ICT SUPPORT FOR THE THESIS PROCESS: A CASE AS A LITERATURE REVIEW

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Introduction

Thesis supervision is one of the most complex and problematic pedagogical methods (Connell, 1985). Hansson and others discuss this complexity and show that the core activities of supervision require (an estimated) four to five times more effort per individual student than the payment/time allocated (Hansson, Larsson, & Wettergren, 2009). These authors also discuss the nature of thesis supervision and argue that large part of the process is dependent on communication. Communication is time-consuming and hence may be one of the reasons for this problematic state of affairs; maintaining the quality of communication is a challenge. The Department of Computer and Systems Sciences (DSV) faced this challenge when several theses were reviewed by the Swedish Authority of Higher Education (Bider & Jalali, 2016). The DSV had initiated a project to implement an ICT supported system for the thesis supervision process in 2011 in order to address the issue of quality. Sci-Pro, the thesis supervision support system, was launched in 2011 and has grown into a mature system during the last six years. There is a lack of comprehensive studies of ICT support systems; the aim of the current study is to conduct a literature review of the published articles about the DSV thesis supervision system to explore how ICT can support the thesis supervision process. The results of this study therefore offer benefits to individuals who intend to develop or use ICT support for the thesis process.

Methodology

This study was conducted as a literature review, and was limited to a particular project initiated by the Department of Computer and Systems Sciences. Research papers were selected only if the article concerned the Sci-Pro system. Google Scholar and Stockholm University Library search tools were used to collect published papers. We found 34 papers on the Sci-Pro system from between 2009 and 2017. One of the authors initiated the conceptual design, and the other a study of the development of thesis support information systems from a design science perspective. The Discussion section includes a summary of the published papers on Sci-Pro, and the conclusion shows how ICT can provide support and where this is applicable.

Discussion: Summary of Published Papers

The concept of developing a thesis support system first appeared as a design concept, published with the title "Open and flexible ICT: support for student thesis production –

design concept for the future" (Hansson et al., 2009). This paper discusses the importance of supervisor feedback, and shows that a supervisor's time is a limited resource. These authors therefore suggested that information and communication technology could be used as a tool to enhance supervision, and proposed an innovative organisational model. The overall aim is to propose a design concept for a flexible and semi self-adaptive ICT system for the mass-individualisation of supervision in the thesis process at various levels. The authors suggested the features of a new ICT-based model for the thesis process including supervision pathways, hyper-video, chatterbots, anti-plagiarism methods and social learning. The design aim was to use ICT technology to facilitate higher quality face-to-face meetings with the supervisor and between peer students. The model included a concept called *supervision-pathways* which involved six phases: a research plan, background and methods, a data collection method, data collection, data summary and data analysis. They suggested enhancing the quality and efficiency of each of these phases, including both face-to-face meetings with peer students and supervisors and online collaboration and social integration. A model called *Structured and Flexible Process* guides and helps students, generating a personalised project plan using ICT tools including hyper-video, content creation and Web 2.0 collaborative technologies. The paper proposed a conceptual framework that can support the thesis supervision process.

The next study was published in 2010, and extended the conceptual framework proposed by the previous study. The article was entitled, "Sci-Pro: improving universities" core activity with ICT supporting the scientific thesis-writing process (Hansson, Collin, Larsson, & Wettergren, 2010). The proposed system was called Sci-Pro, an acronym for the SCIentific PROcess. The system was expanded, introducing the five stakeholders of students, supervisors, the university, business and society, and showed how the proposed system benefits all involved (Figure 1). The Sci-Pro system expanded the previous conceptual system (Hansson et al., 2009) to include administrators, business, and society. The paper also shows how the features of the conceptual design (Hansson et al., 2009) can be implemented within the Department of Computer and Systems Sciences. This paper emphasises Sci-Pro as a system that enhances creativity, innovation, productivity, flexibility, communication, and administrative support.
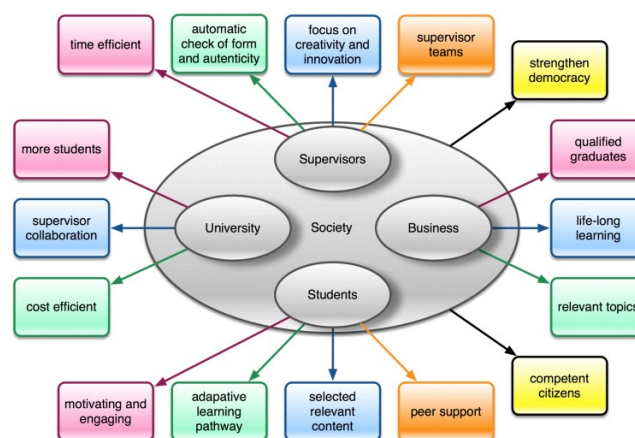

Figure 1. Target groups and major benefits of the Sci-Pro system (Hansson et al., 2010)

In 2011, another study was conducted on the trend towards increasing number of students in higher education as a challenge for supervision (Larsson & Hansson, 2011). This study highlighted the use of contextualised topical hyper-videos, automatic assessment and plagiarism detection and multilingual support from sub-titles in the hyper-video episodes as possible ICT-enabling tools that could enable the mass individualisation of the thesis-writing process with fewer resources. The next version of the Sci-Pro system brought several further improvements to the thesis supervision process. The paper was entitled "Quality processes in technology-enhanced thesis work: Negotiating knowledge interests and providing process support online" (Hansson & Moberg, 2011); it showed how the thesis support system functioned within DSV, and introduced several new concepts. The key feature of this version is the match module, which matches students with supervisors based on the interests of each. Both students and supervisors can publish ideas on the Idea Bank. Students publish their ideas on the system using keywords that relate to certain research areas within the DSV. These keywords are assigned to supervisors, and the matching system is updated with the currently available supervisors, the number of students they are ready to supervise and the educational level they are prepared to supervise (Bachelor's or Master's). Supervisors can also publish ideas to the system, in addition to students. The Match function helps supervisors and students to select ideas in advance, and projects can then be started before the planned date. The system also reduces the workload for administrators. The authors also argue that meta-supervision support reduces the workload of supervisors. Meta-supervision support means that comprehensive guidance is provided by IT resources, so that the supervisors do not need to repeat the same information to new or additional students. A peer review system is also introduced, as a tool whereby students review work done by peers; this reduces the workload and enhances the quality of the thesis.

A comprehensive study of the project initiation phase was conducted by Bencherifa (2012), which proposed a framework for idea creation and display to related stakeholders and inclusion of external parties into the process. Bencherifa (2012) shows how ICT can be used in the project initiation stage and introduced the concept of the Idea Bank, with more details of ways in which integration with the thesis supervision process can be achieved. A further study was then conducted on the evolution of the Idea Bank (Hansson, Moberg, & Peiris, 2012), which compares three versions of the Idea Bank module. Although the Idea Bank was considered to be a useful concept, fewer ideas were contributed by supervisors; many student ideas had been submitted by the end of 2012, but ideas from supervisors were scarce. In view of the low number of supervisor ideas, the DSV introduced a new policy whereby each supervisor was required to create three thesis topics for the Idea Bank, making the Idea Bank richer. In 2015, the same study was conducted, expanding the scope with more data. The study found that the number of supervisor ideas had increased between September 2012 and December 2013. The study also suggested four types of matching methods and compared their advantages and disadvantages. The four matching methods were student selection, supervisor selection, automatic matching and administrator matching. The authors argued that students and supervisors choosing each other based on mutual interests (without a middleman or administrator) was the best procedure from a motivational perspective (Hansson, Moberg, &

Peiris, 2014). Until 2012, expanding supporting functions were gradually developed for Sci-Pro.

One of the objectives of the thesis supervision system is plagiarism prevention. Larsson and Hansson (2012) conducted a study of how an ICT support system can be used to address this issue. They show how Sci-Pro can support the prevention and detection of plagiarism. They argue that transparency and fairness within the process are factors which can have a positive effect on the supervisor–student relationship regarding the prevention of plagiarism. In addition to prevention, Sci-Pro includes an application programming interface (API) for communicating with a commercial (third party) text-matching tool for the detection of copied text. The final thesis is automatically sent to the text-matching software system when the student uploads it. The report from the text-matching system is stored in Sci-Pro, and examiners and supervisors are able to view the report. Assessment is a critical issue in education, and particularly in the thesis process, in comparison with traditional courses which use structured examinations. Formative assessment methods are more effective than summative methods, although the implementation of formative assessment presents a challenge, since it requires more time and resources than the summative assessment methods (Peiris & Hansson, 2013). The Sci-Pro system addresses this challenge, and one study has shown how Sci-Pro supports the implementation of formative assessment methods in the thesis supervision process using ICT support (Peiris & Hansson, 2013). The study discusses how the various tools that are implemented in Sci-Pro can be used for this assessment.

Mobile phones are becoming increasingly popular and advanced, even in developing countries. According to the World Bank, even low-income countries have a mobile subscription rate of 93% (World Bank, 2015). A study conducted in order to explore students' perspectives of using Sci-Pro as a mobile app for thesis supervision found that about 95% of the respondents (from the DSV) used mobile applications for higher education and believed in the utility of mobile applications in supporting learning within higher education. More than 70% of the respondents thought that a Sci-Pro mobile app would add value to their thesis process (Aghaee & Larsson, 2013).

Two primary objectives in the development of Sci-Pro were reductions in supervisor time and enhancements in quality. Video- and text-based learning resources were included as tools to achieve these objectives. Students, as the primary stakeholders in ICT-based thesis support systems, use these resources; it is therefore worthwhile to study the usefulness of Sci-Pro system e-resources from the student's perspective. A study was conducted to investigate learners' perspectives on the usefulness of structured e-resources in reducing barriers to finding information related to the thesis process using Sci-Pro (Aghaee, Hansson, Tedre, & Drougge, 2014). This study was conducted using an open online survey, carried out in 2012–2013, from the students' perspective. This study evaluated the usefulness of Sci-Pro resources (video- and text based), dividing them into three categories. The first category of basic resources covers the essentials, and more than two thirds of learners indicated that this was useful. The second category, additional resources, included resources which support deeper research skills and the gaining of additional knowledge for producing higher quality theses,

and was reported as being useful by more than half of the learners. The third category covers a particular type of information related to a higher academic level, and was reported as useful by this particular group of learners. In general, this study shows that learners have a very positive attitude towards learning support systems similar to Sci-Pro. The majority of participants (96% of learners at both Master's and Bachelor's level) believe that these resources are useful in learning about the thesis description, structure and process, and are important for the thesis initiation and writing process. This study also shows that the use of Sci-Pro with a set of structured e-resources facilitates self-directed learning, and allows learners to find the required information independently. Thesis support systems therefore enable students to avoid the waiting time required to obtain general information from their supervisors and can reduce the time spent searching on the Internet. One of the main objectives of designing Sci-Pro was a reduction in the supervision workload (Hansson et al., 2009) and the results of this study showed that one of the main objectives of Sci-Pro system had been achieved.

Students complete a thesis as an individual or in pairs; they therefore experience a lack of peer interaction within the course of the thesis, in comparison with the traditional classroom environment. It appears that it is difficult for students to meet physically, since they are working on their thesis independently. ICT support systems can therefore be used as a platform to enable peer interaction. Two bachelor students initiated a project to develop a peer review system in 2011 (Kjellman & Peters, 2011). They implemented a system to develop a process for online written peer reviews, extending the Sci-Pro web system with peer-review functionality, thereby supporting the thesis process. A further study of the use of ICT support for peer review conducted by Aghaee and Hansson (2013) used data collected from the Sci-Pro peer review module. As these authors stated, the peer-review system is entirely student-driven, and thus saves time for supervisors by creating a direct interaction between students without input from supervisors. This paper describes an online peer-review system known as Peer Portal and the results of its use in enhancing the quality of Bachelor's and Master's thesis manuscripts. The overall results show that about 40% of the students reported excellent or good peer reviews. The results also show that the quality varies considerably, and the authors suggest structuring the peer reviews by introducing a rating system. They conclude that Peer Portal is valuable, since it is student-driven and brings benefits for students, supervisors and the department. In 2016, Aghaee and Keller (2016) conducted another study with the purpose of investigating learners' perceptions of the usefulness of an ICT-based support system (ICTSS) for peer interaction and the factors influencing the quality of the peer interaction. The results show that learners believe that establishing a culture of using ICTSS for peer interaction facilitates synchronous and online asynchronous communication, enhances collaborative learning, and improves the quality of theses. The majority of the learners reported that support for online and in-person peer interaction through the use of an online ICTSS was a useful facility.

Although the system includes many functions, its success depends on its usability. As a way of understanding usability, a study conducted in 2012 (Aghaee, Larsson, & Hansson, 2012) analysed the significant issues raised by Sci-Pro users. All of these were connected to the core

issue of a lack of comprehensive instruction for using the existing information in the system. Aghaee (2015) conducted another study, expanding the scope of the previous one, and identified six main categories of problems thesis initiation, info-mail, technical issues, exemption, supervision and final seminar. From a consideration of these categories, Aghaee suggested two strategies, the first relating to communication and second to instruction. From a communication perspective, the author suggested enhancing learner-learner interactions, learner-instructor interactions, and learner-content interactions, and highlighted the importance of the clarification of responsibilities, roles and expectations for both learners and supervisors. This author also suggested integrating the existing information system as a strategy to enhance both communication and the motivation of students. From an instruction strategy perspective, the author suggested constructing scenarios using screen captures or short videos to demonstrate the navigation and use of the system. He also suggests motivating supervisors to develop templates for unifying the supervision process and to use the system for the transfer of primary knowledge to students. In summary, this study suggests that the usability of the system can enhance the procedures and functions that are related to communication and instructions.

Another study was conducted in 2015 from an information systems perspective, entitled "Limiting variety by standardizing and controlling knowledge intensive processes" by Bider and Jalali (2016). According to the authors, the Sci-Pro system standardises and controls the process in a flexible way. As these authors discuss, there are three goals within the thesis process, including assessment, knowledge creation and learning. From an assessment perspective, they conclude that Sci-Pro has a positive effect on assessment, and recommended conducting further investigations to assess the achievement of other goals, knowledge creation and learning. In general, these authors argue that that the Sci-Pro system improves the average quality of a thesis. They also suggested adding more templates which take into account the types of research approaches, as a strategy to enhance student satisfaction.
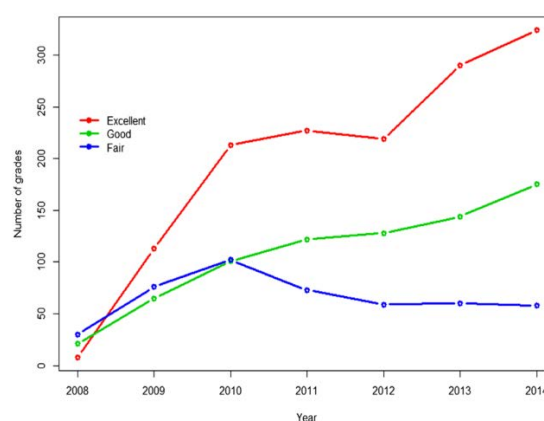

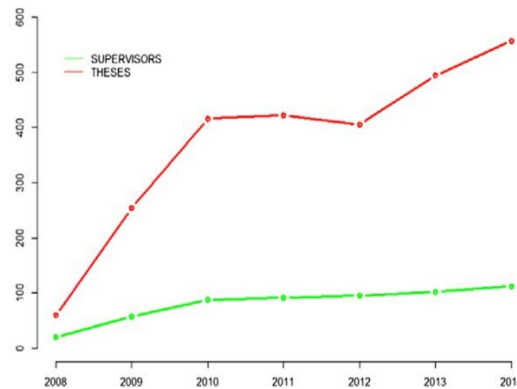Figure 2. Changes in grades after implementation of the system

Figure 3. No. of supervisors and theses after implementation of the system

A study was recently conducted to investigate the quality and efficiency of the thesis process in the DSV (Karunaratne, Hansson, & Aghaee, 2017). This study investigated the change in the quality and efficiency of thesis supervision after introducing the Sci-Pro system within the DSV. The results show that thesis quality has progressively increased throughout this period, as shown in Figure 2. Not only are current theses of much higher quality than before the change processes were implemented, but the number of low-quality theses has also significantly decreased during this period. The authors also show that the completion rate of theses has progressively increased. From an efficiency perspective, the study shows that there has been a significant increase in supervisor productivity and, on average, five more theses are completed per supervisor per year.

Conclusion

The thesis support system was introduced with the aim of developing an open and flexible ICT support system (Hansson et al., 2009). The system not only introduced ICT support but also suggested a procedural change. The project was developed with the idea of improving the quality of theses by implementing an open and flexible ICT system. The use of ICT in thesis supervision can offer benefits beyond those to students and supervisors; the university, business and society as a whole can also benefit from an ICT support thesis supervision system (Hansson et al., 2010). The concept of the Idea Bank provides a framework for idea creation, display to related stakeholders and the inclusion of external parties (including businesses) into the process (Bencherifa, 2012). As a type of direct user, thesis course coordinators (administrators) can also use the system for administrative activities. For instance, the concept of the Idea Bank reduces the workload for administrators, providing a tool for the selection of ideas by students and supervisors (Hansson & Moberg, 2011); (Hansson et al., 2012), meaning that administrators are required to match fewer projects. The removal of the middleman from idea-matching also motivates both students and supervisors alike (Hansson et al., 2014).

Supervisors and examiners are required to spend considerable time detecting plagiarised text. The Sci-Pro system shows how to integrate text-matching systems with thesis supervision, in order to address this issue (Larsson & Hansson, 2012). Sci-Pro also makes the thesis process transparent. Larsson and Hansson (2012) argue that the transparency and fairness of the

process enhance the supervisor–student relationship in a positive way in terms of the prevention of plagiarism. Another area that can benefit from a thesis support system is assessment. Peiris and Hansson (2013) show how Sci-Pro supports the implementation of formative assessment methods within the thesis supervision process using ICT. ICT can also be used as a tool in the thesis process for peer interaction. An online system can support a peer review scheme, since students work on their theses individually. Sci-Pro demonstrates how peer review can be implemented in both a pedagogical and technical sense. The introduction of a peer review system reduces the supervisor's workload, and peer reviews provide feedback to students. However, since not all the reviews are of good quality, Aghaee and Keller (2016) highlight strategic solutions for developing the pedagogical and technical aspects when developing a peer review system.

When exploring the use of ICT in the thesis process, the student's perspective is crucial. Student find the e-resources provided by the ICT system to be useful when learning about the thesis description, structure and process, and report that these systems are important in the thesis initiation and writing process (Aghaee et al., 2014). These authors also argue that an ICT support system facilitates self-directed learning and reduces the supervisor's workload. Furthermore, the thesis support system should focus on enhancing communication (interaction) and instructions for the use of the system. Students report that their motivation increases if the thesis supervision system is integrated with other information systems. The development of a thesis support system that can be accessed from mobile phones will also enhance student engagement. Aghaee and Larsson (2013) studied students' perceptions of this issue and showed that a Sci-Pro mobile application adds value to the thesis process. Bider and Jalali (2016) discuss how the Sci-Pro system standardises and controls the process in a flexible way, showing that that the Sci-Pro system has improved the average quality of the thesis through the use of an ICT support system. An ICT support thesis supervision system has increased not only the quality but also the efficiency of the thesis process within the DSV (Karunaratne et al., 2017). A study of the DSV thesis supervision management system shows that ICT can support both the thesis process and the end product. The literature shows how ICT can be used to enhance the efficiency of the thesis process, its quality and the effectiveness of the product, thereby benefiting industry and business.

Concluding remarks

A review of the above papers shows that ICT support thesis supervision systems can enhance the efficiency and effectiveness of the thesis process, standardising and controlling it while maintaining flexibility. ICT support systems reduce the workload of supervisors and administrators, and motivate students by supporting self-directed learning. The prevention and detection of plagiarism is another dimension that can be considered as an area for development. From a process perspective, an ICT system can support the entire thesis process, including initiation, supervision and assessment; from an interaction perspective, an ICT support system enhances student-supervisor, supervisor-supervisor, and student-student interactions. An ICT support thesis system can also be used as a tool for garnering real world issues from business and society and as a channel to share the knowledge generated. As a

whole, an ICT-based thesis supervision system can offer benefits not only to students and supervisors, but can help to enhance university-industry collaboration and thereby benefit society as a whole.

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