and losing the goal of this dissertation. In the following sub-sections, a short summary of each included paper is presented in order to reflect the findings and a short description of two further studies has also been included. The results of the two further studies were used to strengthen the findings of this dissertation; however, the entire papers are not included in this dissertation.

4.1 Paper 1

Aghaee (2013): a single-author journal article. This paper explored problems that learners encountered during the thesis courses by analyzing issues in the emails which were sent to the SciPro support group, called ThesisSupport. A random sample of one hundred emails was analyzed with the help of content analysis, in order to develop the categories which covered the discussed issues. The chosen time interval was from January 1, 2012 to March 15, 2012, as the learners used the second major pilot of SciPro in the thesis courses in the spring of 2012. The result showed six categories of problems: 1) thesis initiation, 2) info-mail, 3) technical issues, 4) exemption, 5) supervision, 6) final seminar. Depending on the significance of the categories, two groups of strategic suggestions were developed: 1) developing communications and 2) developing instructions. These strategies were intended to support the thesis process by the use of an ICTSS to facilitate different types of educational interaction and reduce the problems, thus improving the thesis completion rate and quality.

4.2 Paper 2

Aghaee and Hansson (2013) (contribution 70%): a journal article with one co-author. This paper describes an online peer review system, called Peer Portal, designed to support peer interaction in the bachelor and master thesis process. The peer review system was completely student-driven to facilitate peer interaction without involvement of supervisors, and therefore saved the latter's time. The purpose of Peer Portal was to improve the quality of the thesis manuscripts by providing opportunities for learners to review their peers' manuscripts and provide constructive feedback in the early phases of the thesis, before getting to the final phase of the thesis process. It was initiated in 2012 and in total 260 peer reviews were completed between January 1 and May 15, 2012. The purpose of this paper was to analyze all peer reviews for this period of time with the help of content analysis to consider and categorize the quality of the peer reviews based on some developed criteria. The results are categorized in four groups: 1) excellent, 2) good, 3) fragmented, and 4) poor. Almost 40% of the students produced "Excellent or Good" peer reviews and almost as many produced "Poor" peer reviews. The result shows that the quality varies considerably. Explanations of these quality variations need further study (as discussed further by Paper 5, Aghaee & Keller, in press). However, alternative hypotheses followed by some strategic suggestions are discussed in this paper (Paper 2). Finally, a way forward in terms of improving peer reviews is outlined: 1) development of a peer wizard system, and 2) rating of received peer reviews based on the quality categories created in this paper. A Peer Portal version 2.0 is suggested, which may reduce the number of fragmented and poor-quality peer reviews, but still keep the peer review process student-driven to make the supervision time more efficient.

4.3 Paper 3

Aghaee et al. (2014) (70% contribution): a journal article with three co-authors. In this paper, the purpose was to investigate the interaction problems that learners experienced during the thesis process and evaluate learners' perspectives regarding the usefulness of the information resources of the ICT support system. The target group was learners on the bachelor and master degree courses with active thesis projects between November 2012 and February 2013. The findings of this paper were divided into two phases; 1) interaction problems in the thesis process, and 2) evaluation of learners' perception of the usefulness of two inter-connected types of information resources: text-/video-based information resources. In the second phase of the findings, based on the learners' perspectives, five categories of problems were developed: 1) thesis initiation, 2) supervision, 3) technical issues, 4)

exemption, and 5) final seminar. In the second phase, two types of information resources were described to facilitate instruction and information access. The first type of information resources (text-based resources) centered on the main information required, such as grading criteria, description of thesis work and thesis process, access to the students' thesis support, and student FAQ. The second type of information resources (video-based resources) were the complementary resources, such as introduction to the thesis phases, method courses, supervisors' presentations, and how to use the ICTSS for the thesis and other useful software and tools in the thesis process. The paper has two co-related variables: learners' perceived usefulness of the structured e-resources and categorization of the number/percentages of learners who perceived the structured information e-resources as useful. Regarding the first variable, the results indicated that most students considered structured e-resources as a useful part of producing a better quality thesis. Regarding the second variable, three categories of structured resources were developed from the learners' perception of the usefulness of the e-resource (text-/video-based) in each category. The results can be found in Figure 6.

4.4 Paper 4

Aghaee and Larsson (2014) (75% contribution): a Springer publication, written with a co-author. Use of information and communication technologies (ICT) in pedagogy and learning in higher education supports the concept of technology enhanced learning (TEL) and mobile learning (m-learning). Mobile devices and applications with educational purposes are part of facilitating self-managed learning, accessing information, and offering more possibilities of more convenient communications. However, developing and using mobile applications in higher education to support courses is still a developing concept, not widely known and frequently experienced by all learners. The purpose of this paper was to evaluate learners' perspectives regarding the use of mobile applications in higher education, and learners' perception of the usefulness of developing a specific mobile application to support information access and communications in the thesis process. The mobile application was considered in connection with the use of the SciPro system in the thesis process in bachelor and master degree courses. The data were collected through an online survey questionnaire, including both closed- and open- ended questions. The questionnaire was sent to learners with active thesis projects between January 1, 2012 and April 1, 2013, and responses were requested between April 12 and 19, 2013. The findings of the paper indicated that almost 95% of learners use mobile applications for higher education purposes and believe in the usefulness of m-learning. Moreover, more than 70% of the respondents think that a SciPro mobile application will add value

to the thesis process. According to the findings of the paper, even though using a mobile application may not directly affect the speed and quality of the thesis, it increases the mobility, availability, and flexibility of accessing information and resources, which supports mobile learning in the thesis process. Furthermore, mobile application facilitates communications by supporting learners to get important notifications through their mobile devices instead of emails.

4.5 Paper 5

Aghaee and Keller (in press): a journal article, written with one co-author. The purpose was to describe the affordances of information and communication technology-based support system (ICTSS) to facilitate peer interaction in the bachelor and master thesis courses. Peer interaction had two interaction phases. The first phase centered on the peer reviews on the incomplete thesis manuscripts with formulated research questions and methods. The second phase focused on opposition and active participation in the last phase of the thesis process, and reviewing the completed thesis manuscript. The paper had two dependent variables. The first dependent variable was students' perspectives about the usefulness of peer interaction in the thesis process. The second dependent variable was students' perspectives about influential factors on the quality of peer interaction and failures of online technology-based peer communication. The results of this paper indicated that most students considered peer interaction as useful in producing a better quality thesis. Moreover, the findings demonstrated six major factors related to the quality and differences of peer interaction in the first and second phases. In conclusion, the study developed a set of strategic suggestions from both pedagogical and technical aspects to enhance the peer interaction in the thesis process. Considering these suggestions makes the use of the ICTSS more effective to enhance the quality of thesis learning outcomes.

4.6 Interview Study (Expansion and Validation of Paper 1 to 5)

A summary of the findings and analysis of this interview study is presented in this dissertation in connection with the findings of Papers 1 to 5. The questions of the interview included five main themes (Appendix D), which were mainly based on the findings of Papers 1 to 4, with an additional focus on peer interaction to develop the result of Paper 5. The result of the findings of each paper discussed above was strengthened by the different themes of this interview study. Figure 2 illustrates the connections between the studies (Papers 1 to 5). The figure indicates that the findings of Paper 3 strengthened the findings of Paper 1. The findings of Paper 5 strengthened the findings of Paper 2. The figure also demonstrates the connections of Papers 1 to 5 with the interview study. The interview study increased the credibility of the findings of the five papers by interviewing learners in the last phase of their thesis process and letting them evaluate the functionality of the ICTSS and the structured e-resources.
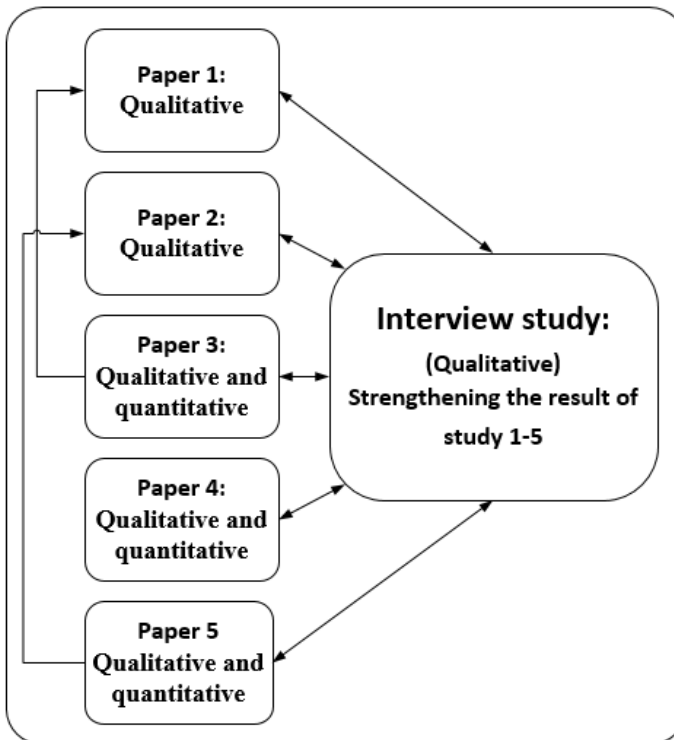
Figure 2 Connection of the five studies with each other and with the interview study

4.7 Thesis Completion Rate and Quality Enhancement

In the light of the results of the thesis completion rate and the grades of the completed theses registered in SciPro between 2010 and 2014, a statistical study was conducted. The result of the study shows the improvement of the thesis results over time with the ICTSS (SciPro) (Hansson, Karunaratne, & Aghaee, under review). By connecting the result of this study with this dissertation, the assumption that the use of the ICTSS in the thesis process can positively affect the learners' outcomes and satisfaction has been strengthened. As shown by Hansson, Karunaratne and Aghaee (under review), an ICTSS supports different types of interaction and can influence positively the thesis completion rate and quality of the learning outcomes. This study shows that using an ICTSS in the thesis process helps reduce the educational interaction problems and increase the number of completed theses of higher quality.

However, since the result of this study is not part of this dissertation and only used as a reference, issues related to the data collection, methodologies, and the use of data mining to analyze the result of the collected data are beyond the scope of this dissertation and cannot be defended by the author.

5. Findings and Analysis

"The value of an education in a liberal arts college is not the learning of many facts, but the training of the mind to think something that cannot be learned from textbooks."

<div align="right">

Albert Einstein, 1921 (Ratcliffe, 2011)

</div>

Educating learners means providing learning opportunities and supporting them to achieve learning outcomes through a unified learning system providing similar learning opportunities for all. Since thesis courses are in many aspects similar to distance courses, there are similar opportunities and challenges, which may be reduced by providing support through the use of ICTSSs. As observed by Moore (1989), learner-content interaction determines the characteristics of education and peer interaction determines collaborative learning. This dissertation is about the opportunities that are provided by an ICTSS to facilitate learners' interaction, with a focus on learner-content, learner-supervisor, and peer-to-peer interaction in the thesis process. Moreover, the dissertation discussed how the use of the ICTSS may facilitate the three additional types of interaction, supervision, supervisor team, and content managements. Even though, the ICTSS can facilitate many aspects of educational interaction, it is still a complementary information resource and communication channel and not recommended as a replacement for individual supervision of every thesis. The following sub-sections include the summary and findings of the five papers of this dissertation.

5.1 Connection of the Studies and Description of the Phases

Given the research problems and aim, the focus in this dissertation is on the learners' perspectives. Singhal et al. (2014) regard learners' perspectives as an important factor in the success of ICTSS integration in higher education. The general approach of the dissertation is a case study connected to the findings divided into four main phases (described below and shown in Figure

3). These phases were developed in connection with the aim of the dissertation and in order to answer the research questions. The collected data and the target groups in different phases of this dissertation were connected to the used case study and the evaluation of the perspectives of learners who used the ICTSS for thesis courses at DSV.

In the first phase of this dissertation, learners' problems in the thesis process were considered through analysis of the problems that learners encountered during the thesis courses (Paper 1 and Paper 3). The learners' potential requirements in the thesis process and a set of strategic suggestions regarding the information and communication requirements were developed.

In the second phase, since the learners were already using SciPro, learners' perception of the usefulness of some of its functionalities was evaluated. This means that the focus was not on the evaluation of the functionalities of the system, but rather on the evaluation of the learners' perspectives regarding the usefulness of those functionalities to support the learning process in the thesis courses. However, this does not cover learners' perspectives regarding all the functionalities of the ICTSS but the support of the peer interaction (presented in Papers 2, 3 and 5), learner-content interaction (presented in Papers 3 and 4), and using a mobile application (presented in Paper 4). In this phase, a set of strategic suggestions have been developed in relation to each interaction type, and how to enhance the communications and getting of notifications through using a mobile application.

In the third phase, the results of all the studies were iteratively discussed and the strategic suggestions were analyzed and further improved in order to develop a conceptual framework (Section 6.2). The framework has been iteratively developed, based on the literature reviews and models (discussed in Section 2) in connection with the results of the studies and the strategic suggestions.

In the final phase of the dissertation, phase 4, based on the developed framework and the result of a longitudinal case study (*ref. will be added when the paper is finalized*), the contribution of the dissertation was formulated and developed. This phase concluded the research findings and contributions to fulfill the research aim and objectives and answer the research questions. As discussed above, there are four phases which cover the different steps of this dissertation. Figure 3 illustrates the connections between the phases and shows the papers in each phase. The description of each phase is given in the following sub-sections.
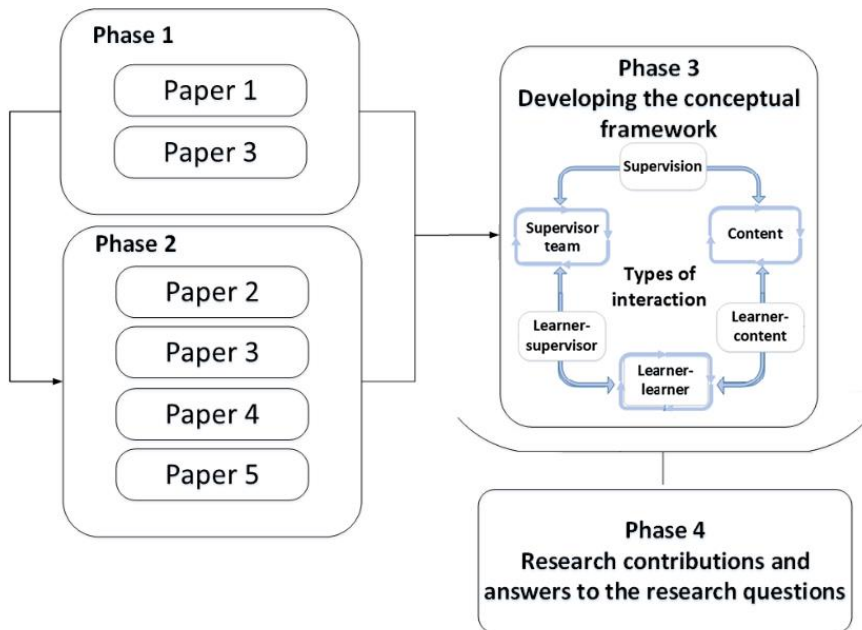
Figure 3. Visualization of the phases of the dissertation and their connections

5.2 Interaction Problems (Phase 1: Findings from Papers 1 and 3)

At the very beginning, in order to investigate the problems and the most important issues with which students needed help, an analysis of the emails, sent to the thesis support group, was performed (Paper 1). The support group of the thesis is called ThesisSupport, which supported learners by answering their basic and general questions through emails. Learners asked questions about general and specific problems during the thesis process. Hence, in study 1, 100 emails sent to the ThesisSupport were analyzed in order to investigate the problems and find strategic suggestions to reduce these problems in the thesis process. The emails were analyzed in 2012, when the very first version of the system was under use of learners and supervisors. The following figure (Figure 4) shows the result of the findings from this study, the six mutually exclusive categories of the interaction problems in the thesis process (Paper 1: Aghaee, 2015:p.9).

Category name	Number of queries (out of 128)	Percentage of the queries (%)
1. Thesis initiation	33	26 %
2. Info-mail	6	4.7 %
3. Technical issue	22	17.1 %
4. Exemption	24	18.7 %
5. Supervision	22	17.1 %
6. Final seminar	21	16.4%
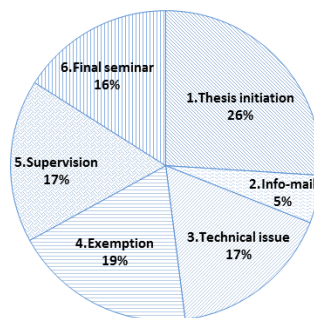
Figure 4. Categories of learners' problems in the thesis process (result of Paper 1)

The findings of study 1 were confirmed by a survey (Paper 3), in order to investigate learners' perspectives about the problems that they encountered in the thesis process and the potential solutions to these problems. The problems mentioned by the respondents of the open-ended online questionnaire were categorized into the following five categories, which are very close to the findings in study 1. Table 4 shows the results of this study (Paper 3, Aghaee et al., 2014, p.9).

Table 4. Summary of the findings and categories of problems in Paper 3

Problem category	Items mentioned by the respondents
Thesis initiation problems	• Finding or developing the right and relevant topic is a big challenge • Choosing methodology for data collection is a big challenge • Have to change the thesis topics several times • There is no support or references
Supervision problems	• Getting confirmation from supervisors about the topic of the thesis is a big challenge • More time and effort expected by students from supervisors • Lack of student-supervisor connection and communication is a big problem • Insufficient information and guidelines from supervisors is a big problem
Final seminar problems	• Students are facing different problems regarding final seminars registration • Students are facing problems finding peer reviewers • Students are facing problems finding opponent • Students are facing problems finding final reviewers
Exemption problems	• Further information is required for exceptional cases • The old students need to follow the new procedures and methods than the time they had started their thesis • The old students need to restart their thesis
Technical problems	• Insufficient knowledge and experiences have negative impacts on learners' motivation to use the CMCS • System errors have negative impacts on learners' motivation to use the CMCS • Missing information or not being able to find instructions when needed have also negative impacts on learners' motivation to use the CMCS

The issues in the thesis process (discussed in Table 3) may have been mentioned and observed by other researchers. However, no single study covered all these interaction problems and suggested strategic solution about how to reduce or iron out these problems. Following the findings of Paper 3, an interview study was conducted to collect learners' perspectives in their own words to find out if there were any additional categories of interaction problems. In the light of the discussion by Moore (1989) and Anderson (2008) regarding the general types of interaction, and the results of Papers 1 and 3, and the findings confirmed by the interview study, the three following main categories of problems were developed in this dissertation.

Thesis initiation and supervision (learner-supervisor interaction). There was a need to clarify roles, tasks, and responsibilities for the supervision process. In many cases, learners were very unsatisfied with the supervisors and the supervision process. There was a need for support, a better learner-supervisor communication channel than the university email, sight of supervisors' activities and feedback, and documented communications. Learners needed better interaction with the supervisors and more supervision, more specific research instruction and information, and guidelines. Learners had to contact the supervisors to get the basic information and learn about how to start the thesis. Those learners who got less supervision time missed out some information and could never get enough basic instructions about the thesis process, different thesis phases and the tasks that they had to do.

Lack of instruction and structured information resources (learner-content interaction). Learners required instructions and more structured information presented in small steps to learn how to develop their knowledge and understanding about the thesis process, how to start the thesis, choosing a topic and methodology, choice of methods, etc. Learners needed to know the basic information, obligatory and optional tasks, and preliminary milestones in each phase of the thesis. Moreover, learners required to learn how to assess their own and their peers' thesis manuscripts to get and provide feedback and constructive comments to enhance the quality of their theses. Moreover, learners required adequate appropriate instructions regarding how to use the ICTSS and deal with the technical issues/problems. In addition, the exceptional learners required accessing information covering exceptional cases and supporting learners with special requirements. Lastly, there was a need for learning about the final seminar and what to prepare and how to be prepared.

Peer interaction and final seminar (peer-to-peer learner-interaction). Learners needed to understand the value of the peer interaction and be able to practice it during the thesis process in order to support their peers and learn from the process. There was a lack of motivation among learners to support their peers. Learners required to learn how to register for a peer final seminar, do the peer reviews by using the system, and communicate with their peers without involvement of supervisors. There was a need for better interaction among peers, since the thesis course is similar to a distance course and the learners can become isolated. There was a need for understanding the importance of peer interaction in different phases of the thesis, in order to help learners to get the required knowledge and skills and be prepared for the final peer opposition and learn how to provide the opposition report to support their peers.

In addition, there was a lack of peer collaboration and peer learning in the thesis process until the very last phase of the thesis process. Providing better opportunities for learners' peer interaction reduces the problems regarding the peer review process and registering for peer's final seminar, which is useful for learners' own thesis improvements as well. Learners may learn from their peers' thesis manuscripts while supporting one another to produce a better quality thesis. The peer interaction helps learners to communicate with each other and avoid being isolated or only dependent on their supervisors in order to get feedback on their thesis manuscripts. Peer interaction enhances collaborative learning among peers and facilitates learners' cooperation, and the quality of the thesis outcomes. In the final seminar, learners can benefit from participating in peers' final seminars to understand the process of the thesis and learn from the peer interaction. There is a need for communication channels, forums, and clear peer tasks to enhance the peer interaction in the thesis process and the thesis final seminar.

5.3 Evaluation of the Learners' Perspectives (Phase 2: Findings from Papers 2, 3, 4, and 5, and the Interview Study)

Based on the categories of problems (Paper 1 and 3), a set of strategic suggestions were developed in phase 2. These suggestions are connected with providing online structured information resources (Paper 3), enhancing and facilitating different phases of peer interaction (Papers 2 and 5), and developing a mobile application to provide notifications regarding information updates and communications with peers or supervisors. The next sub-sections include these issues based on the findings of the studies (Papers 2, 3, 4 and 5) to evaluate of the learners' perspective and perceived usefulness of the use of the ICTSS and different functions of the system. Based on these findings and evaluation of the learners' perspectives, Tables 5 and 6 show the useful functions covered and not covered by the ICTSS (SciPro).

5.3.1 Instructions and Structured Information Resources

In the light of study 3 and the learners' perspectives, developing learner-content interaction can be a part of the solution and help to facilitate access to the structured information resources and instructions in the thesis process. Based on the learners' perspectives, learners used the available instructions and information resources in order to learn about the thesis phases and process including the thesis initiation, structure of the thesis and how to choose methodology, the tasks that should be done in different phases, the milestones for internal task deadlines, how to learn about the tools and systems as well as the processes, and use the structured resources such as grading criteria, references and other important information. Hence, as regards the learner's perspectives and the interaction problems discussed above, the resources were categorized and structured in Paper 3.

As mentioned previously (Section 4.6), the result of this study was mostly confirmed by the interview study. The result of this study (Paper 3) was shown to the interviewees to collect their individual perspectives. The interviewees were asked to reflect on the usefulness of the resources in their thesis process. The interviewees were also asked to reflect whether they agree with the categories of these resources or if they believed that something had to be modified (in Figure 3, in Aghaee et al., 2014, p.164). Most of the interviewees agreed with almost all parts of this categorization. However, a few mentioned that maybe FAQ has to be placed in "Basic resources" category rather than in "Additional resources" category, since it has to be used by almost all learners. Hence, as shown by Figure 5, Figure 3 in Paper 3 (Aghaee et al., 2014, p.164) has been slightly modified.

Moreover, given the result of study 3 and the findings of the interview study, supporting learners to access the online structured information resources through the ICTSS facilitates learners' self-managed learning (autonomous learning). The information resources such as grading criteria provide opportunities for learners' self-assessment and use of the criteria when providing feedback for their peers. Grading criteria cover the important factors and issues that learners need to know in order to achieve better thesis outcomes and grades.

The three categories of the resources prioritize the text-/video-based information resources in which learners at different levels and with different requirements can access to them according to their needs. Hence, providing the structured resources at different levels is useful in the thesis process and can support learners to achieve better learning outcomes and grades. The information resources regarding different types of peer interaction (discussed in study 5) clarify the requirements and the potential benefits of supporting peers, and facilitate understanding of the importance of the peer interaction to do the tasks properly.
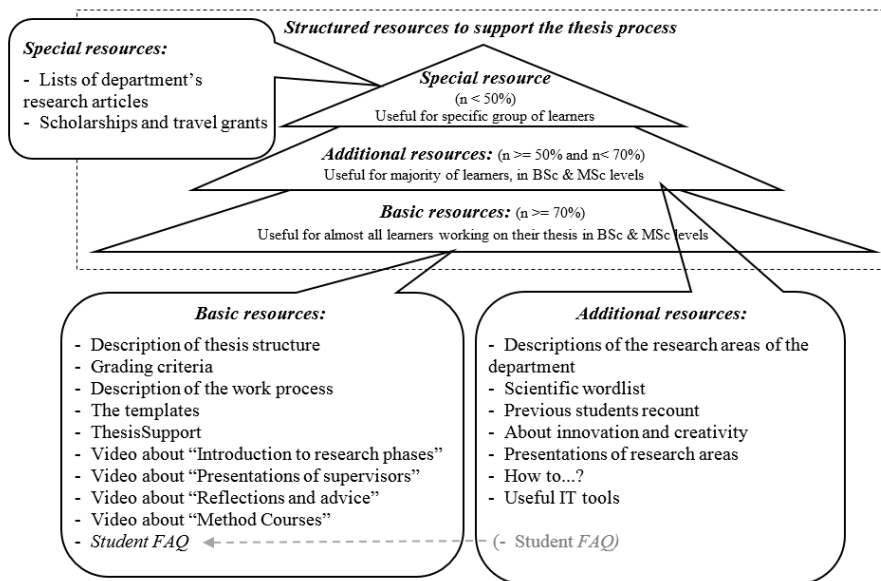
Figure 5. Categories of the structured resources (result of Paper 3)

5.3.2 Peer Interaction

The ICTSS in education increases learners' motivation to interact with and support their peers. As noted in Paper 2 (Aghaee & Hansson, 2013), more appropriate pedagogic discourse should draw on the familiar notion of peer interaction from the world of research. This means that by supporting peer interaction through the use of the ICTSS in the thesis process the learners are more motivated to adopt collaborative learning and support their peers to enhance the quality of the theses. As shown by Paper 5, the different types of peer-to-peer interaction positively impact the learning process by enabling learners to develop their communication skills and ability to provide feedback and discuss the relevant issues with their peers. Moreover, learners can learn from a peer's manuscript with regard to structure and content.

Based on the result of the studies in Papers 2 and 5, apart from the traditional classroom learning from the interaction with supervisors and peers, the online inter-learner group or peer interaction is highly valued by most learners. Figure 6 (from Paper 2, Figure 2 in Aghaee & Hansson, 2013, p.197) shows that at least 40% of the learners provide excellent or good peer reviews in the thesis process.
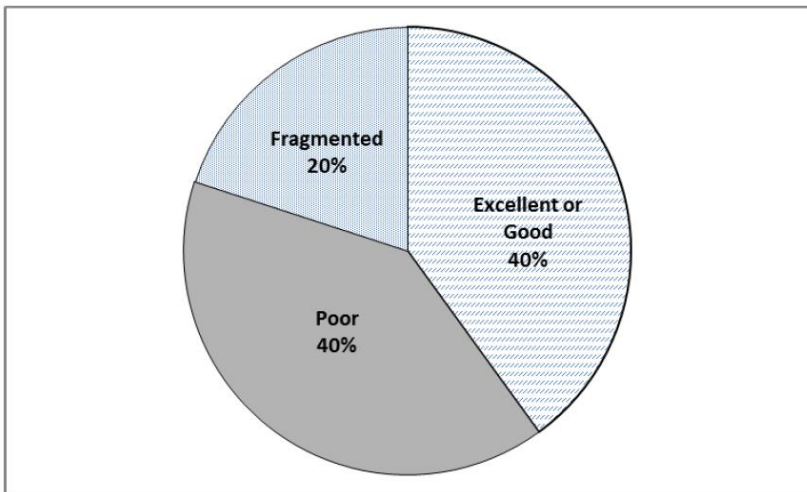
Figure 6. Major quality differences among the peer reviews (result of Paper 2)

As discussed in Paper 2 and suggested focusing on some influential factors, in Paper 5, the findings show that the quality of the peer interaction is connected and depends on different factors and circumstances, shown in Figure 7 (result of Paper 5). Hence, as a result of learners' perception of usefulness of the different types of peer interaction in the thesis process (result of Papers 2 and 5, and the interview study), peer interaction is a way to enhance the quality of the thesis and collaborative learning. Developing peer interaction can be categorized as follows: peer reviews on the incomplete thesis manuscripts in the middle phases of the thesis process; active participation in peers' final seminars to understand the process and support fellow students; and providing possibilities for learners to be involved in the discussions and give constructive comments and feedback by being an opponent of another learner in their final thesis defense.
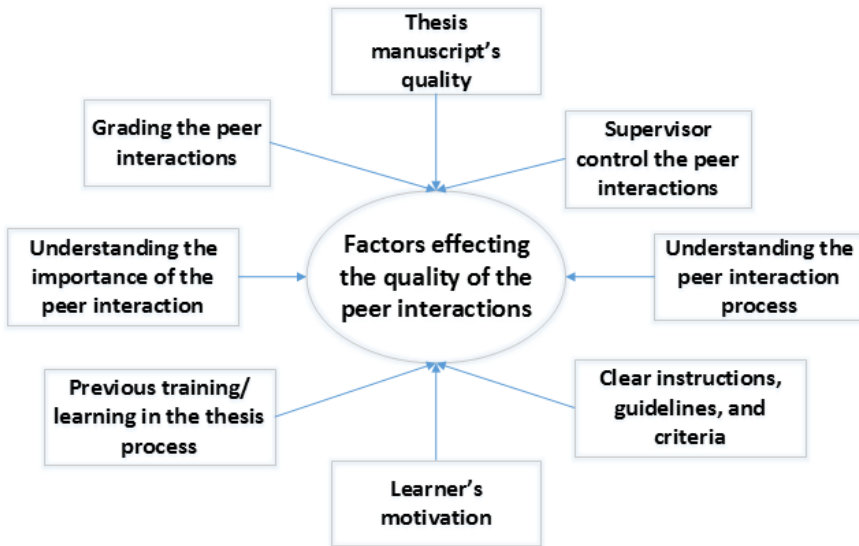
Figure 7. Influential factors on the quality of peer interaction (result of Paper 5)

5.3.3 M-learning through Mobile Application

As discussed by Motiwalla (2007), m-learning connected with mobile applications is useful to improve the learning environment by enabling learners to control or filter the information flow and communication, improve real-time interactivity and collaboration, and access the services, regardless of time and location. Result of Paper 4 shows that although learners regularly used mobile applications in their informal learning and private life, they did not believe that a mobile application would directly affect thesis quality. Learners mentioned that using a mobile application for large tasks such as working on the thesis manuscript, downloading files, or updating documents (attaching files) through mobile phones would not be a good idea or useful in the thesis process. However, providing instant notifications through a mobile application would be useful and was an interesting functionality for many learners.

As discussed by Ally (2009) and Motiwalla (2007), the result of Paper 4 also showed that m-learning would positively influence achieving the learning outcomes. M-learning makes different types of interaction easier and faster in the thesis process by enabling learners to get access to the information (learner-content updates) and notifications regarding the issues related to peer-to-peer and learner-supervisor interaction. A mobile application is required which supports availability of the e-resources on mobile devices and provides notifications about updated information, facilitates learner-content, peer-to-peer, and learner-supervisor interaction in a more effective way (Figure 8). The application would help to reduce the pending time for a specific update or notification, which saves time for both learners and supervisors.
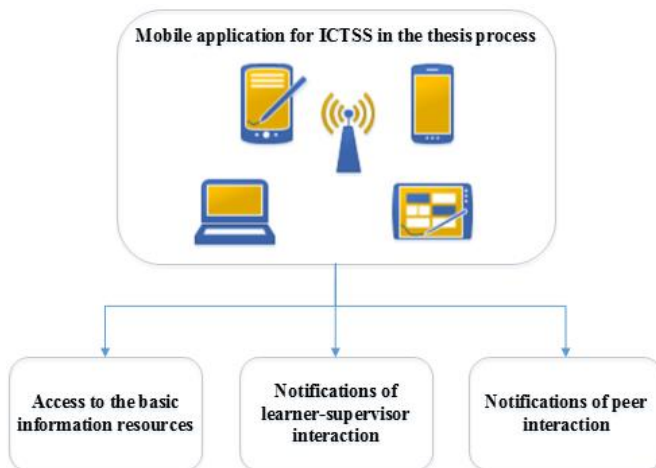

Figure 8. Usefulness of mobile application in the thesis process (result of Paper 4)

5.4 Functionalities of the ICTSS (SciPro)

Given the findings of Papers 1 to 5 and the additional studies, the two following tables (Table 5 and 6) were developed to indicate the available functionalities and resources in SciPro and what is lacking. Table 5 was developed with respect to the findings of the papers and the different types of interaction (by Moore, 1989; Anderson, 2008). As a complement to Table 5, Table 6 shows the required functions which are not currently part of the system but based on the learners' perspectives, they need to be.

Table 5. Overview of the functionalities and issues provided by current SciPro

Functionality/ Resource	Description
Learner-instructor interaction	
Interaction between learner and supervisor/ co-supervisor(s)	To facilitate arranging meetings and providing oral and written feedback throughout the entire thesis process (from thesis initiation to the grading after the final seminar). The system records the planned meetings, submissions (thesis manuscripts), activities (communications through the forums), and supervisions (provided guidelines and information resources), which is very useful if the learner changes her/his supervisor. It also registers all information (date, time, and place) regarding the decided final seminar that the supervisor books for the student.
Instructor-instructor interaction	
Interaction between supervisor and reviewer	The supervisor sends the rough draft and the final seminar manuscripts in different phases of the thesis to the reviewer for quality approval and feedback to send to the learner.
Examiner	Grading and reporting are done by the supervisory team (including the main supervisor, co-supervisor(s), and reviewer). If the team cannot agree about the thesis grade, then the final thesis manuscript will be sent to the examiner to grade it.

Functionality/ Resource	Description
	Learner-content interaction
Text-based/video-based information resources and instructions	The information resources, called ThesisInfo, covers information and instructions: thesis instruction, thesis phases, thesis process, templates, video resources, referencing and scientific references, etc. (discussed in detail in Paper 3).
Grading criteria	A set of important criteria (Appendix E) as a general reference for both learners and supervisors to focus on, in order to support achieving the course outcomes and producing unified and approved quality theses (referred to in Papers 2, 3, and 5).
Self-assessment	Checklists, including more specific criteria based on the grading criteria with a set of related questions to each phase of the thesis: Project plan, rough draft, result and discussion, a complete thesis manuscript, final check based on the grading criteria.
Milestones	Preliminary assignment of deadlines for submission of the thesis manuscripts to the supervisor and reviewer (through the supervisor), and for the peer-to-peer interaction.
	Learner-learner (peer-to-peer) interaction
Peer review through the peer portal	Reviewing two other thesis manuscripts written by peers (not necessarily the same person) aligned with the grading criteria, in different phases of the thesis, e.g., project plan, rough draft, result and discussion (discussed in detail in Papers 2 and 5)
Peer opposition for the final thesis manuscript	Written opposition report aligned with the grading criteria to provide constructive feedback and relevant questions. Sending the opposition report before the final seminar, followed by an oral presentation and discussion at the final seminar, whose date and place are decided by the learner and supervisor. The participants (thesis author, opponent, active participant) have the possibility of online participation in the final seminar through Skype or another video-conferencing tool (discussed in detail in Paper 5).

Functionality/ Resource	Description
Peer interaction through active participation in other learners' final seminar	Reading the thesis manuscript and providing constructive feedback or relevant questions to enhance the quality of the final thesis manuscript (discussed in detail in Paper 5).
Instructor-content interaction	
General information and resources	Providing a set of basic and general information and resources within supervisors' specific area of research which can be useful for all learners writing their thesis within that knowledge area.
Group Forum for instructing several students	Supervisors have the possibility of starting group forums to instruct and leave information for all the learners that they place in that group (e.g., all the learners they supervise in each semester). This also enables learners to interact with other members of the group to discuss the contents or resources that supervisors have provided there.
Content-content interaction	
Video-based information resources	Information about other contents, such as thesis instructions, how to do clips that explain how to use the system's functionalities or other related tools in the theses, e.g., research method tools.

The functionalities shown in Table 5 are part of the ICTSS (SciPro). As many respondents mentioned, these are useful functions, which add value to the learning process in thesis courses. However, as many of the respondents noted, adding functionalities which are only used by a few learners makes the system complicated and not focused on priority information and instructions in the thesis process. Clarifying the tasks, e.g., what is obligatory and what is optional, helps learners to prioritize the tasks correctly in order to fulfill the aim of the course and achieve higher quality results. Moreover, from the learners' perspectives, there are other functions and resources requested to be added to the ICTSS, which are defined in Table 6.

Table 6. Overview of the functionalities and issues not provided by current SciPro

Additional requirements	Description
Synchronous communication: chat function among peer learners	SciPro facilitates learners and supervisors to manually add their Skype ID into their SciPro account. However, possibility of being available for chat synchronously with fellow students was a requirement. The learners wished to have the possibility of the option of being visible or invisible to their fellow students and have a chat function in the system, as in Facebook, to have the possibility of synchronous interaction with peers.
Asynchronous communication: student forums with peers	Possibility of asynchronous communication with peers in order to ask questions. This functionality motivates learners to communicate with their peers with less or no supervisor involvement. The learners wished to have the possibility of asking questions anonymously when they had sensitive issues to discuss.
Mobile application	The learners wished to have the possibility of having the possibility of getting notifications, updates, general information, and simple communications through a mobile application.
Structure information resources and instruction	Lack of information categorization in ThesisInfo made finding required resources complicated for learners at different educational levels and in different phases of the thesis process. Structuring the resources based on the three categories suggested by the result of Paper 3 facilitates finding required resources easier and faster.
Clarifying the tasks	Learners need to know about the importance of each task. They also required to know which tasks are obligatory and what is required to fulfill the tasks. The same applies to the supervisors, who need to clarify their roles and responsibilities in the thesis courses.
Short instructional videos	Over-long videos may get boring to watch and follow. Learners wished to access short videos to describe the process of doing important tasks, e.g., peer review or opposition. The videos are required to be easy to understand and remember, to enable learners to refer back to the issues in the videos.

6. Discussion and Development of the Conceptual Framework

Adapting the ICTSS makes the process more unified and leaves less work to be done at the end. The ICTSS supports the thesis process, making it a more agile method to learn and getting feedback in smaller iterations instead of the traditional waterfall process. This offers opportunities to avoid providing/getting all feedback and comments from peers and the supervisor team at the end of the theses. This means that by developing and adapting online supports through an ICTSS, learners get the opportunity to learn in smaller steps and get feedback more frequently, before it is too late for fundamental changes, rethinking the methodology, analysis of data, and drawing conclusions. This enables users to go back to the previous steps and have the possibility of modifying errors, filling in the gaps, or enhancing the quality of the thesis manuscripts in smaller steps (thesis phases). Users can get feedback from the different types of interaction and have the chance of getting another perspective on their thesis manuscript from their own and their supervisor's. This means that the system enables learners to interact with their peers and the supervisor team (co-supervisors, reviewers, and the examiner) in order to know if there is a need for major or minor changes in different phases of the thesis.

The main purpose is to facilitate different types of interaction in the thesis process to facilitate getting feedback for improvements before submission of the last version of thesis manuscripts. With this system, learners have a set of milestones, enabling self-assessment through the provided structured resources. The system also facilitates getting feedback on the incomplete thesis manuscripts from different perspectives: thesis supervisor(s), peers, reviewer(s), and thesis examiner. However, in some cases, reviewers still provide comments after the thesis final seminar, which mainly influences the final grade of the thesis rather than the quality of it. There are also some problems regarding the use of the system and benefiting from it in the thesis process which are mainly owed to lack of competences or proper understanding of the system by some learners, supervisors, reviewers, or complicated use of the system or finding e-resources.

6.1 Connection with Instructional Principles

In the light of the theories discussed in Table 2 (Section 2.1) and the findings in this dissertation, the following descriptions have been developed in connection with the common instructional principles in the learning theories, specifically in the thesis process. Many of these issues were discussed by Moore (1993, pp.28-29) and Schunk (2012, p.19). The following phases show the process of developing the findings in this dissertation.

Learners' progress through stages/phases

There are five different thesis phases at DSV (shown by Figure 2 in Paper 5, Aghaee & Keller, in press), which are known as the thesis process (from start to finish). These phases help the learners to know where they are in the thesis process, refer to relevant online instructions, guidelines, and e-resources related to each specific thesis phase, and get peer feedback as well as feedback from the supervisor team. The phases help the learners to get a view on where they are, what they have passed and what is left in the thesis process. In some of the phases, there are self-assessment criteria and opportunities, recommended peer interaction, and the possibility of uploading thesis manuscripts to get help from peers. The visibility of the learners' progress is part of the aim of dividing the thesis process into the different phases and allowing learners to do the self-assessment, peer assessment, and check which milestones they have passed, and the next step in the process.

Division of the tasks into different phases and an iterative system for developing the quality of the thesis manuscripts makes the process more efficient and enables learners to plan their next step. The learners advance by going forward through the phases, which means they produce better thesis manuscripts, higher quality peer interaction, and improve their communication skills, which makes them ready for the final thesis phase. Facilitating development of the thesis in smaller phases and steps means moving from a waterfall method (traditional thesis process) to an agile method to provide a possibility of enhancing the thesis in smaller steps, with the use of smaller phases, milestones, self-assessment and peer assessment with the use of the grading criteria, and reviewer approval to confirm that the thesis is on the right track.

Material organized and presented in small steps

In the light of the theories and the learner perspectives in this study, it is important that learners have access to a set of classified and categorized structured resources in the thesis process. Structured resources were categorized into smaller categories based on the learners' requirements and

perceived usefulness of the functionalities, in order to make learners more motivated to use them when they need them at different levels. For instance, basic information should be easier to find and specific resources should only be available to the specific group of learners, who would like to use them. The model developed in Paper 3 discussed the importance of organizing e-resources in different steps and how to categorize and structure the required resources in order to reduce learner-content interaction problems and enhance self-managed learning in the thesis process. Categorizing material enables learners to refer to the e-resources depending on their needs and gives them the opportunity to get the material into a meaningful context within their special subject. The result of Paper 3 and the usefulness of categorizing e-resources into three levels or stages was confirmed by the interviewees, who were another group of learners in the next generation using the ICTSS. Learners believed organized and structured e-resources in different steps would have been useful and motivated learners to use the resources more frequently and remember them when they needed them.

Learners' requirement of practice, feedback, and review

As discussed in Papers 2 and 5, interaction, which refers to the practice of interacting with learning materials and communicating with both peers and supervisors, is a significant part of the learning process. In this dissertation, an important focus is on the practice of interaction such as communicating with peers in different thesis phases in order to provide and receive feedback and reviews. The agile method of providing peer feedback based on a specific set of criteria supports the learning process and provides more possibilities of enhancing thesis quality rather than the traditional waterfall process, in which learners had to submit the final manuscript and peer comments were given only once at the end of the thesis.

Another important part of the ICTSS, which is not discussed in detail in this dissertation, is to practice and communicate with the supervisors to get feedback and comments during the thesis process and on the incomplete manuscripts. Different types of interaction support thesis quality enhancement and learners' motivations to learn more and achieve better outcomes. Feedback and supervisors' comments are usually the main way of providing guidelines in the thesis process. Hence, as discussed in Hrastinski (2006) and Pargman et al. (2013), the availability of forums and synchronous interaction enables learners to participate more actively in online group work and online learning. Availability of forums for online or distance learner-supervisor communications helps learners to get more frequent feedback and have the possibility of asking questions in the writing process instead of making an appointment to meet the supervisor to ask questions. The ICTSS also facilitates archiving of all the previous online written communications and

feedback, so that learners and supervisors have the possibility of referring back to a specific issue.

Motivational and contextual factors influence learning

In this dissertation, the results of the studies show that learners believe in the usefulness of an ICTSS in the thesis process, which affects their motivation to use the system. There might be motivation for the thesis initiation; however, maintaining the motivation during the entire thesis process is important in order to finish the thesis and achieve a good quality thesis outcome. Hence, in this dissertation the author argues that developing an ICTSS based on learners' perspectives and requirements has the potential of increasing learners' motivation, supporting the thesis process, and facilitating the different types of interaction to enable learners to achieve higher quality thesis outcomes. Considering the three other principles discussed above, learners' progress through stages/phases, organized and presented material in small steps, and fulfillment of learners' requirement of practice, feedback, and review are some of the motivational and contextual factors influencing the learning process.

The three other principles, using structured resources, educating learners to use peer interaction, and developing communication skills, have great potential for increasing the motivation of learners to communicate and learn. Biggs and Tang (2011) suggest that both motivation for initiation and maintaining engagement during learning are important factors in the learning process. Motivation is the key that can affect the thesis initiation as well as the entire process of the thesis.

As discussed in Paper 5, different motivational and contextual factors affect learners' learning process and production of good-quality thesis manuscripts, as well as supporting peers and providing good peer interaction (peer reviews and opposition reports). In Paper 5, the factors which impact peer interaction are interconnected, one of which is motivation. Motivation is connected with understanding the process and why learners should go through this process. Learners must understand the importance of doing tasks of good quality in order to become motivated to fulfill the requirements. It is also important that the use of the ICTSS is simple and efficient, in order to motivate learners to benefit from it.

6.2 Developing the Conceptual Framework (Phase 3)

The conceptual framework (Smyth, 2004) is a structured description of the ideas and principles, which is used as a useful tool to scaffold the research. This means that a framework is formed as part of the research agenda to scrutinize the results and discussions, and facilitates use of subsequent findings as a starting point for reflection on the research and its context (Smyth, 2004). The conceptual framework was defined here as a tentative theory to form the design, and develop the goal, research questions, methods, and potential internal validity of the study, and to justify the findings of the research (Maxwell, 2012). Further, this conceptual framework was based on Maxwell (2012, p.44) for an actual research study based on four main sources: 1) existing research and theory, 2) researcher's experiential knowledge, 3) researcher's pilot and exploratory research, 4) thought experiments.

The conceptual framework (shown in Figure 9) was based on the three main types of interaction (Moore, 1989), the model by Anderson (2008), and the common instructional principles of Schunk (2012), besides inspiration drawn from other references connected to the empirical findings in Papers 1 to 5. However, none of the studies covered all the elements of this framework and this framework was iteratively developed from the findings of the papers included in this dissertation. The framework depicts how an ICTSS can be used as an umbrella to cover and facilitate different types of interaction, and self-managed and collaborative learning, in order to reduce interaction problems and enhance the learning outcomes in the thesis courses. More specifically, the framework illustrates the importance of the five types of interaction besides the importance of supervision in the thesis process. The framework covers the main issues in Tables 5 and 6.

In Section 6.3, a detailed description of each element illustrated in the framework is discussed and related to the interaction problems to show how the use of an ICTSS can facilitate different types of educational interaction to enhance the learning outcomes in the thesis process.
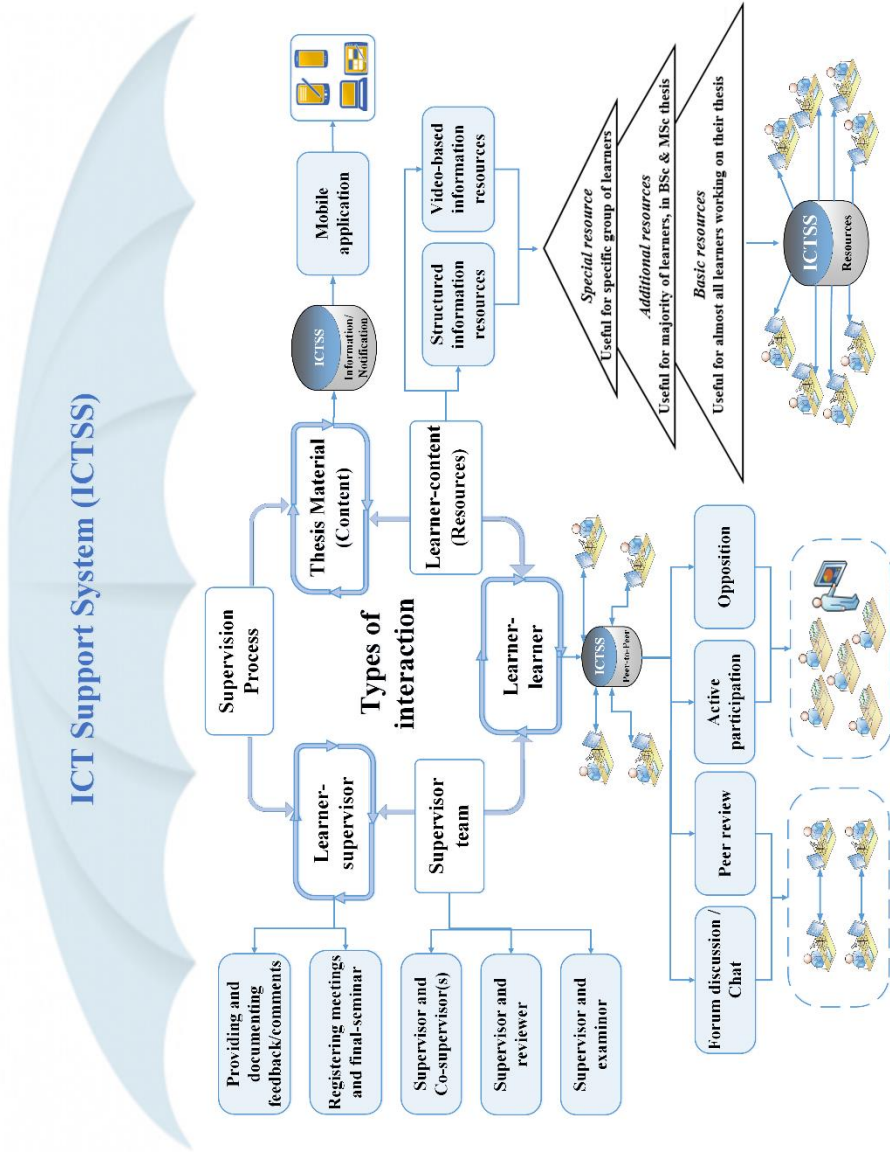
Figure 9. Conceptual framework developed based on theories and empirical findings, as an overview of different types of educational interaction, which can be facilitated and supported by ICTSSs (as an umbrella), in the thesis process.

6.3 Main Contributions (Phase 4)

The elements included in this framework describe how an ICTSS can be used as an umbrella to facilitate self-managed interaction by supporting learners' access to the required content, enabling collaborative learning among peers, and getting better supervision from a supervisory team to enhance learning process and thesis quality. This framework was developed as a package of requirements based on learners' interaction problems in the thesis process and the perceived usefulness of the functionalities to reduce these interaction problems. All these elements together facilitate the thesis process and support learners to finish their thesis with higher quality outcomes.

Based on the first research question, the findings of the studies led to three main interaction problems in the thesis process, which are also affected by the lack of three additional types of interaction, supervision, supervisory team, and available contents.

1) Lack of structured information resources or learner-content interaction. Lack of unified access to the basic information and dependence of learners on supervisors for basic information and resources was an important issue, requiring a system to cover a set of structured resources, equally available to all learners. There was a need for a unified system to clarify the basic information and instructions for learners regarding the thesis phases and important steps (from initiation to the end). This means learners required access to a set of structured information resources and instructions, including the grading criteria, milestones, information regarding the thesis initiation, thesis process, tasks, and responsibilities. Moreover, they needed more specific information about the use of the ICTSS in the thesis process, how to use the supporting tools, how to handle the peer interaction or communication with supervisors, and other similar content-based guideline requirements.

2) Lack of peer interaction, communication skills, understanding the importance of supporting peers and collaborative learning among peers was another issue in the thesis process. There was a need for systematic peer interaction among learners with less involvement of supervisors. Learners needed support to learn collaborative learning and how peer interaction can positively impact the quality of their thesis manuscripts. There was a need for other perspectives on thesis manuscripts, both early in the thesis process and in the final phase. Peer interaction was poor and not many of the learners were motivated to support their peers to enhance

their thesis manuscripts. More structured peer interaction and obvious tasks were required by the learners in order to foster motivation for peer interaction and collaborative learning in the thesis process.

3) Lack of supervision and supervisors' support for learners. There was a lack of supervision, which in many cases meant the supervisor was not available when the learners needed support or they did not have enough knowledge within a specific area of research. Learners required more guidelines and support in order to choose their thesis topics, research area, methodology, how to proceed with the thesis, and how to fulfill the thesis requirements. A structured set of grading criteria was needed by the learners to understand the grading process and their achieved grade at the end of the course, since supervisors had different grading criteria.

Based on the second research question and the conceptual framework (shown in Figure 9), the findings of the studies led to the development of an ICTSS with a set of useful functionalities and information resources as the solution to the interaction problems.

1) The ICTSS provides a set of structured resources (*learner-contents*) and instructions which supports learners' self-managed learning and access to the required information with less dependence on their supervisors. The ICTSS provides similar opportunities for all learners to have access to the basic information in a unified system. Providing contents and facilitating learner-content interaction reduces the need for learner-supervisor interaction to gain the basic information and instructions, which helps save supervisors' time and uses the supervision times more efficiently on a more specific issue.

The structured resources were categorized on three different levels: basic or general information, additional information, and specific information resources, depending on the importance and usefulness of each item in the thesis process. The basic online resources proved to be required and useful for almost all learners, additional online resources were useful for the majority of the learners, and the special online resources fulfilled the need of the learners (exceptions) with special requirements.

Grading criteria (Appendix E) are an important element of the system, and belong to the basic category of structured resources. These criteria are needed in order to clarify the basis of grading by the supervisory team, to be used for more structured peer interaction, and in order to facilitate learners to do a self-assessment of their own thesis manuscripts.

Moreover, providing content and instructions supports peer interaction by clarifying the tasks, requirements, and the importance of peer interaction. In addition, the thesis support group guides learners to find the right information from online resources, or to contact the right person if they cannot manage situations on their own or with their supervisor(s).

2) Facilitating *peer interaction* and collaborative learning, which provides opportunities for learners to learn from one another, develop their interaction skills, and be able to provide support for their peers in the thesis process. The first interaction centers on the peer reviews in earlier phases of the thesis, to provide comments on the peers' incomplete thesis manuscript. The second peer interaction focuses on enabling learners to provide feedback for peers' completed thesis manuscript as an opponent in the final seminar. The third interaction is active participation in peers' final seminar to provide oral questions and comments. The synchronous peer forum or synchronous communication channels, also mentioned by the interviewees in this dissertation, was a requirement in SciPro to enhance learners' active participation and enhance the learning outcomes in the distance learning process (Hrastinski, 2006), as in the thesis process. Moreover, Hrastinski (2008) notes that providing possibilities of synchronous peer communication induces arousal and motivation as well as increased convergence on meaning, especially in small groups.

The peer reviews enable learners to get feedback from their peers early in the thesis process and be able to rethink the fundamental issues, to be able to develop their thesis manuscripts from the early stages via an agile method rather than the traditional waterfall method. In addition, the peer reviews make the learners o develop their communication skills and understand the importance of the peer interaction to be prepared for the final opposition. The peer opposition is on a larger scale and provides feedback on the thesis work in the final seminar, which includes a written opposition report and synchronous discussions with the author of the thesis. Active participation also takes place in the final seminar, which enables learners to register and attend to the other learners' final seminar and provide them with oral comments and questions, which is instructive for both thesis authors and the active participants.

However, there are influential factors in the thesis process which may affect the quality of the peer interaction outcomes. These factors need to be considered when peer interaction is developed as part of the thesis quality enhancement.

3) Supporting *learner-supervisor* interaction helps learners to contact their supervisors when they need support. This includes getting feedback from the supervisor team, provides the possibility of communicating through closed forums, and enables supervisors to book the meeting and the final seminar for the learners through the ICTSS. Facilitating this type of interaction makes the process more visible by registering the manuscripts, comments, thesis progress and learners' current position in the thesis process. This provides opportunities to document the tasks that have been done, offers control of communication and supervision, and develops a better learner-supervisor information transfer. This hence enhances the quality of the supervision by providing a more structured supervision process and letting learners know about the thesis phases and milestones.

4) Supporting the *supervisor team* facilitates interaction between the supervisor and the co-supervisors, reviewer, and examiner, which makes the communication and updates easier and more efficient and enhances the supervision process. The role of the reviewer is to approve the thesis manuscripts in two phases, and the support supervisor decides the final grade of the thesis. However, if agreement cannot be reached, the supervisor can contact the examiner to solve the situation to decide about the final grades of theses.

5) *Thesis material (Content), including mobile application as a part for mobile information and notification*: as a potential part of the system, mobile-learning is a developing concept to support the thesis material (content). The thesis material covers any kind of general information or required materials, besides the main concept of mobile learning through the help of the mobile application. Mobile application is very popular among the new generation of learners. It needs to be part of the ICTSS to enable flexible learning and simplify communications through a mobile application on mobile devices. The mobile application provides the possibility of accessing contents and structured resources wherever and whenever through mobile devices. The mobile application also facilitates receiving notifications, such as approval of the thesis by the supervisor, peer reviews, and final seminars. However, the application is not recommended for managing main tasks such as uploading or downloading files or providing peer interaction.

The result of Paper 1 was strengthened by the result of Paper 3 and the findings and result of the interview study. The result of Paper 2 was strengthened by the result of Paper 5 and the interview study. The result of Paper 4 was strengthened by the result of the interview study, and the interview study was part of Paper 5 to strengthen the result of the survey in the same study. Moreover, the results of all Papers (1 to 5), and the interview study, which indicated the evaluation of the learners' perspectives regarding the usefulness of an ICTSS in the thesis process, were affirmed by the final evaluation study (Hansson, et al., under review). The evaluation study shows how an ICTSS can be an important factor in enhancing the thesis completion rate and the quality of the thesis outcomes. Hence, the entire process of the connections and affirmations increases the internal validity of this dissertation.

6.4 Methodological Discussion

In this section, the reliability, validity and transferability of the findings followed by a discussion about the limitations of this dissertation is reflected.

6.4.1 Reliability, Validity and Transferability

According to Lincoln and Guba (1985), there is no generalizability but only transferability of the findings from one study and context to another. Studies do not necessarily have to be generalizable, as the lack of a general conclusion does not detract from the value of the study (Gomm, Hammersley, & Foster, 2000). It is also important to know about fitness, which refers to the comparability of different contexts, and how the finding in one context can match another one (Lincoln & Guba, 1985). According to Humphrey and Lee (2004), in case study research, instead of generalizability, it is better to think about procedural reliability, contextual validity, and transferability. Hence, these issues are discussed in this section.

To ascertain the reliability and validity of each study, a number of issues were taken into consideration. To increase the reliability of the content analysis in the first two studies (Papers 1 and 2), two independent researchers analyzed the data. The categories in each study were developed by discussing and considering the aspects developed by the researchers. The differences between the analyzed results were discussed, and in most cases a unified result was reached. However, when the researchers did not agree on a unified result, either the result was removed from the study or a third person was invited to assess the result. A set of criteria were developed by the researchers to be used for the data analysis and the assessment of the data to increase the reliability of the findings.

To increase the reliability of the survey questionnaires (Papers 3, 4, and 5), descriptive statistics of quantitative data from closed-ended questions were reported for the questionnaire items. To evaluate associations between certain variables in Papers 3 and 5, quantitative data were analyzed using SPSS to calculate Pearson's $\chi2$ test for independence and correlations. However, this was not done in the same way in Paper 4, where the findings were mainly analyzed manually, since the answers of the closed-ended questions were tightly bound to the open-ended questions in each section. In this Paper (Paper 4), the questions were based on the criteria set by Cohen et al. (2007) in addition to providing motivation boxes as complementary data collection techniques for eliciting detailed information, social objections and further suggestions.

To increase the reliability of the interviews, the interview questions were based on the interview guide devised by Patton (2002, pp.341-342). The interview questions were confirmed by two lecturers at the department and two pilot interviews were conducted before the full interviews. Moreover, the same interview guide and coding scheme were used for all the interviews.

To ensure the construct validity of the survey and interview studies, the questions were based on Cohen et al. (2007) and Patton (2002), and in each study the questions were checked and confirmed by at least two docents, and a pilot study was conducted. As the questions of the survey and interviews were tested by experienced academic researchers, it was presumed that their construct validity would be sufficient. Moreover, in the survey questionnaires, the motivation boxes were complementary data collection techniques for eliciting learners' detailed reflections, social objections, and further suggestions, which increased the validity of the results from the closed-ended questions. In many cases, in the motivation boxes, learners voluntarily added comments on the reasoning behind the chosen options or when disagreements took place.

Internal validity ensures that the findings of the studies make sense and reflects the reality in line with the aim of the study and whether the findings of the studies are transferable to another research setting. To provide internal validity, the respondents chosen genuinely represented learners using the ICTSS in their thesis courses at a department of computer and systems sciences. The sampling of the interview study was maximum variation from the learners who were in the last phase of the thesis process, in order to involve diverse groups of learners and identify important common patterns, as suggested by Miles and Huberman (1994). In the survey studies (Papers 3, 4, and 5), the questionnaires were sent to all learners with active thesis projects within a specific time interval. Learners were invited to participate in the same way, through the university email and the participation was completely voluntary. In Paper 1, a sample random of maximum variation, in which all the learners sent an email to the Thesissupport, was chosen in order to provide an equal chance of each email being chosen and analyzed. In study 2, the whole population comprised the sample and the peer reviews within the specified time interval were analyzed and considered equally.

6.4.2 Limitations

The investigation was mainly carried out at DSV, which is a Computer and Systems Sciences campus at Stockholm University. The studies were done internally and the respondents were from the department. In the department, the level of English is satisfactory; however, there is always a risk of missing concepts, because English is a second language. When the responses were in Swedish, the respondents' native language, the researcher was not a native Swedish speaker, and again the same risk should be considered.

In each study, the number of respondents could have been larger to increase credibility. The low response rate exposes the results of the studies to non-response bias through refusal (Denscombe, 2014). Moreover, in the interview study, there were four additional interviewees who were not satisfied with the supervision process and their supervisors, and their reflections were strongly negative. Hence, the interviews were not used because of ethical issues (being able to identify or track the learner or the supervisor), and in two cases the interviewees did not even agree to be part of the studies.

The results of the studies in this dissertation cover some phenomena which may have been very computer- or ICT-oriented, and general educational purposes for theses within non-technical fields might have been lost. This means that the usefulness of the ICTSS may not be transferable to scientific fields where learners are unfamiliar with the use of ICT in higher education. However, in the age of online technology, it seldom happens that the learners do not have the knowledge and motivation to use ICT to enhance the quality of their education. A study by Colombage (under writing process) shows that the use of ICTSS in the thesis process can be applied in different countries, and especially within computer and systems sciences. Most of the findings have been filtered through the lens of the coordinator of the thesis courses or/and the Thesissupport group. Hence, they may be transferable in similar situations in different contexts. However, as mentioned before, in different situations, the process, findings, and results may be interpreted differently from a non-technical perspective, or with another culture of using online technology in education.

Credibility was the counterpart to internal validity, in order to represent the alignment between the collected data and the conclusions drawn. All the studies were carried out at a technical or ICT-savvy department, where in most cases the data collection was online and technology-based by the use of the Internet. Participation in all studies was totally optional. However, the frequent users of the system, who were more positive about and interested in using it, may have had greater possibilities of participating in the online survey and the interview studies.

7. Concluding Remarks

The more we give and help others, the more we get back from the eco of life!

"*As we work to create light for others, we naturally light our own way.*"

Mary Anne Radmacher

Different types of educational interaction are important in order to support the learning process, especially in distance courses (Moore, 1989; Anderson, 2008). Since thesis courses at the bachelor and master levels in higher education are in many respects similar to distance courses, this proposition was confirmed in the thesis process by the findings of the case study in this dissertation and shown by the conceptual framework in Figure 9. As noted by Iivari and Ervasti (1994), with ICTSSs, interaction in education takes place in a more convenient way, and otherwise, it could be less efficient and effective. The interaction problems and the usefulness of an ICTSS in the thesis process must be considered as an important issue in the thesis courses. The study results demonstrate the usefulness of the ICTSS in the thesis process and as an important part of thesis quality enhancement and thesis completion rate. Particularly, this dissertation delineated what elements an ICTSS must include to support learners' requirements and needs in the thesis process, in order to make the use of the ICTSS more effective in the thesis courses.

The notion of using ICTSS as a complementary support to supervision seems to be generally acknowledged and appreciated among learners. Developing an ICTSS supports managing contents, supervision, and interaction of the supervisor team, besides facilitating the learner-content, learner-supervisor, and learner-learner (peer-to-peer) interaction. The usability and the usefulness of the functionalities and information resources of the ICTSS were approved and valued by learners on different educational levels. These functionalities of the ICTSS include providing online access to the structured e-resources with an additional mobile application, as well as facilitating synchronous and asynchronous communications and planning face-to-face meetings and seminars, in a more efficient and effective way in the thesis courses. The ICTSS saves time of both learners and supervisors and documents the thesis process and the tasks in different phases.

The ICTSSS provides further learning opportunities by enabling learners to get feedback from their peers and supervisors in the early stage of the thesis as well as in the final phases of the thesis process. Facilitating peer interaction through the use of ICTSS provides collaborative learning opportunities as well as improving learners' communication skills and critical thinking.

Supporting different types of interaction is important to enhance learners' motivation and self-managed learning, which positively impact the quality of the learning outcomes and the number of completed theses in higher education. Hence, it is important for all institutions, challenged by a high number of thesis dropouts or low thesis completion within the stipulated time and unsatisfactory thesis quality, to consider the interaction problems and ICT-based strategic solutions in the thesis courses.

In this dissertation, the most important issue for the author was to find a way to provide learning opportunities for all learners as fairly and equally as possible. It is always dramatic to see that the learning outcomes of the learners depends on the knowledge and time allocation of the supervisors. In the interview study, two interviewees (who refused to allow their reflections to be used in the studies and this dissertation) whimpered and whined regarding the unfairness of the system and the thesis situations they had experienced. Two others were so sad and depressed about the situation they had experienced themselves and/or had seen in the thesis process.

Providing access to structured e-resources such as grading criteria, information resources, responsibilities, rights and regulations, besides facilitating educational interaction (synchronous or asynchronous) among peers enables all learners to have a more similar opportunity of learning in the educational communities and get more support from each other and the supervisor team. It is important to consider learners' perspectives, interaction problems, and learners' perceived usefulness of an ICTSS in the thesis process, even though it may not always be in favor of all supervisors. Appropriate ICTSSs may have dramatically positive influences on the thesis courses and consequently the educational system. Fair and similar opportunity of learning in the educational communities and providing enough supports for specific courses, positively impact the quality of the learning outcomes and learners' motivation.

7.1 Recommendations

Applying an appropriate ICTSS is helpful to improve the thesis process and enhance the quality of completed theses. At each institution, investigation of the problems in order to find the reasons for thesis attrition and low quality of the completed thesis within the stipulated time should be part of the educational research and quality enhancement of the thesis courses. It is recommended that interaction problems are investigated from the learners' perspectives, as they are the stakeholders most affected in the educational system. Developing a system in line with learners' requirements is recommended in order to facilitate learning opportunities and enhance learners' motivation.

A main finding of this dissertation, and a most important one, is that facilitating peer interaction, providing grading criteria for the assessment of peers' thesis manuscripts and learners' self-assessment, specification of the tasks and the thesis process and instructions, and providing m-learning through a mobile application were appreciated by the learners. These actions are recommended to provide further learning opportunities in the thesis process and positively affect the number of thesis completions of higher quality. The use of an ICTSS is recommended since a well-structured ICTSS supports the learning process and reduces learners' confusion regarding the different phases, tasks, responsibilities, and expectations, provides further interaction, and gives additional support for learning, rather than providing only a single supervisor during the entire thesis process.

7.2 Future Research

From the empirical findings of the dissertation, three main interaction issues were identified. Each of these issues could serve as a theme for further research on strategic solutions other than the ones discussed in this dissertation.

To plan similar research with a different target group and evaluate perspectives of the supervisor team (supervisor, co-supervisor, examiner, and reviewer).

To create a complete framework in order to reduce the interaction problems and support thesis courses, other influential factors influencing the increment of the thesis completion rate and quality deserve to be explored.

References

Abbott, C. (2003). *ICT: Changing education*. New York, NY: Routledge.

Abdullahi, H. (2014). The role of ICT in teaching science education in schools. *International Letters of Social and Humanistic Sciences, 8*(3), 217-223.

Aghaee, N. (2015). Finding potential problems in the thesis process in higher education: Analysis of e-mails to develop a support system. *Education and Information Technologies, 20*(1), 21-36.

Aghaee, N., & Hansson, H. (2013). Peer portal: Quality enhancement in thesis writing using self-managed peer review on a mass scale. *International Review of Research in Open and Distributed Learning, 14*(1), 186-203.

Aghaee, N., Hansson, H., Tedre, M., & Drougge, U. (2014). Learners' Perceptions on the structure and usefulness of e-resources for the thesis courses. *European Journal of Open, Distance and E-Learning, 17*(1), 154-171.

Aghaee, N., & Keller, C. (in press). Influential factors on the peer interaction quality in the thesis process. Computers & Education Journal

Aghaee, N., & Larsson, K. (2013). Students' perspectives on utility of mobile applications in higher education. *In Trends in Mobile Web Information Systems* (pp. 44-56). Springer International Publishing.

Alavi, M. (1994). Computer-mediated collaborative learning: An empirical evaluation. *MIS quarterly, 18*(2) 159-174.

Alavi, M., & Leidner, D. E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly, 25*(1), 107-136.

Alavi, M., Wheeler, B. C., & Valacich, J. S. (1995). Using IT to reengineer business education: An exploratory investigation of collaborative tele learning. *MIS Quarterly, 19*(3). 293-312.

Ally, M. (2009). *Mobile learning: Transforming the delivery of education and training*. Canada: Athabasca University Press.

Anderson, T. (Ed.) (2008). *The theory and practice of online learning*. Canada: Athabasca University Press.

Angeli, C., Valanides, N., Mavroudi, A., Christodoulou, A., & Georgiou, K. (2015). Introducing e-TPCK: An Adaptive E-Learning Technology for the Development of Teachers' Technological Pedagogical Content Knowledge. *In Technological Pedagogical Content Knowledge* (pp. 305-317). Springer US.

Anthony, O. (2012). *Challenges of effective use of ICT as a tool for implementing the UBE schemes*. 53rd Annual Conference of Science Teachers Association of Nigeria 2012. HEBN publishers.

Benbunan-Fich, R., & Hiltz, S. R. (1999). Impacts of asynchronous learning networks on individual and group problem solving: A field experiment. *Group Decision and Negotiation, 8*(5), 409-426.

Benson, A., & Blackman, D. (2003). Can research methods ever be interesting? *Active Learning in Higher Education, 4*(1), 39-55.

Biggs, J., & Tang, C. (2011). *Teaching for quality learning at university.* New York, NY: McGraw-Hill. ISBN: 978-0-33-524275-7.

Blanc, R. A., DeBuhr, L. E., & Martin, D. C. (1983). Breaking the attrition cycle: The effects of supplemental instruction on undergraduate performance and attrition. *Journal of Higher Education, 54*(1). 80-90.

Bonk, C. J., & Cunningham, D. J. (1998). Searching for learner-centered, constructivist, and sociocultural components of collaborative educational learning tools. *Electronic collaborators: Learner-centered technologies for literacy, apprenticeship, and discourse, 25*. Retrieved from http://publicationshare.com/docs/Bon02.pdf.

Bonk, C. J., & Graham, C. R. (2012). *The handbook of blended learning: Global perspectives, local designs*. San Francisco: John Wiley.

Boud, D., & Lee, A. (2005). 'Peer learning' as pedagogic discourse for research education 1. *Studies in Higher Education*, *30*(5), 501-516.

Bradburn, E. M. (2002). Short-term enrollment in postsecondary education: Student background and institutional differences in reasons for early departure, 1996-98. Postsecondary Education Descriptive Analysis

Reports. U.S. Department of Education Office of Educational Research and Improvement, NCES 2003-153. Retrieved from http://files.eric.ed.gov/fulltext/ED470227.pdf

Christie, M. F., & Ferdos, F. (2004). The mutual impact of educational and information technologies: Building a pedagogy of e-learning. *Journal of Information Technology Impact, 4*(1), 15-26.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed). New York, NY: Routledge.

Concannon, F., Flynn, A., & Campbell, M. (2005). What campus-based students think about the quality and benefits of e-learning. *British Journal of Educational Technology, 36*(3), 501-512.

Creswell J. W. (1994). *Research design: Qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.

Creswell. J.W. (2012). *Qualitative inquiry and research design: Choosing among five approaches*. Cambridge: Sage.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage publications.

Dann, S. (2008). Applying services marketing principles to postgraduate supervision. *Quality Assurance in Education, 16*(4), 333-346.

Denscombe, M. (2010). *The good research guide for small-scale social research projects* (3rd Ed.). Berkshire: McGraw-Hill International.

Denscombe, M. (2014). *The good research guide: for small-scale social research projects* (5th Ed.). McGraw-Hill Education (UK).

De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006). Content analysis schemes to analyze transcripts of online asynchronous discussion groups: A review. *Computers & Education, 46*(1), 6-28.

Dong, Y. R. (1998). Non-native graduate students' thesis/dissertation writing in science: Self-reports by students and their advisors from two US institutions. *English for Specific Purposes, 17*(4), 369-390.

Dong, Y. R., Chai, C. S., Sang, G. Y., Koh, J. H. L., & Tsai, C. C. (2015). Exploring the profiles and interplays of pre-service and in-service teachers' technological pedagogical content knowledge (TPACK) in China. *Journal of Educational Technology & Society, 18*(1), 158-169.

Duque, L. C. (2014). A framework for analysing higher education performance: students' satisfaction, perceived learning outcomes, and dropout intentions. *Total Quality Management & Business Excellence, 25*(1-2), 1-21.

Eco, U., Farina, C. M., Farina, G., & Erspamer, F. (2015). *How to write a thesis.* MIT: MIT Press.

Elliot, A. J., & Church, M. A. (1997). A hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology, 72*(1), 218.

Evans, D., Gruba, P., & Zobel, J. (2011). *How to write a better thesis*. Melbourne Univ. Publishing: Melbourne.

Federico, P. A. (2000). Learning styles and student attitudes toward various aspects of network-based instruction. *Computers in Human Behavior, 16*(4), 359-379.

Fox, D. (1983). Personal theories of teaching. *Studies in Higher Education, 8*(2), 151-163.

Garrison, D. R. (2011). *E-learning in the 21st century: A framework for research and practice* (2nd Ed.). London: Taylor & Francis.

Gomm, R., Hammersley, M., & Foster, P. (Eds.). (2000). *Case study method: Key issues, key texts.* London: Sage.

Hansson, H., Karunaratne, T., & Aghaee, N. (under review). The effect of multiple change processes on quality and completion rate of theses: A longitudinal study.

Hashim, N., & Hashim, H. (2010). Outcome based education performance evaluation on the final year degree project. *Proceedings of the 7th WSEAS International Conference on Engineering Education.*

Horizon Report (2015). *Higher education edition.* Retrieved from http://cdn.nmc.org/media/2015-nmc-horizon-report-HE-EN.pdf

Hrastinski, S. (2006). The relationship between adopting a synchronous medium and participation in online group work: An explorative study. *Interactive Learning Environments, 14*(2), 137-152.

Hrastinski, S. (2008). The potential of synchronous communication to enhance participation in online discussions: A case study of two e-learning courses. *Information & Management, 45*(7), 499-506.

Hrastinski, S., Keller, C., & Carlsson, S. A. (2010). Design exemplars for synchronous e-learning: A design theory approach. *Computers & Education, 55*(2), 652-662.

Humphrey, C., & Lee, B. H. (Eds.). (2004). *The real life guide to accounting research: a behind-the-scenes view of using qualitative research methods*. Elsevier.

Iivari, J., & Ervasti, I. (1994). User information satisfaction: IS implementability and effectiveness. *Information & Management, 27*(4), 205-220.

Islam, A. N., & Azad, N. (2015). Satisfaction and continuance with a learning management system: Comparing perceptions of educators and students. *International Journal of Information and Learning Technology, 32*(2).

Ives, G., & Rowley, G. (2005). Supervisor selection or allocation and continuity of supervision: PhD students' progress and outcomes. *Studies in Higher Education, 30*(5), 535-55.

Jaldemark, J. (2013). Om lärandets sammanhang och mobilitetens utmaningar. *Pedagogisk forskning i Sverige, 18*(1-2), 102-118.

Jaldemark, J., & Lindberg, J. O. (2013). Technology-mediated supervision of undergraduate students' dissertations. *Studies in Higher Education, 38*(9), 1382-1392.

Kahn R.L., & Cannell C.F. (1957). *The dynamics of interviewing: Theory, technique, and case.* Oxford:Wiley.

Keller, C. (2007). Virtual learning environments in higher education: A study of user acceptance [Doctoral dissertation]. Linköping University.

Kelly Garrett, R. (2006). Protest in an information society: A review of literature on social movements and new ICTs. *Information, Communication & Society, 9*(02), 202-224.

Kemp, D. A. (1999). *Knowledge and innovation: a policy statement on research and research training.* Canberra, Australia: Commonwealth of Australia.

Kerry, T., & Wilding, M. (2004). *Effective classroom teacher: developing the skills you need in the classroom*. Harlow: Pearson Education.

Krippendorff, K. (2004). *Content analysis. An introduction to its methodology* (2nd Ed.). London: Sage Publications.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Thousand Oaks, CA: Sage Publications.

Lombard, M., Snyder-Duch, J., & Bracken, C. C. (2002). Content analysis in mass communication: Assessment and reporting of intercoder reliability. *Human Communication Research, 28*(4), 587-604.

Looi, C. K., Seow, P., Zhang, B., So, H. J., Chen, W., & Wong, L. H. (2010). Leveraging mobile technology for sustainable seamless learning: a research agenda. *British Journal of Educational Technology, 41*(2), 154-169.

Luck, L., Jackson, D., & Usher, K. (2006). Case study: a bridge across the paradigms. *Nursing Inquiry, 13*(2), 103-109.

McCormack, C. (2004). Tensions between student and institutional conceptions of postgraduate Research. *Studies in Higher Education, 29*(3), 319-334.

McGaha, V., & Fitzpatrick, J. (2005). Personal and social contributors to dropout risk for undergraduate students. *College Student Journal, 39*(2), 287.

Manathunga, C. (2005). Early warning signs in postgraduate research education: a different approach to ensuring timely completions. *Teaching in Higher Education, 10*(2), 219-33.

Maxwell, J. A. (2012). *Qualitative research design: An interactive approach: An interactive approach* (3rd ed.), Vol. 41. USA: Sage.

Merriam, S. B. (1988). *Case study research in education: A qualitative approach.* San Francisco, CA: Jossey-Bass.

Merriam, S. B. (1998). *Qualitative research and case study application in education, revised and expanded from case study research in education*. San Francisco, CA: Jossey-Bass.

Merriam, S. B. (2002). *Qualitative research in practice. Examples for discussion and analysis*. San Francisco, CA: Jossey-Bass.

Merrill, B. (2014). Determined to stay or determined to leave? A tale of learner identities, biographies and adult students in higher education. *Studies in Higher Education, (ahead-of-print)*, 1-13.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: a sourcebook of new methods* (2nd Ed.). CA: Sage.

Moore, M. G. (1972). Learner autonomy: The second dimension of independent learning. *Convergence, 5*(2), 76-88.

Moore, M. (1989). Three types of interactions. *American Journal of Distance Education, 3*(2), 1-6.

Moore, M. G. (1993). *Theory of transactional distance.* Theoretical principles of distance education, 22. Retrieved from http://www.c3l.uni-oldenburg.de/cde/support/readings/moore93.pdf

Moore, M. G., & Kearsley, G. (1996). *Distance education: a systems view.* Boston, MA: Wadsworth.

Motiwalla, L. F. (2007). Mobile learning: A framework and evaluation. *Computers & Education, 49*(3), 581-596.

Muilenburg, L.Y., & Berge, Z.L. (2005). Student barriers to online learning: A factor analytic study. *Distance Education 26*(1), 29-48.

Ness, D., & Lin C. L. (2015). Technology in education. *International Education: An Encyclopedia of Contemporary Issues and Systems*. NY: Routledge.

Nunan, D. (1996). Towards autonomous learning: some theoretical, empirical and practical issues. Taking control: Autonomy in language learning, 13-26. Hong Kong: Hong Kong University Press.

Nunan, D. (1987). Communicative language teaching: Making it work. *ELT journal, 41*(2), 136-145

Pargman, D., Hedin, B., & Hrastinski, S. (2013). Using group supervision and social annotation systems to support students' academic writing. *Högre Utbildning, 3*(2), 129-134.

Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods* (3rd Ed.). California: Sage.

Penny, K. (2011). Factors that influence student e-learning participation in a UK higher education institution. *Interdisciplinary Journal of E-Learning and Learning Objects, 7*(1), 81-95.

Pollock, P. H., & Wilson, B. M. (2002). Evaluating the impact of internet teaching: Preliminary evidence from American national government classes. *Political Science & Politics, 35*(03), 561-566.

Randolph, J.J (2007). *Multidisciplinary methods in educational technology research and development*. Hämeenlinna: Julkalsija, HAMK University of Applied Sciences.

Ratcliffe, S. (Ed.). (2011). *Oxford treasury of sayings and quotations*. NY: Oxford University Press.

Ratna, P. A., & Mehra, S. (2015). Exploring the acceptance for e-learning using technology acceptance model among university students in India. *International Journal of Process Management and Benchmarking, 5*(2), 194-210.

Roblyer, M. D. (2003). *Integrating educational technology into teaching* (3rd ed.). Upper Saddle River, NJ: Merrill Prentice Hall.

Robson, C. (2002). *Real world research* (2nd ed.). Oxford: Blackwell.

Rosenshine, B. (1983). Teaching functions in instructional programs. *The Elementary School Journal, 83*(4), 335-351.

Sarkar, S. (2012). The role of information and communication technology (ICT) in higher education for the 21st century. *Science, 1*(1), 30-41.

Schunk, D. H. (2012). *Learning theories: an educational perspective* (6th ed.). Boston, MA: Pearson.

Seidman, I. (2012). *Interviewing as qualitative research: A guide for researchers in education and the social sciences.* NY: Teachers College Press.

Shuell, T. J. (1988). The role of the student in learning from instruction. *Contemporary Educational Psychology, 13*(3), 276-295.

Shuell, T. J. (1990). Phases of meaningful learning. *Review of Educational Research, 60*(4), 531-547.

Singhal, P., Sehgal, V., & Singh, V. (2014). Transforming the e-learning platform through its critical success factors. *International Journal of Intercultural Information Management, 4*(4), 197-215.

Smyth, R. (2004). Exploring the usefulness of a conceptual framework as a research tool: A researcher's reflections. *Issues in Educational Research, 14*(2), 167-180.

Spector, J. M., & Anderson, T. M. (2000). *Integrated and holistic perspectives on learning, instruction and technology.* Dordrecht/Boston/London: Kluwer Academic.

Stacey, E. (Ed.). (2009). *Effective blended learning practices: Evidence-based perspectives in ICT-facilitated education: Evidence-Based Perspectives in ICT-Facilitated Education.* London: IGI Global.

Stake, R. E. (2000). Case studies. In: N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 435-454).Thousand Oaks, CA: Sage Publications.

Tarhini, A., Hassouna, M., Abbasi, M. S., & Orozco, J. (2015). Towards the acceptance of RSS to support learning: An empirical study to validate the Technology Acceptance Model in Lebanon. *Electronic Journal of e-Learning, 13*(1), 30-41.

Tinio, V. L. (2003). *ICT in education.* United Nations Development Programme-Asia Pacific Development Information Programme, New York. Retrieved from http://www.eprimers.org/

Todd, M., Bannister, P., & Clegg, S. (2004). Independent inquiry and the undergraduate dissertation: perceptions and experiences of final-year social science students. *Assessment & Evaluation in Higher Education, 29*(3), 335-355.

Todd, M. J., Smith, K., & Bannister, P. (2006). Supervising a social science undergraduate dissertation: staff experiences and perceptions. *Teaching in Higher Education, 11*(2), 161-173.

Tournaki, N., & Lyublinskaya, I. (2014). Preparing special education teachers for teaching mathematics and science with technology by integrating TPACK framework into the curriculum: A study of teachers' perceptions. *Journal of Technology and Teacher Education, 22*(2), 243-259.

Venkatesh, V., Croteau, A. M., & Rabah, J. (2014). *Perceptions of effectiveness of instructional uses of technology in higher education in*

an era of Web 2.0. In System Sciences (HICSS), 47th Hawaii International IEEE Conference (pp. 110-119).

Venuleo, C., Mossi, P., & Salvatore, S. (2014). Educational subculture and dropping out in higher education: a longitudinal case study. *Studies in Higher Education, (ahead-of-print)*, 1-22.

Vong, J., & Song, I. (2015). Technology in education. *In Emerging Technologies for Emerging Markets* (pp. 147-154). Singapore: Springer (eBook).

Wang, M. Y., & Hwang, M. J. (2004). The e-learning library: only a warehouse of learning resources? *The Electronic Library, 22*(5), 408-415.

Wegner, S. B., Holloway, K. C., & Garton, E. M. (1999). The effects of internet-based instruction on student learning. *Journal of Asynchronous Learning Networks, 3*(2), 98-106.

Wendt, J., & Rockinson-Szapkiw, A. (2015). *Synchronous and asynchronous communication technologies in online group work: Implications for design and practice.* Society for Information Technology & Teacher Education International Conference, pp. 2625-2627.

Witte, J., De Jonge, J., & Schoonman, W. (2014). *Success in higher education and the labor market*. Retrieved from http://ssrn.com/abstract=2456688

Yin, R. K. (2013). *Case study research: Design and methods.* CA: Sage Publications.

Zhao, G. (2015). Discussion on cultivation of students' innovative ability during a graduation thesis of an undergraduate. *International Conference on Education, Management, Commerce and Society (EMCS-15). Atlantis Press.* Retrieved from http://www.atlantis-press.com/php/download_paper.php?id=16401

Appendices

Appendix A: Open-ended online survey (questionnaire) regarding the structured resources (Paper 3)

Informed consent was obtained at the beginning of the survey questionnaire, and partially in the email sent to the learners:

"*In the last few years the Department of Computer and System Sciences has progressively developed processes and resources for students who are writing their theses. This questionnaire is intended to gather students' experiences and wishes regarding the thesis writing process in order to continue to develop and improve theses written in the department. All respondents will be totally anonymous, even if you include your contact information at the end of the questionnaire (which is optional). We would appreciate it if you spent time to provide more detailed reflections, social objections, and further suggestions in the motivation boxes. Your participation plays an important role in improving the quality of theses. We look forward to receiving your opinions!*"

(01) Please mark how useful you feel the following resources are for writing your thesis.

	Very useful	Rather useful	A little useful	Not useful at all
Grading criteria	○	○	○	○
Description of the work process	○	○	○	○
Description of the structure of the thesis	○	○	○	○
Access to templates for the thesis	○	○	○	○
Frequently asked questions (FAQ)	○	○	○	○
Lists and links to research articles within the research areas of the department	○	○	○	○
Descriptions of the research areas of the department	○	○	○	○
Scientific wordlist	○	○	○	○
Information about scholarships and travel grants	○	○	○	○
The ability to ask questions by email (Thesis Support)	○	○	○	○

Questions 9 to 14 were not included in this study and are part of Study 5 (presented in Appendix C).

Regarding video in the SciPro system

(15) We plan to offer video resources more clearly (organize them in a menu, make them easier to find, and record more) and more nuanced (several different types of video films for different needs). Please indicate how interested you are in following video resources.

	Very interested	Rather interested	A little interested	Not interested at all
Video category: "How to do it?" Screen recordings with a step-by-step navigation and narrative voice that instructs how to use SciPro system functions (to do peer review, arrange his final seminar, etc.)	○	○	○	○
Video category: "Introduction to the phases of research". Videos that provides information on what is expected and give advice and recommendations for the various phases of the research process: Project plan, background and methodology, data collection, data summary, data analysis, report writing and final seminar with opposition.	○	○	○	○
Video category: "Reflections and advice". Video addressing the overarching themes of "Writing in a language other than their mother tongue," "The most common beginner mistakes", "Being part of a research team", "Making a thesis with a topic from industry", and the like.	○	○	○	○
Video category: "Useful IT tools". Video introducing software that facilitates thesis work, eg reference management software, web survey software, statistics software, analysis of qualitative data, grammar/language software and more.	○	○	○	○
Video category: "Method Courses". Video recorded for the methodology courses of the department at the Bachelor's and Master's levels.	○	○	○	○

Video category: "Previous students recount". Video where graduates talk about their experiences writing their theses and give advice to new students, what to consider, avoid, anticipate, what was particularly instructive and rewarding, etc.	○	○	○	○
Video category: "Presentations of research areas". The research of the department presented by researchers at the institution.	○	○	○	○
Video category: "Presentations of supervisors". The department supervisors introduce themselves and their research, and how they prefer to mentor.	○	○	○	○
Video category: "About innovation and creativity". Video with examples, tips, and examples taken from science and IT entrepreneurs.	○	○	○	○

Regarding the final seminar module in SciPro

(16) How easy is it to use the final seminar module in SciPro?

	Very easy	Rather easy	Rather hard	Very hard	I have not used it yet
To register as an active participant.	○	○	○	○	○
To register as an opponent.	○	○	○	○	○
To obtain information about the time and place of the final seminar.	○	○	○	○	○
To arrange one's own final seminar (upload the final draft, determine one's opponent, place, time, etc.)	○	○	○	○	○

(17) Is there anything you would like develop/improve regarding final seminars?

(18) Does your supervisor encourage you to use SciPro?

○ Yes

○ No

(19) What do you consider as most important to develop support for thesis supervision?

(20) If you are willing to participate in an interview regarding SciPro in order to gather further information, please leave your name, email address and telephone number so that we can contact you (entirely voluntary);

Thank you for your cooperation! You are helping to improve SciPro and thesis supervision!

Appendix B: Open-ended online survey (questionnaire) regarding the use of mobile applications (Paper 4)

Informed consent was obtained at the beginning of the survey questionnaire, and partially in the email sent to the learners: "*The results of this questionnaire will be used in a research publication and all respondents will be totally anonymous, even if you include your contact information at the end of the questionnaire (which is optional). There are only 12 multiple choice questions, which take a maximum of 10 minutes to answer. However, we would appreciate it if you spent more time to provide more detailed reflections, social objections, and further suggestions in the motivation boxes as they will be valuable complementary data for our study. We look forward to receiving your opinions and thanks in advance!*"

Gender:
- ○ Male
- ○ Female

How old are you?

[ ]

1. Do you use any mobile devices (i.e., smartphone, tablet), which support online applications?
- ○ Yes
- ○ No

2. Do you use one or more applications regularly on your mobile device?
- ○ Yes
- ○ No

3. Have you ever used any application for educational purposes?
- ○ Yes
- ○ No

If so, which application?

[ ]

4. Do you think mobile applications are useful for supporting learning in higher education?
- ○ Yes, absolutely
- ○ Doubtful/ I don't know

○ No, not at all
Please give reasons for your answer (voluntary)

[   ]

5. Would an online mobile application for SciPro help you to speed up your thesis process?

○ Yes, absolutely

○ Doubtful/ I don't know

○ No, not at all

Please give reasons for your answer (voluntary)

[   ]

6. Would an online mobile application motivate you to have more communication with your supervisor, eg., to get notifications from them when they post messages on the forum?

○ Yes, absolutely

○ Doubtful/ I don't know

○ No, not at all

Please give reasons for your answer (voluntary)

[   ]

7. Would an online mobile application motivate you to have more peer communications with your fellows, eg., via forum, chat or email functions?

○ Yes, absolutely

○ Doubtful/ I don't know

○ No, not at all

Please give reasons for your answer (voluntary)

[   ]

Would an online mobile application be useful for you to see ...

8. ... when your supervisor posts a new message or answers your questions in the forum?

○ Yes, absolutely

○ Doubtful/ I don't know/ I don't know

○ No, not at all

○ Other: [   ]

9. ... when a new thesis manuscript is uploaded and available for peer review in SciPro peer portal?

    ○ Yes, absolutely

    ○ Doubtful/ I don't know

    ○ No, not at all

10. … when your thesis manuscripts has been selected by another student to be peer reviewed?

    ○ Yes, absolutely

    ○ Doubtful/ I don't know

    ○ No, not at all

11. … when there is a new thesis manuscript uploaded and available for opposition?

    ○ Yes, absolutely

    ○ Doubtful/ I don't know

    ○ No, not at all

12. … when there is an update about SciPro resources or a new functionality available for SciPro?

    ○ Yes, absolutely

    ○ Doubtful/ I don't know

    ○ No, not at all

Thank you for your cooperation! You are helping to improve SciPro and thesis quality in higher education!
If you are willing to participate in an interview regarding SciPro, please leave your email address or telephone number so that we can contact you (completely voluntary). Thank you!

Thank you for your cooperation! You are helping to improve SciPro and thesis supervision!

Appendix C: Open-ended online survey (questionnaire) regarding the usefulness of peer interaction (Paper 5)

Informed consent was obtained at the beginning of the survey questionnaire, and partially in the email sent to the learners:

"*In the last few years the Department of Computer and System Sciences has progressively developed processes and resources for students who are writing their theses. This questionnaire is intended to gather students' experiences and wishes regarding the thesis writing process in order to continue to develop and improve theses written in the department. All respondents will be totally anonymous, even if you include your contact information at the end of the questionnaire (which is optional). We would appreciate it if you spent time to provide more detailed reflections, social objections, and further suggestions in the motivation boxes. Your participation plays an important role in improving the quality of theses. We look forward to receiving your opinions!*"

Regarding Peer Reviews in the SciPro system

(09) In the Peer Portal over 500 peer reviews have been conducted this year. Of these approximately 40% are of good quality, while 40% are of low quality. What is your opinion of the cause of the poor/incomplete peer reviews in the Peer Portal?

(10) Please indicate to what extent you agree with the following statements. The cause of poor peer reviews is probably due to...

	Totally agree	Agree to a large extent	Partially agree	Strongly disagree
that peer reviews are not controlled by a supervisor.	○	○	○	○
that peer reviews are not graded by a supervisor.	○	○	○	○
that students do not spend enough time and effort on peer reviews.	○	○	○	○
that students do not consider peer reviews important.	○	○	○	○
that students do not understand what peer reviews are about.	○	○	○	○
that students lack previous peer review training in their studies.	○	○	○	○

(11) How do you estimate the quality of your own peer reviews?

	Excellent	Good	OK	Poor	I have not done/received one yet.
The first peer review I did.	○	○	○	○	○
The second peer review I did.	○	○	○	○	○
The first peer review I received on my thesis draft.	○	○	○	○	○
The second peer review I received on my thesis draft.	○	○	○	○	○
What was the quality of the thesis draft that you did your first peer review on?	○	○	○	○	○
What was the quality of the thesis draft that you did your second peer review on?	○	○	○	○	○
What do you think was the quality of your thesis draft when you handed it in for the first peer review?	○	○	○	○	○
What do you think was the quality of your thesis draft when you handed it in for the second peer review?	○	○	○	○	○

(12) If you have not done a peer review, please tell us why:

(13) According to you, what motivates a student to make a good peer review?

(14) According to you, what is the most important measure that can improve peer reviews?

Thank you for your cooperation! You are helping to improve SciPro and thesis supervision!

Appendix D: Thematic Interview

Informed consent was obtained at the beginning of each interview: "*This interview will be used for a research publication by the interviewer. However, all the answers will be confidential: your/ your supervisor(s) identities will be totally confidential. All the answers should be provided honestly as you do not need to worry about any repercussions regarding remarks on problems, supervisors, personal issues, or not liking any parts of the system. The interviews will be recorded and later transcribed, but your personal and individual information will remain confidential. The audio records and transcriptions will not be sent to any third party, not even supervisors or other colleagues. So please feel free to answer the questions and give your reflections to help improving the thesis process. Negative reflections are as welcome as positive ones and you are free to criticize the functionality of the ICTSS and disagree with the usefulness of any specific element. During the interview, you are free to interrupt and stop taking part at any time.*"

(a) Age
(b) Gender
(c) When did you start your thesis (how long up to now)?

1. **Process and problems**
   (a) How do you find the thesis process in general? Hard, easy, OK, boring, challenging, etc.? Why?
   (b) What interaction problems have you encountered during the thesis (with the thesis process, your supervisor(s), your peers, the available resources or course content, etc.)?
   (c) Which one of these (following) issues were problems in your thesis process? What other interaction problems do you think exist in addition to these 5 categories?
   Categories of Interaction Problems:
   > i. *Thesis initiation*
   > ii. *Supervision*
   > iii. *Final seminar*
   > iv. *Exemption/exceptional issues*
   > v. *Technical issues.*

2. **Information Resources**
   (a) What do you think about the possibility of accessing a set of structured information resources (like thesis info)? Good, too complicated, useful, or not useful at all? Why?

(b) How much time did you spend reading, understanding and using the resources? Did you use them only when you were stuck, or for learning?

(c) How easy was it to find the specific information that you needed?

3. **Peer Communication**

(a) What do you think about the peer portal and the idea of peer review to provide feedback?

(b) How much have you learned from the online peer reviews?

(c) How much time did you spend reading, understanding and supporting your peers' manuscripts?

(d) Was the system a good option to be able to read and choose your peers by yourself rather than automatically being assigned one by your supervisor?

(e) How do you think we can motivate students to provide useful feedback for each other? Any criteria?

(f) Would using the star system be a way to produce better quality peer review?

Doing peer review→ the author of the manuscript gives a star (rating 0 to 5)→ 0 means the person has not passed that task and has to do it again.

Do you think would this help?

(g) How did the peer reviews affect your thesis process?

(h) Do you think you provided useful feedback for your peers or just did it to finish the obligatory task?

4. **Final Seminar**

(a) What do you think about the opposition process? Was it useful?

(b) How did you find the opposition process when you were an opponent? Do you think you provided useful feedback for your peer based on the grading criteria?

(c) What about the active participation? Was it good to be able to choose the seminars yourself?

(d) Any comparison between peer communication, opposition, and active participation?

(e) Would you participate in another person's presentation, or support a peer student, if it weren't an obligatory part of the course?

(f) What was the difference between the peer reviews and the final opposition report? Why?

5. **Mobile Application**

(a) How useful do you think a mobile application would be in the thesis process?

(b) How about if it helps you to get the notification of different functionalities on SciPro, e.g, peer manuscript uploaded on SciPro,

your manuscript is picked by someone, your supervisor starts a new discussion forum, etc.?

6. *Self- managed Learning*
   (a) Do you think an ICTSS like SciPro would facilitate self-managed learning?
   (b) What else would provide more opportunities to facilitate self-managed learning in the thesis process?
   (c) How useful do you think ThesisInfo was in your thesis process?
   (d) Please you highlight the most important (red), rather important (orange), and not very important items in this figure.
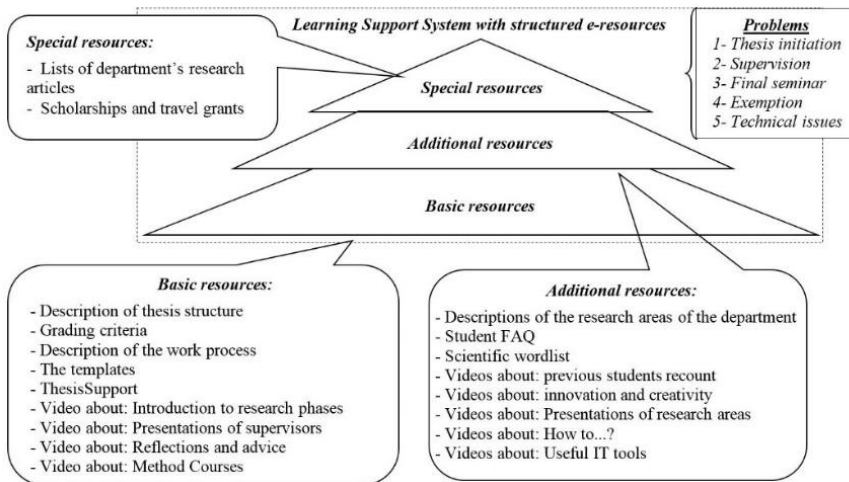
7. *Additional Questions*
   (a) What is your general impression of the use of the ICTSS? What was good or bad? What was complicated or negative?
   (b) Any additional points or comments? How could the system be more useful for learners?
   (c) What are the key issues to be included and what should not be included?
   (d) What communication channels are basic and what more is required?

Thank you for your cooperation and time! You are helping to improve the thesis courses and their learning outcomes, as well as supporting my studies and research within this area.

Appendix E: The Grading Criteria

The grading criteria were developed by the coordinator of theses, Associate Professor Henrik Hansson, and the thesis examiner, Professor Paul Johannessson. "*Grades for theses are decided in the following way: First, each criterion in the table below is given a value (possible values for each criterion are shown in the first column for each thesis type). The final grade is then calculated based on the rules described after the table. The minimum requirement for a passing grade is indicated with a bold typeface for each criterion*" (DSV Thesis Handbook).

Criterion	Description	Bachelor's	One-year Master's (Swedish Magister)	Master's
U1. Abstract	Requirement for 1 point: that the abstract of the thesis briefly describes the research question, choice and application of the research method, result and conclusions and that it can be read separately from the thesis and that it correctly and in a well-balanced way reflects the contents of the thesis.	0/**1**	0/**1**	0/**1**
U2 Background	Requirement for 1 point: that the thesis provides a subject-related foundation, where it is made evident in which area of computer and system science the thesis contributes and on which scientific works the thesis builds upon. Additional requirement for 2 points: that a deep and critical discussion is made regarding how the thesis relates to previous academic work. Additional requirement for 3 points: that a systematic and thorough literature study is made that is the basis for positioning and evaluating the contribution of the thesis in an academic context.	0/**1**/2	0/**1**/2	0/1/**2**/3
U3 Problem	Requirement for 1 point: that the thesis clearly describes a practical or theoretical problem of general interest that partially or entirely can be solved by answering the research question, thereby motivating the choice of the latter.	0/**1**	0/**1**	0/**1**
U4 Research Question	Requirement for 1 point: a clearly formulated and delimited research question that is of general interest and is reasonable in relation to the allotted time and resources. Additional requirement for 2 points: an innovative research question that provides the conditions so that the thesis could make a significant contribution.	0/**1**/2	0/**1**/2	0/**1**/2

U5 Choice of research method	Requirement for 1 point: that alternative scientific methods and techniques that can be used to attack the research question are discussed, that the choice of scientific methods and techniques are clearly motivated and described, and that relevant, ethical deliberations are discussed. Additional requirement for 2 points: that alternative, applicable scientific research methods and techniques are thoroughly discussed and that a deep argument regarding the choice of method and technique is made, where the motives for the choices made are clearly stated. Additional requirement for 3 points: that the choice of methods and techniques is discussed in relation to methods and techniques used in related academic studies that can be seen as state-of-the-art.	0/**1**/2	0/**1**/2	0/1/**2**/3
U6 Application of research method	Requirement for 1 point: that the application of the chosen scientific methods and techniques are clearly described and that relevant ethical aspects are discussed. Additional requirement for 2 points: that there is a clear argumentation as to how the application of the chosen methods and techniques are done in accordance with the demands of said methods and techniques. Additional requirement for 3 points: that the reproducibility, reliability, and validity of the application of the research method is analyzed.	0/**1**/2	0/**1**/2	0/1/**2**/3
U7 Result	Requirement for 1 point: that the results are of such a magnitude and quality that the research question can be answered. Additional requirement for 2 points: that the results are of a considerable magnitude and high quality so that conclusions of relevance for the research question can be made. Additional requirement for 3 points: that the results are well written and of considerable magnitude and high quality so that well grounded conclusions of the relevance for the research question can be made.	0/**1**/2	0/1/**2**/3	0/1/**2**/3

U8 Analysis	Requirement for 1 point: that the results are analyzed and their significance for the research question is discussed. Additional requirement for 2 points: that well-grounded conclusions are drawn after a profound analysis. Additional requirement for 3 points: that a reflective argument about the implementation and limitations of the analysis is made.	0/1/2	0/1/**2**/3	0/1/**2**/3
U9 Discussion	Requirement for 1 point: that the limitations of the composition of the thesis and its influence on the conclusions are discussed as well as how the results relate to previous research, and that possible future research in relation to the actual thesis and that possible ethical and social consequences of the conclusions in the thesis are discussed. Additional requirement for 2 points: that the limitations of the study are thoroughly discussed and that a profound argument about possible and relevant future research is made.	0/**1**/2	0/**1**/2	0/**1**/2
U10 Structure	Requirement for 1 point: that the thesis is divided into distinct and logical, coherent sections.	0/**1**	0/**1**	0/**1**
U11 Language	Requirement for 1 point: that the text only contains a few spelling and grammatical mistakes and that the text is coherent.	0/**1**	0/**1**	0/**1**
U12 References and documentation	Requirement for 1 point: that references in the thesis to previous research are made in a correct way according to a recognized reference system, that a clear listing of used references is made in the same system, that all quotes from previous work are clearly specified, and that relevant supplemental attachments are included. Bachelor's theses should have at least 5 references to academic research and Master's theses at least 10 references to academic research.	0/**1**	0/**1**	0/**1**
U13 Originality and significance	Requirement for 1 point: that the thesis contributes with significant or original ideas, artifacts, products, or services. Additional requirement for 2 points: that the results are of such quality that the thesis could be presented in a scientific workshop of good quality. Additional requirement for 3 points: that the thesis provides a well-documented foundation that motivates why the thesis can be expected to lead to a presentation in a high quality, scientific conference or that it could be commercialized. Additional requirement for 4 points: that the results are of such quality that they could be published in a high quality, scientific journal.	**0**/1/2/3	0/**1**/2/3	0/1/**2**/3/4

Included Publications

Paper I:

Aghaee, N. (2015). Finding potential problems in the thesis process in higher education: Analysis of e-mails to develop a support system. *Education and Information Technologies, 20*(1), 21-36.

Paper II:

Aghaee, N., & Hansson, H. (2013). Peer Portal: Quality enhancement in thesis writing using self-managed peer review on a mass scale. The International Review of Research in Open and Distributed Learning, 14(1), 186-203.

Paper III:

Aghaee, N., Hansson, H., Tedre, M., & Drougge, U. (2014). Learners' perceptions on the structure and usefulness of e-Resources for the thesis courses. European Journal of Open, Distance and E-Learning, 17(1), 154-171.

Paper IV:

Aghaee, N., & Larsson, K. (2013). Students' Perspectives on Utility of Mobile Applications in Higher Education. In Trends in Mobile Web Information Systems (pp. 44-56). Springer International Publishing.

Paper V:

Aghaee, N., & Keller, C. (in press). ICT-supported Peer Interaction among Learners in the Bachelor's and Master's Thesis Courses. Computers & Education Journal.

DEPARTMENT OF COMPUTER AND SYSTEMS SCIENCES
Stockholm University/KTH
www.dsv.su.se
Ph.D. theses:

No 91-004 **Olsson, Jan**
An Architecture for Diagnostic Reasoning Based on Causal Models
No 93-008 **Orci, Terttu**
Temporal Reasoning and Data Bases
No 93-009 **Eriksson, Lars-Henrik**
Finitary Partial Definitions and General Logic
No 93-010 **Johannesson, Paul**
Schema Integration Schema Translation, and Interoperability in Federated
Information Systems
No 93-018 **Wangler, Benkt**
Contributions to Functional Requirements Modelling
No 93-019 **Boman, Magnus**
A Logical Specification for Federated Information Systems
No 93-024 **Rayner, Manny**
Abductive Equivalential Translation and its Application to Natural-
Language Database Interfacing
No 93-025 **Idestam-Almquist, Peter**
Generalization of Clauses
No 93-026 **Aronsson, Martin**
GCLA: The Design, Use, and Implementation of a Program Development
No 93-029 **Boström, Henrik**
Explanation-Based Transformation of Logic programs
No 94-001 **Samuelsson, Christer**
Fast Natural Language Parsing Using Explanation-Based Learning
No 94-003 **Ekenberg, Love**
Decision Support in Numerically Imprecise Domains
No 94-004 **Kowalski, Stewart**
IT Insecurity: A Multi-disciplinary Inquiry
No 94-007 **Asker, Lars**
Partial Explanations as a Basis for Learning
No 94-009 **Kjellin, Harald**
A Method for Acquiring and Refining Knowledge in Weak Theory Domains
No 94-011 **Britts, Stefan**
Object Database Design
No 94-014 **Kilander, Fredrik**
Incremental Conceptual Clustering in an On-Line Application
No 95-019 **Song, Wei**
Schema Integration: - Principles, Methods and Applications

No 95-050 **Johansson, Anna-Lena**
Logic Program Synthesis Using Schema Instantiation in an Interactive
Environment
No 95-054 **Stensmo, Magnus**
Adaptive Automated Diagnosis
No 96-004 **Wærn, Annika**
Recognising Human Plans: Issues for Plan Recognition in Human -
Computer Interaction
No 96-006 **Orsvärn, Klas**
Knowledge Modelling with Libraries of Task Decomposition Methods
No 96-008 **Dalianis, Hercules**
Concise Natural Language Generation from Formal Specifications
No 96-009 **Holm, Peter**
On the Design and Usage of Information Technology and the Structuring of
Communication and Work
No 96-018 **Höök, Kristina**
A Glass Box Approach to Adaptive Hypermedia
No 96-021 **Yngström, Louise**
A Systemic-Holistic Approach to Academic Programmes in IT Security
No 97-005 **Wohed, Rolf**
A Language for Enterprise and Information System Modelling
No 97-008 **Gambäck, Björn**
Processing Swedish Sentences: A Unification-Based Grammar and Some
Applications
No 97-010 **Kapidzic Cicovic, Nada**
Extended Certificate Management System: Design and Protocols
No 97-011 **Danielson, Mats**
Computational Decision Analysis
No 97-012 **Wijkman, Pierre**
Contributions to Evolutionary Computation
No 97-017 **Zhang, Ying**
Multi-Temporal Database Management with a Visual Query Interface
No 98-001 **Essler, Ulf**
Analyzing Groupware Adoption: A Framework and Three Case Studies in
Lotus Notes Deployment
No 98-008 **Koistinen, Jari**
Contributions in Distributed Object Systems Engineering
No 99-009 **Hakkarainen, Sari**
Dynamic Aspects and Semantic Enrichment in Schema Comparison
No 99-015 **Magnusson, Christer**
Hedging Shareholder Value in an IT dependent Business society - the
Framework BRITS
No 00-004 **Verhagen, Henricus**
Norm Autonomous Agents

Mastering the Use of Gobbledygook - Studies on the Development of Expertise Through Exposure to Experienced Practitioners' Deliberation on Authentic Problems

No 03-014 **Kjellman, Arne**

Constructive Systems Science - The Only Remaining Alternative?

No 03-015 **Rydberg Fåhræus, Eva**

A Triple Helix of Learning Processes - How to cultivate learning, communication and collaboration among distance-education learners

No 03-016 **Zemke, Stefan**

Data Mining for Prediction - Financial Series Case

No 04-002 **Hulth, Anette**

Combining Machine Learning and Natural Language Processing for Automatic Keyword Extraction

No 04-011 **Jayaweera, Prasad M**.

A Unified Framework for e-Commerce Systems Development: *Business Process Patterns Perspective*

No 04-013 **Söderström, Eva**

B2B Standards Implementation: Issues and Solutions

No 04-014 **Backlund, Per**

Development Process Knowledge Transfer through Method Adaptation, Implementation, and Use

No 05-003 **Davies, Guy**

Mapping and Integration of Schema Representations of Component Specifications

No 05-004 **Jansson, Eva**

Working Together when Being Apart – An Analysis of Distributed Collaborative Work through ICT from an Organizational and Psychosocial Perspective

No 05-007 **Cöster, Rickard**

Algorithms and Representations for Personalised Information Access

No 05-009 **Ciobanu Morogan, Matei**

Security System for Ad-hoc Wireless Networks based on Generic Secure Objects

No 05-010 **Björck, Fredrik**

Discovering Information Security Management

No 05-012 **Brouwers, Lisa**

Microsimulation Models for Disaster Policy Making

No 05-014 **Näckros, Kjell**

Visualising Security through Computer Games

Investigating Game-Based Instruction in ICT Security: an Experimental approach

No 05-015 **Bylund, Markus**

A Design Rationale for Pervasive Computing

No 05-016 **Strand, Mattias**

External Data Incorporation into Data Warehouses
No 05-020 **Casmir, Respickius**
A Dynamic and Adaptive Information Security Awareness (DAISA)
approach
No 05-021 **Svensson, Harald**
Developing Support for Agile and Plan-Driven Methods
No 05-022 **Rudström, Åsa**
Co-Construction of Hybrid Spaces
No 06-005 **Lindgren, Tony**
Methods of Solving Conflicts among Induced Rules
No 06-009 **Wrigstad, Tobias**
Owner-Based Alias Management
No 06-011 **Skoglund, Mats**
Curbing Dependencies in Software Evolution
No 06-012 **Zdravkovic, Jelena**
Process Integration for the Extended Enterprise
No 06-013 **Olsson Neve, Theresia**
Capturing and Analysing Emotions to Support Organisational Learning:
The Affect Based Learning Matrix
No 06-016 **Chaula, Job Asheri**
A Socio-Technical Analysis of Information Systems Security Assurance
A Case Study for Effective Assurance
No 06-017 **Tarimo, Charles N.**
ICT Security Readiness Checklist for Developing Countries:
A Social-Technical Approac**h**
No 06-020 **Kifle Gelan, Mengistu**
A Theoretical Model for Telemedicine
- Social and Value Outcomes in Sub-Saharan Africa
No 07-001 **Fernaeus, Ylva**
Let's Make a Digital Patchwork
Designing for Children's Creative Play with Programming Materials
No 07-003 **Bakari, Jabiri Kuwe**
A Holistic Approach for Managing ICT Security in Non-Commercial
Organisations
A Case Study in a Developing Country
No 07-004 **Sundholm, Hillevi**
Spaces within Spaces: The Construction of a Collaborative Reality
No 07-005 **Hansson, Karin**
A Framework for Evaluation of Flood Management Strategies
No 07-007 **Aidemark, Jan**
Strategic Planning of Knowledge Management Systems
- A Problem Exploration Approach
No 07-009 **Jonsson, Martin**
Sensing and Making Sense

Contextualizing co-located game play practices and experiences
No 12-008 **Mona Riabacke**
A Prescriptive Approach to Eliciting Decision Information
No 12-010 **Geoffrey Rwezaura Karokola**
A Framework for Securing e-Government Services
The Case of Tanzania
No 13-001 **Evelyn Kigozi Kahiigi**
A Collaborative E-learning Approach
 Exploring a Peer Assignment Review Process at the University Level in
Uganda
No 13-002 **Mattias Rost**
Mobility is the message: Explorations in mobile media sharing
No 13-003 **Rasika Dayarathna**
Discovering Constructs and Dimensions for Information Privacy Metrics.
No 13-004 **Magnus Johansson**
Do Non Player Characters dream of electric sheep?
No 13-006 **Baki Cakici**
The Informed Gaze: On the Implications of ICT-Based Surveillance
No 13-008 **Johan Eliasson**
Tools for Designing Mobile Interaction with the Physical Environment in
Outdoor Lessons
No 13-010 **Andreas Nilsson**
Doing IT Project Alignment – Adapting the DELTA Model using Design
Science
No. 14-001 **Ola Caster**
Quantitative methods to support drug benefit-risk assessment
No. 14-002 **Catarina Dudas**
Learning from Multi-Objective Optimization of Production Systems - A
method for analyzing solution sets from multi-objective optimization
No. 14-003 **Thashmee M. Karunaratne**
Learning predictive models from graph data using pattern mining
No. 14-007 **David Hallberg**
Lifelong learning - The social impact of digital villages as community
resource centres on disadvantaged women
No. 14-008 **Constantinos Giannoulis**
Model-driven Alignment - Linking Business Strategy with Information
Systems
No. 14-014 **Jalal Nouri**
Orchestrating Scaffolded Outdoor Mobile Learning Activities
No. 14-016 **Jamie Walters**
Distributed Immersive Participation – Realising Multi-Criteria Context-
Centric Relationships on an Internet of Things
No. 14-017 **Peter Mozelius**

Education for All in Sri Lanka - ICT4D Hubs for Region-wide Dissemination of Blended Learning

No. 15-001 **Maria Skeppstedt**
Extracting Clinical Findings from Swedish Health Record Text

No. 15-002 **Florence Kivunike**
A Structured Approach for Evaluating the ICT Contribution to Development

No. 15-004 **Karin Hansson**
Accommodating differences – Power, belonging, and representation online

No. 15-008 **Thushani Weerasinghe**
Designing Online Courses for Individual and Collaborative Learning – A stud of a virtual learning environment based in Sri Lanka

No. 15-009 **Tuwe Löfström**
On Effectively Creating Ensembles of Classifiers - Studies on Creation Strategies, Diversity and Predicting with Confidence

No. 15-010 **Shahzad Saleem**
Protecting the Integrity of Digital Evidence and Basic Human Rights During the Process of Digital Forensics

No. 15-011 **Elias Mturi**
Design of Business Process Model Repositories - Requirements, Semantic Annotation Model and Relationship Meta-model

No. 15-014 **Magnus Hjelmblom**
Norm-Regulation of Agent Systems – Instrumentalizing an Algebraic Approach to Agent System Norms

No. 15-015 **Hiran Ekanayake**
Validating User Engagement and Effectiveness of Training Simulations - A mixed methods approach informed by embodied cognition and psychophysiological measures

No. 15-016 **Kim Nevelsteen**
Distributed Technology - Sustained Pervasive Applications

No. 15-017 **Meshari Alwazae**
Template-driven Documentation of Best Practices

No. 15-018 **Elly Gamukama**
Analytical Modelling of Internet Provision and Usage in the Context of Development through a Utility Based Framework

No. 15-019 **Javier Francisco Guerrero Rázuri**
Decisional-Emotional Support System for a Synthetic Agent – Influence of Emotions in Decision-Making Toward the Participation of Automata in Society

No. 15-020 **Orlando Zacarias**
Mining Mozambique Health Data The Case of Malaria: From Bayesian Incidence Risk to Incidence Case Predictions

No. 15-021 **Aron Henriksson**
Ensembles of Semantic Spaces: On Combining Models of Distributional Semantics with Applications in Healthcare