Department of Industrial Engineering and Management

Students' experiences of support during doctoral studies in industrial engineering and management

Katja Lahenius

Aalto University

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Katja Lahenius

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Abstract

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Abstract

This dissertation investigates doctoral students' experiences of the practices in supervision and in doctoral education promoting doctoral studies in industrial engineering and management. Previous research has noted that doctoral students need scientific, financial, and mental support, and identified several sources of support for doctoral students: family and friends, peer students, their supervisor, an additional supervisor, course work, study planning, and the learning environment. While investigating doctoral students' experiences of support during their doctoral studies, this study focused on support from supervisors, support from study planning and support from peer students.

The overall intent of this study was to gain an understanding of doctoral education from the doctoral students' perspective, relying as much as possible on doctoral students' views of doctoral education. The main research questions of the study are: 1. What kind of practices in supervision and in doctoral studies promote doctoral studies according to student evaluation?, and 2. How do different doctoral student groups differ in their support needs?. The study was conducted within one technical university department in Finland during 2008-2009.This single case study explored a bounded system through detailed data collection, using a mixed-methods approach as the research design.

The overall findings of this study show that all doctoral students need support and guidance during their studies, especially in the early stages of their studies. The results suggest that that besides the single supervisor, doctoral students have other sources of support during their studies that have not been widely discussed in previous studies, such as study planning and peer students and an additional supervisor. Further, this study highlights the different support experiences and needs of different student groups. Part-time students' poor resources and experience that they received less support from academia mean that their studies are conducted under totally different conditions when compared to the support and resources enjoyed by full-time students. This study also highlights the students' role as active learners, acting as self-regulated learners acknowledging their own responsibility for making learning meaningful and monitoring it.

Keywords doctoral education, mixed methods research, students' experiences, support

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Tiivistelmä

Tämän väitöskirjan tavoitteena on tutkia tuotantotalouden tohtorikoulutuksen erityiskysymyksiä ja ohjauskäytänteitä erityisesti jatko-opiskelijoiden kokemusten näkökulmasta. Aiempi tutkimus on huomioinut, että jatko-opiskelijat tarvitsevat tieteellistä, taloudellista ja henkistä tukea jatko-opintojensa aikana. Lisäksi on todettu useita tuen lähteitä: perhe ja ystävät, vertaisopiskelijat, ohjaajat ja valvojat, kurssityöskentely, opintosuunnittelu ja oppimisympäristö. Tämä tutkimus kohdistuu opiskelijoiden kokemuksiin ohjaajalta, opintosuunnittelusta ja vertaisopiskelijoilta saatuun tukeen.

Väitöskirjan tavoitteena on lisätä ymmärrystä jatkokoulutuksesta opiskelijoiden näkökulmasta. Tutkimuksen pääkysymykset ovat: 1. Millaiset ohjausmallit ja käytänteet edistävät jatko-opinnoissa etenemistä opiskelija-arviointien mukaan?, ja 2. Miten eri opiskelijaryhmät eroavat tuentarpeissaan? Yksityiskohtaiset vastaukset löytyvät artikkeleista. Tutkimus suoritettiin teknillisen yliopiston tuotantotalouden laitoksella vuosina 2008-2009. Tutkimusaineiston hankinnassa käytettiin niin laadullisia kuin määrällisiäkin tutkimusmenetelmiä.

Tutkimustulosten mukaan jatko-opiskelijat tarvitsevat tukea ja ohjausta, etenkin opintojensa alkutaipaleella. Tutkimustulosten mukaan eri jatko-opiskelijaryhmien kokemukset tuesta erosivat toisistaan. Tutkimustulokset paljastivat, että päätoimiset opiskelijat, jotka olivat edenneet hyvin opinnoissaan, omasivat paremmat mahdollisuudet etsiä ja saada ohjaajalta tukea kuin osa-aikaiset opiskelijat, ja siksi kokivat saavansa enemmän tukea ohjaajaltaan kuin osa-aikaiset opiskelijat. Lisäksi tutkimustulosten mukaan opiskelijoiden tulisi ottaa vastuu omista opinnoistaan sekä varata riittävästi aikaresursseja suorittaakseen tutkintonsa.

Avainsanat jatkokoulutus, opiskelijoiden kokemukset, tuki

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This dissertation thesis is dedicated to “my boys”: Jukka and Ilari. Thanks for being there and giving the meaning for my life.

Lahti, November 2012

Katja

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List of Publications

This dissertation consists of an overall summary and the following original papers:

1. Lahenius, K. & Martinsuo, M. (2010) Personal study planning in doctoral education, *European Journal of Engineering Education,* 35(6), pp. 607-618.

2. Lahenius, K. & Martinsuo, M. (2009) Students' experiences of supervising in doctoral education in industrial engineering and management. *The IEEE International Conference on Industrial Engineering and Engineering Management, IEEM 2009*, Hong Kong, China, 8-11.12.2009. pp. 2003-2008. IEEM 2009 proceedings.

3. Lahenius, K. & Ikävalko, H. (2012) Joint supervision practices in doctoral education – a student experience, *Journal of Further and Higher Education, iFirst Article,* pp. 1-20.

4. Lahenius, K. (2012): Communities of practice supporting doctoral studies, *International Journal of Management Education,* 10(1), pp. 29-38.

5. Lahenius, K. & Martinsuo, M. (2011): Different types of doctoral study processes. *Scandinavian Journal of Educational Research*, 55(6), pp. 609-623.

The articles are appended to the report. All the articles are reprinted with the original publisher's permission.

Contribution of the doctoral candidate: In the co-authored article 1 while studying the personal study planning in doctoral education with mixed method research design, the qualitative data were gathered and analyzed by the author. She participated in performing the literature review and analyzing and reporting the results. In the co-authored article 2 while studying the students' experiences of supervision with mixed method research design, the qualitative data were partly gathered and solely analyzed by the author. She participated in performing the literature review and analyzing and reporting the results. In co-authored article 3 while studying joint supervision practices the data were gathered and analyzed by the author.
In co-authored article 5 while studying doctoral study processes the research was designed and the data were gathered and mainly analyzed by the author. As the first author of all manuscripts, she has also had the main responsibility for writing the articles, with the active participation of the co-authors.

List of Concepts

Concept	*Definition*
Academic discipline	A field of study
Adviser	Someone who guides and advises a doctoral student during her/his studies
Doctoral education	Training aiming towards a doctoral degree
Doctoral studies	Studies aiming towards a doctoral degree
Doctoral training	Emphasizes the process of becoming an independent researcher, familiar with all kinds of research methods and aiming at broad labor markets
Full-time student	Student that can concentrate on her/his studies all the time
Graduate school	Structured doctoral education funded by the Finnish Academy in Finland
Instructor	Someone who guides and advises a doctoral student during her/his studies, usually concentrating on the thesis work
Joint supervision	More than one supervisor involved in thesis work
Learning environment	Is comprised of four factors: physical; relationships; structures and expectations, and language and communication.
Part-time student	Student that is doing her/his studies in addition to other work
Peer	Someone of the same social standing, while a peer group consists of those of the same status with whom one interacts
Personal study planning	An ongoing process during which the students can plan and monitor their own studies
Scholarly community	The multiple relationships that result from the pursuit of shared scholarly interest and endeavor
Supervision	To steer, guide, and support students through the process of working towards a doctorate.

1. Introduction

1.1. Background

In the context of the Bologna Process[1], doctoral training has recently gained greater importance on the European higher education agenda (EUA 2005). Unlike American universities, which rely on structured doctoral programs that guide the student through the first two years, European universities have traditionally emphasized a high level of flexibility in doctoral education and its being research-driven, without an emphasis on structured courses (Önnerfors 2007; Kyvik & Tvede 1998). However, poor completion rates and long studying times, as well as the fragmented financing of doctoral studies in Finland, indicated that there is a need to restructure doctoral education (Dill et al. 2006). The organization of doctoral education has been mainly on a departmental level, in some cases in doctoral programs. In order to get doctoral students to complete their degree in a timely manner departments and doctoral programs are seeking to find ways to support students better during their doctoral studies.

When rethinking doctoral education on the departmental level it is important to give students a voice and investigate the practices of the doctoral process from their perspective. It has been noted that their voice is the least heard (Golde 2000; McAlpine & Norton 2006). After all, the students are the ones to complete the degree. Earlier research has shown that the family plays an important role as a source of support. However, departments and doctoral programs are more interested in what they can do to support students to complete their degree within the recommended time. The earlier studies conducted on doctoral education have mostly focused on the structured systems in the USA, addressing the importance of supervision (Girves & Wemmerus 1988; Kluever 1997; Zhao et al. 2007). In these survey studies it was noted that supervision lies at the core of the doctoral process. In Europe, too, with its less structured system, the supervisor has been seen as being important (Pole 1998; Frischer & Larsson 2000; Chiang 2003; Armstrong 2004) in providing scientific, mental, and financial support for doctoral students (Peura 2008). Although

[1] The purpose of the Bologna Process (or Bologna Accords) is the creation of a European Higher Education Area by making academic degree standards and quality assurance standards more comparable and compatible throughout Europe, in particular under the Lisbon Recognition Convention.

supervision has gained significant attention, there are still issues related to supervision that need more attention, such as joint supervision practices, while the Finnish doctoral education system relies mainly on the traditional single supervision approach.

Further, even though the experiences of different student groups have been studied, the focus has been on students of different genders (Maher et al. 2004; Brown & Watson 2010) or ethnic (Perna 2004) backgrounds. In Finland the majority of doctoral students are doing their studies on a part-time basis (Dill et al. 2006). There are some studies focusing on the experiences of part-time students related to doctoral education in general (Martinsuo & Teikari 2008). Therefore, the experiences of different student groups of supervision should be investigated in greater depth, especially in other contexts than the Anglo-American one.

In terms of the support experienced, recent research conducted on students' experiences of doctoral education has noted the importance of a scholarly community. Different disciplinary contexts provide different kinds of learning environments for doctoral students and therefore provide different kinds of support (Pole 1998; Chiang 2003; Gardner 2007; Pyhältö et al. 2009; Stubb et al. 2012). The recent research has highlighted peer students as a source of support (Gardner 2007; Gardner 2009; Martinsuo & Turkulainen 2011) that has been almost unnoticed by the faculties (Devenish et al. 2009; McAlpine & Amundsen 2011). Therefore, this study aims to provide insights into what kind of support the department of industrial engineering and management provides to its doctoral students, and also gain information about how different student groups experience the support from their peers.

The Department of Industrial Engineering and Management at Helsinki University of Technology (since the year 2010 named Aalto University) has a long tradition of organizing its doctoral education by itself. In the year 2008 concern about the doctoral students' delayed study times encouraged the Department to launch a development project on doctoral education. The aim of this two-year project was to build a structure and process to support high-quality doctoral education in industrial engineering and management. The development project contained topics such as the recruiting process, study paths, supervision and advice, and the evaluation of the study success. During the development project concrete development measures took place

and some new courses and steps were piloted, which resulted in nine different unpublished reports. During the development project different kinds of data were collected, both quantitative and qualitative, on doctoral students' experiences. This study is based on those data and therefore, this study concentrates on doctoral education in the Department at that time. Since the development project, there have been major changes on the organizational level at the University and also in the doctoral program. However, the results of the study are still valid in terms of their content.

In recent years, the structures of Finnish doctoral education have faced a significant reform in process. The universities are now taking greater responsibility for the development of the doctoral education. Most universities have introduced the one-graduate-school morel during 2011, where all the disciplines and doctoral students belong to the one doctoral program within one university (Niemi et al. 2011). This kind of systematization creates the structure and practices that are in harmony with the European doctoral education (Bologna Process, the third cycle) and further, it creates common models and practices in different fields of research and education. Also, the follow-up report on restructuring the doctoral education in Finland showed that on the national level there have been made notable structural changes, however that the implementation differs within different disciplines (Niemi et al. 2011).

Although doctoral education has gained significant interest lately, there is a need for thorough research on students' experiences of support during their doctoral studies in one university context using multiple research methods. This study uses the data collected during the development project in order to understand the doctoral students' experiences during their doctoral studies and, further, investigate how doctoral programs could and should support doctoral students during their unique study paths.
This research aims to gain an understanding of what kind of practices in supervision and in doctoral education do promote doctoral studies according to student evaluation.
The overall research questions are:

1. What kind of practices in supervision and in doctoral education do promote doctoral studies according to student evaluation?,
2. How do different doctoral student groups differ in their support needs?

1.2. The system of doctoral education

The system of doctoral education includes three levels: national, school, and departmental. At the national level in Finland, the Ministry of Education and the Finnish Government direct the education through the university law, settings, and regulations. Schools provide the setting for doctoral education. The departmental level contains different processes, including the supervision relationship, the practices of the doctoral program, and seminars and research groups (Nummenmaa and Pyhältö 2008, pp. 24). McAlpine and Norton (2006) suggest that the core of doctoral education lies in the relationship between the student and the supervisor in the department-disciplinary context.

In Finland, the traditional doctoral education system, like in other Nordic countries, allows considerable freedom for the students to focus on their specific field of study. The doctoral students are required to gain 30-60 credits for their studies, in addition to researching and writing their dissertation thesis (Önnerfors 2007). Doctoral students can select their studies from their home university, as well as other universities, and compile their entire study package in a personal manner (Dill et al. 2006, Kyvik & Tvede 1998). Studies are usually planned by the student, observing the requirements for the chosen research field, but with some mandatory requirements being defined by the university (Wallgren & Hägglund 2004). The research-driven model of doctoral education has traditionally followed the apprenticeship model, where the supervisor advises and guides the doctoral students. This kind of system leaves a great deal of responsibility and freedom for the students for their own studies.

Moreover, earlier European doctoral education emphasized the contribution to knowledge rather than personal development and specialized research training (Blume 1995). As the number of doctoral degrees awarded is growing, more doctoral degree holders will be aiming for careers outside academia (Kehm 2007), meaning that the expectations of the knowledge and skills gained after doctoral education are different than earlier. While earlier the focus was on scientific training in core research skills, nowadays training in transferable personal and professional skills and competences is acknowledged to be equally important.

European universities do not have common institutional strategies, rules, and regulations concerning doctoral programs, and the organization of doctoral education is left to the responsibility of faculties or departments (EUA 2005). Therefore the organization of doctoral programs shows great diversity, not only across different countries in Europe, but also across universities within the same country and across faculties within the same university.

Recently, European universities have acknowledged the two different approaches – an individual study program and a structured program (EUA 2005) – that co-exist with each other in individual countries. The individual study program is based on an informal-to-formal working alliance between a supervisor and a doctoral candidate (an apprenticeship model), with no structured coursework phase (Önnerfors 2007). This kind of approach has received a good deal of criticism lately; for example, Frischer and Larsson (2000) describe the situation as the illusion of freedom, where neither the supervisor nor the student take responsibility for the studies. Ives and Rowley (2005) also noted that a friendship relationship between the supervisor and the student can have a negative influence on how effectively supervisors fulfill their responsibilities, for example by giving negative feedback.

As questions are being asked about whether this individual approach is appropriate to meet the multiple new challenges of research training, there is an increasing tendency in many European countries towards structured programs with doctoral candidates grouped in doctoral schools (EUA 2005). In Finland too, Graduate Schools (GS) were introduced in higher education on the national level in the 1990s by the Ministry of Education. Considerable flexibility of structure and focus was permitted in the development of these schools. Therefore, they are not graduate schools in the US meaning of the term, but rather collaborative doctoral programs. Because of the GS system new practices and research environments emerged in Finnish doctoral education, and increased doctoral education's efficiency. Especially, a few GS developed a comprehensive, well organized supervision system for doctoral students, including the Steering Committees and a progress files. (Dill et al. 2006) Despite the existence of the GS system in Finland, the majority of doctoral students do their studies outside of the GS system (Dill et al. 2006).

In contrast to the individual program, the structured program is organized within research groups or doctoral schools and has two phases: a taught phase and a research phase. The taught phase includes mandatory and optional courses or modules (EUA 2005). The structured approach has been seen to provide more support to students than the individual approach; among other things it provides a comprehensive, well-organized supervision system for doctoral students, and ensures that four years' worth of funding is provided during doctoral studies (Dill et al. 2006). The structured approach has been used in the United States, but there are also difficulties in completion rates in United States despite the structured program, for only a little more than 50 percent of all doctoral students entering their programs will complete their degree (Sowell et al. 2008). Therefore, recently, there has also been a major re-thinking of doctoral education in the United States (Kehm 2007). The conclusion is that despite the approach to doctoral education that has been adopted, there is a need for critical consideration and development steps in the sphere of doctoral education.

In addition to the individual and structured approaches to doctoral education, Kehm (2009) has noticed that during the last few years, seven different models of doctoral education in Europe have emerged: a research doctorate (a dissertation is central), the taught doctorate (consists of substantial proportion of course work), PhD by published work (cumulative dissertation, consisting published peer reviewed journal articles), the professional doctorate (a programme of advanced studies towards developing research skills needed within a professional context), the practice based doctorate (the doctorate in the Arts and in Design), the "new route" doctorate (integrated doctorate for international students or students with the Bachelor degree), and two models of the joint doctorate (doctoral programmed jointly offered by two or more universities). However, in Finland, the model of doctoral education seems to be the mixed model, while the dissertation is central like in a research doctorate model, but the dissertation can be in addition to the monograph, a cumulative dissertation, like in the PhD by published work model. Also the requirement of substantial proportion of course work, like in industrial engineering and management the 60 credits to be completed, refers to the taught doctorate model. There are only a few universities in Finland that are a part of joint doctorate programs. Therefore, while investigating the Finnish doctoral education, the individual and structured programs provide a convenient model.

According to previous studies practices of doctoral education are also influenced by disciplinary differences (Becher 2001; Chiang 2003). For instance, both supervisor choice and supervisor behavior have been noticed to vary across academic disciplines (Zhao et al. 2007). In a questionnaire study within 28 education departments and 31 chemistry departments in British universities, Chiang (2003) found differences in the research environments experienced by doctoral students. Her findings show that the doctoral students experienced the chemistry department as offering better support than the education department during the doctoral studies. The students and their supervisors work on the same research projects with solidarity and a spirit of teamwork. The supervisor acts as their advisor but also a working colleague with the students, who are, however, junior. The interaction between supervisors and doctoral students was casual and non-hierarchical. Students had relatively easy access to funding and facilities (Chiang 2003). Therefore, chemistry students felt valued, not isolated, and recognized as full members of the community (Chiang 2003). On the contrary, the students from the education department felt less supported. The interaction between supervisors and doctoral students was more formal and hierarchical, and less frequent. Students worked on their own. Therefore, the education students felt isolated, unvalued, and excluded from the community of the department. Becher (2001) noticed that this kind of practice is typical in the social sciences and humanities, where academics carry out individual research separate from that of their students.

The differences in disciplinary contexts raise the question of whether doctoral education in the humanities, education, and social sciences in general should adopt practices characteristic of a teamwork training structure. However, as Stubb (2012) suggests, it should be noted, that academic disciplines are not monolithic entities (Brew 2001), because the variation within one domain may be great, like in science (Kamler 2008).

2. Literature review

2.1. The nature of doctoral education

Future doctors in industrial engineering and management will deal with the development, improvement, implementation, and evaluation of integrated systems of people, money, knowledge, information, equipment, energy, material, and processes (Salvendy 1992). While originally the term "industrial" applied to manufacturing, nowadays it encompasses all other industries and services too. Industrial engineering focuses both on extending the human capability to operate, manage, and control the overall production system and, moreover, ensuring the safety and well-being of those working in the system. This means that doctors, being experts in industrial engineering and management, can have a background representing various disciplines: engineering, economics, education, psychology, and social sciences.

Therefore, the structure of doctoral education in industrial engineering and management includes the traditions of both disciplines, engineering and the social sciences. As previous studies have shown (Chiang 2003; Pole et al. 1997), doctoral education in engineering involves teamwork, close supervision relationships, and doctoral students being regarded as members of the group. On the contrary, disciplines in the humanities, such as psychology and social sciences and economics, traditionally emphasize the individual nature of doctoral education. The doctoral studies, and especially the doctoral thesis, are conducted almost in isolation, with doctoral students being regarded as learners and not as full members of the research group (Becher 2001).

In industrial engineering and management, at least in Finland, doctoral students work in close connection with industry. That is because the nature of industrial engineering and management is applied science, testing a theoretical model through the use of formal science, or solving a practical problem through the use of natural science (Salvendy 1992). The research material collected for the dissertation thesis is gathered in some cases in collaborative research projects in industry. Industrial engineering and management offers doctoral students with multi-disciplinary backgrounds a platform for interdisciplinary discussions and settings to collaborate in a demanding context.

Doctors are supposed to have high-quality scientific expertise. Keltikangas and Martinsuo (2009) studied factors associated with professional socialization in the context of electrical engineering education. Their results indicated that doctoral students need, develop, and have more in-depth technological and scientific knowledge, as compared with graduates. While earlier doctoral students were supposed to become academic scholars, today they are expected to be professionally trained researchers (Chiang 2003). Blume (1995) describes this change as vocationalism, in which the nature of doctoral study has shifted from the representation of academic knowledge to the production of societal and market value. Also Chiang (2003) notes the focus of doctoral education has moved from being discipline- and knowledge-based to more broadly training-based. Training-focused doctoral education emphasizes the process of becoming an independent researcher, familiar with all kinds of research methods and aiming at broad labor markets. Walker et al. (2008) state that doctoral students today must be ready for a fast-changing, highly fluid, competitive, and demanding professional world. Further, vocationalism means that today's doctors have several career opportunities (Chiang 2003), for the doctors may seek a life in academe, in universities or research institutions, or, like the majority in some fields, such as industrial engineering and management, may have a career in industry, in business, or in government (Walker et al. 2008).

So far, in many European countries, including Finland, doctoral education has included the doctoral thesis work and some coursework. Scientific expertise has been seen as developing as a by-product of thesis work, studies, and the researcher's interaction with the scientific community (Pyhältö & Soini 2008). Supervision relationships have been very important in terms of successfully completing a doctoral degree (Frischer & Larsson 2000). The traditional approach to scientific expertise was very individually centered; doctors were seen as being, above all, wise men in a factual sense (Pyhältö & Soini 2008). The traditional apprenticeship model supported this kind of system. However, many problems related to this traditional apprenticeship model have been identified (Frischer & Larsson 2000). Cognitive apprenticeship, on the other hand, has been recognized as being very relevant in doctoral education (Austin 2009; Pyhältö et al. 2009). Collins, Brown, and Holum (1991) described cognitive apprenticeship as "a model of instruction that works to make thinking visible" (p. 1). Theories of situated learning, where learning takes place in the same

context in which it is applied (Lave & Wenger 1991), emphasize that learning is enhanced when students make their learning meaningful to themselves and are supported in their learning when they are part of a community of practice in which they are engaged with others (Austin 2009). Lave and Wenger (1991) define communities of practice as "a system of relationships between people, activities and the world; developing over time, and in relation to other tangential and overlapping communities of practice" (p. 98). Further, collaborative learning processes, where the interactions of a learning group are a key to learning (Dillenbourg 1999), enhance the quality of the community of practice and strengthen the learning experience of the participants. Besides cognitive apprenticeship, scientific doctoral education also includes individual meta-cognitive skills that are the ability to reflect upon, understand and control one's learning (Schraw & Dennison 1994). Previous research shows that scientific education facilitates critical thinking skills that play a crucial role in complex problem solving (Hakkarainen & Olson 2009). Anyway, it must be noted that at the present doctoral education is undergoing major changes, where the existing structures and practices are being questioned and reconsidered in order better to serve the needs of both academia and the wider economy.

2.2. Doctoral education as a system

The doctoral study process is seen as a system containing different aspects as proposed by Nummenmaa and Pyhältö (2008). These are selection, environment, teaching and supervision, resources, and process factors (Figure 1). All these aspects influence the quality of the doctoral education (Nummenmaa & Pyhältö 2008), and therefore the doctoral students' experience. The development and maintenance of high-quality doctoral education is dependent on the admission of able and motivated postgraduate students (Dill et al. 2006). Today's doctoral students have increasingly varied backgrounds, expectations, motivations, and responsibilities when starting their doctoral studies (McAlpine & Norton 2006). Therefore, the recruiting of doctoral students plays a more important role. While earlier in Finland it was common that the students just enrolled for studies, nowadays, there are stricter rules for selecting candidates, where previous success in studies and the research plan play a dominant role (Nummenmaa & Pyhältö 2008).

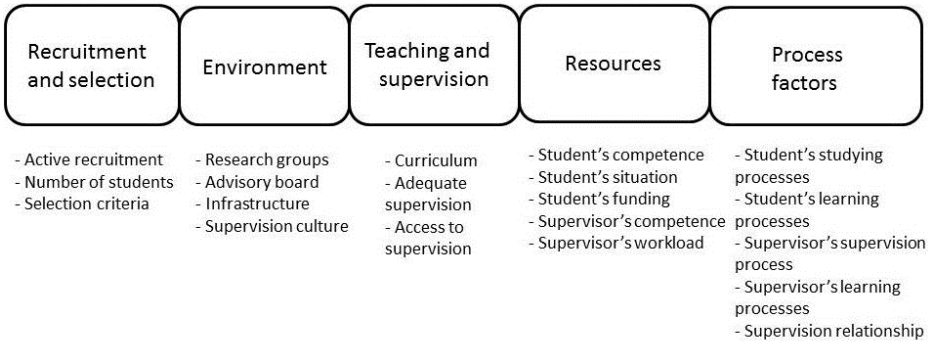

Figure 1. Aspects of doctoral study process (source Nummenmaa & Pyhältö 2008, pp. 27)

The environment of doctoral studies also affects the doctoral student's experience. Previous research suggests that doctoral students need opportunities to gain a sense of belonging to scholarly communities during their doctoral training (Conrad 2007; Pyhältö et al. 2009). As noted earlier, there are disciplinary differences between the learning environments where students conduct their studies (Chiang 2003). Whereas in the natural sciences the students usually do their research in groups, in the social sciences the students work individually. As noted earlier, collaborative ways of working provide students with more support.

Teaching and supervision have been noticed as being two of the most important factors in doctoral education. From the student's point of view major concerns are whether there is enough teaching and advice (Abiddin & West 2007), how accessible it is (Seagram et al. 1998; Chiang 2003), and how it supports the student's own learning (Armstrong 2004). Within different disciplines there are different supervision cultures, which affect the student's experience (Chiang 2003). Earlier research has demonstrated that within the natural sciences the supervisor is more accessible than in the social sciences, which refers to the situation where the research is carried out in the research group (Seagram et al. 1998; Chiang 2003).

Resources, both time and financial, are import for the progress of the doctoral studies. Whether the student is a full-time or part-time student affects the student's experience

and the resources students have. Martinsuo (2007) reported that part-time students possessed few resources in terms of time. This was confirmed by Brown & Watson (2010), who studied female part-time doctoral students' experiences, concentrating on a small number of middle-aged female students with families. Their results indicate that a family is the major obstacle to progress with one's studies. They state that women need empathy from their supervisors and acknowledgement of the fact that the demands of their home situation can make their progress slow. Financial resources also have an effect on the progress of studies and the completion of the degree (Seagram et al. 1998). While in the US the funding for doctoral studies and for dissertation research often comes directly from advisers and their grants (Zhao et al. 2007), in Finland students are supposed to acquire funding themselves. Full-time students can acquire funding from a number of sources, including university positions, research institutes, and scholarships from private foundations (Dill et al. 2006). Part-time students mainly finance their studies by themselves or sometimes with short-term grants (Dill et al. 2006). It is obvious that the length of the studies of part-time students is longer than that of full-time students, given these scarce resources. Further, Martinsuo (2007) and Martinsuo & Teikari (2008) reported the experiences of part-time students in industrial engineering and management, stating that the support systems are usually targeted to the needs of full-time students. However, part-time students' needs should be equally recognized as well.

Finally, the process factors relate to the teaching and supervision, because they include the student's studying and learning processes and the supervisor's supervision and learning process, as well as the supervision relationship. The supervision relationship has been seen as a dyadic relationship between a single supervisor and a student. As noted earlier, the Finnish doctoral education system at the departmental level has long relied on an individual structure, where the supervision relationship has been a key aspect of the doctoral experience. However, while studying supervision in Australia, Malfroy (2005) found out that "the supervisory relationships no longer relied entirely on a dyadic relationship". Instead, other factors, such as the use of panels, and unacknowledged sharing between supervisors in supporting the students' research ideas, indicated more flexible and open practices and processes in doctoral education.

2.3. Supporting doctoral studies

While all the aspects are important for the quality of doctoral education, in this study the focus is on teaching and supervision, and more precisely study planning and supervision. Although supervision has been acknowledged as the most studied issue, it has also been noted as being the most important issue affecting the doctoral experience (Abbidin and West 2007; Armstrong 2004) and the timely completion of the degree (Frischer and Larsson 2000). Personal study planning, on the contrary, has been given less attention, one of the reasons being that it is quite a new phenomenon and also has not been widely used in the context of doctoral education. Therefore this study aimed to focus on supervision, as well as study planning, while investigating the students' experiences of support during their doctoral studies in the department. The recent research has noted the importance of a scholarly community. Peer students are seen to be an important part of that (Gardner 2008). Therefore, this study aims to examine the students' experiences of a certain kind of peer support, namely study groups.

2.3.1. Study planning

Personal study planning is here defined as an ongoing process during which the students can accumulate various study planning documents for themselves or for study counseling (Ansela et al. 2006). Annala (2007) notes that the concept of personal study plans has been used to describe multiple practices in Finland, from filling in forms to reflective processes. In the English language, the most commonly used terms are 'individual study plan', 'personal study plan', or 'personal learning plan' (Ansela et al. 2006). Besides bachelor's and master's studies, personal study planning is also increasingly attractive in doctoral education. According to Nummenmaa, Pyhältö, and Soini (2008), a personal study plan provides a natural tool for self-learning and study counseling in doctoral education.

Personal study planning has recently become an important part of research and literature on the development of higher education. Recent research shows increasing evidence of the adoption and use of personal study planning or personal development planning in various places, including the United Kingdom, the Czech Republic, and Sweden (Clegg & Bradley 2006a; Fry et al. 2002). However, these studies have mostly concentrated on undergraduate studies, while there are few studies dealing

with personal study planning in doctoral education and different student groups. Personal study planning has not been sufficiently investigated in Finnish doctoral education, although universities have started to adopt personal study planning practices.

Doctoral education differs substantially from undergraduate and graduate-level education as a result of its flexibility and need for individualized studies. The recent call for the shortening of the duration of doctoral studies implies that the students' unique studies should be planned and supported in better ways. Doctoral students have so far been taking very personalized and individualized study paths, but the results have not been as successful as expected. Evidently, more research is needed on personal study planning in doctoral education in general and on its situation-specific nature in particular. Differences between different student groups call for new knowledge.

2.3.2. Supervision

Effective supervision of research students is acknowledged to be a crucial factor in the successful completion of a PhD degree (Frischer & Larsson 2000; Vilkinas 2008). The flexibility of doctoral education systems across Europe in general, and in Finland in particular, raises the question of how doctoral studies should be supported and supervised. There are many studies from the supervisor's point of view that concentrate on the supervisor's skills and capabilities (Vilkinas 2008), and roles and responsibilities (Barnes and Austin 2009), and also studies that concentrate on students' experiences of supervision in their doctoral education (Abiddin & West 2007; Armstrong 2004; Girves & Wemmerus 1988; Kluever 1997; Zhao et al. 2007). Prior research has investigated both the viewpoint of faculty (e.g., Vilkinas 2008) and that of students (Zhao et al. 2007) towards supervision, with an emphasis on factors associated with the progress of the thesis. The studies have shown that various aspects of the supervisory relationship have been reported as important factors to doctoral study progress (e.g. Girves & Wemmerus 1988; Seagram et al. 1998), and doctoral student satisfaction (Armstrong 2004; Zhao et al. 2007). Also interaction between the students and their supervisors has been considered as important (Bargar & Mayo-Chamberlain 1983; de Valero 2001).

As noted earlier, in Europe there are two kinds of approaches to supervision in doctoral education, individual and structured approaches (EUA 2005). However, the supervision model generally follows the tradition of individual supervision. In this tradition one supervisor, usually the professor, advises one doctoral student through the doctoral process, including guidance in research and studies and socializing in the scholarly community and providing mental support (Walker et al. 2008). However, this kind of system has attracted considerable criticism lately, and because of the changing doctoral education system, supervision needs more attention, especially in a context that had relied on an individual supervision approach. Students' experiences will demonstrate the contemporary practices in those contexts.

2.3.3. Joint supervision

Over the past decade, new supervision practices and alternative forms of support have been developed in European researcher education to complement personal supervision. Instead of continuing to follow the traditional model of supervision, many universities are now encouraging multiple supervisors or the joint supervision of one student by two or more supervisors (Bitusikova 2009). The new supervisory practices also include committee supervision and supervisory groups. Committee supervision provides complementary expertise that students can call upon, while supervisory groups involve students in their own and each other's supervision (Zhao 2003). These new supervision models are supposed to serve the needs of modern students and supervisors better, while both students and supervisors are more mobile than in the past (Zhao 2003), and the fact that the research problems are more complex and divided requiring inter-disciplinary knowledge (Pole 1998).

There are only a few studies that have concentrated on joint supervision in doctoral education. These show that there are both benefits and problems in the joint supervision model. The benefits include exposing candidates to a diverse range of intellectual perspectives and expertise across academic and professional disciplines, as well as enabling labor in supervisor roles to be divided (Spooner-Lane et al. 2007). Cullen et al. (1994) state, that students receiving regular guidance from more than one supervisor indicated higher overall levels of satisfaction with their supervision. Joint supervision ensured accessibility at any time to at least one senior researcher with

knowledge and involvement in their research and, as a backup, provided a second person, or team, with whom ideas can be discussed (Frame & Allen 2002).

On the other hand, Pole (1998) and Phillips and Pugh (2005) reported different problems related to joint supervision. Pole (1998) reported that difficulties in joint supervision can be caused by the different personalities of supervisors and distances in status between supervisors and students. Phillips and Pugh (2005) also reported a number of different problems that can arise in joint supervision practice. There can be a diffusion of responsibility, and problems can arise if the student plays one supervisor off against another, and additionally there can be problems if no one takes an overall view of the thesis (Phillips & Pugh 2005). There can also be problematic situations arising from conflicting advice received from different supervisors (Taylor & Beasley 2005). As joint supervision has received little empirical attention, there is a need for up-to-date research, especially because of the changing nature of doctoral education and, more precisely, the supervision practice in a context with a tradition of an individual supervision approach.

2.3.4. Peer support

As noted earlier, the learning environment also has a great impact on students' study experience (Chiang 2003; Conrad 2007; Gardner 2007; Pyhältö et al. 2009). One part of the learning environment is the peer students. Falchikov (2001, pp. 1) defines "a peer as someone of the same social standing, while a peer group consists of those of the same status with whom one interacts". The findings of earlier research suggest that students' peer relationships play an important role in doctoral student development (Boud & Lee 2005; Gardner 2007; McAlpine & Amundsen 2011), having a positive effect on the progress of their studies in both coursework and research (Martinsuo & Turkulainen 2011), and the completion rates of doctoral degrees (Devenish et al. 2009). McAlpine and Amundsen (2011, pp. 4) suggest that peers offer support for doctoral students that is "collegial and motivational, giving and receiving feedback in dialogic exchanges". Despite these studies, the support offered by peer students remains understudied. In particular, the experiences of peer support experienced by different student groups, part-time vs. full-time, need more attention, as does the impact of peer support on the doctoral students involved in doctoral education systems that emphasize the individual structure.

2.3. Evidence for the importance of this study

Recently the research focusing on doctoral education has gained increasing attention, and there have been many studies conducted in different contexts focusing on different aspects of doctoral education. Some of these studies also address the issue of support that students receive during their doctoral studies. Earlier research has identified several sources of support for doctoral students. Providers of support include family and friends (McAlpine & Amundsen 2011), peer students (Devenish et al. 2009), the supervisor (Peura 2008; Armstrong 2004), the additional supervisor (Frame & Allen 2002), course work (Martinsuo 2007), study planning (Clegg & Bradley 2006a), and the learning environment (Pyhältö et al. 2009). Further, Table 1 summarizes the earlier studies on doctoral education from the students' perspective, focusing on student experience.

Table 1. Studies related to students' experiences of doctoral education

Authors	*Year*	*Context*	*Research method*	*Outcome*
Girves & Wemmerus	1988	US: social sciences, natural sciences, and engineering	Survey	Supervision: structured system, adviser important
Kluever	1997	US: education	Survey	Supervision: structured system, adviser important
Pole	1998	UK: social sciences, natural sciences, and engineering	Interviews	Disciplinary differences in practices: teamwork - individual
Frischer & Larsson	2001	Sweden: social sciences	Interviews	Laissez-faire system: paralyzing freedom
Chiang	2003	UK: education, chemistry	Interviews	Disciplinary differences in practices: teamwork - individual
Armstrong	2004	UK: business	Survey	Supervision relationship important
Zhao et al.	2007	US: humanities, social sciences, physical and biological	Survey	Supervision: disciplinary differences in choice of advisor and in the relationship
Gardner	2007	US: chemistry, history	Interviews	Disciplinary differences, peer students important
Abiddin & West	2007	UK: unknown	Survey	Supervision: role of supervisor, effective supervisor
Martinsuo & Teikari	2008	Finland: industrial engineering and management	Survey	Part-time students: resources, time management, support experienced
Peura	2008	Finland: natural sciences and humanities	Narratives	Students need scientific, financial, and mental support; somebody must be available to inspire and offer encouragement; otherwise,

				the process will be disturbed
Pyhältö et al.	2009	Finland: arts, medicine, behavioral sciences	Survey	Scholarly community, learning environment: disciplinary differences
Devenish et al.	2009	Australia: business administration	Action research	Peer support: important part of studies, hidden learning
Martinsuo & Turkulainen	2011	Finland: industrial engineering and management	Survey	Commitment, peer support: positive effect on study progress
McAlpine & Amundsen	2011	Canada: education	Progress logs, interviews, recorded conversations	Students get support from different sources; students' own responsibility

As shown in Table 1, most of the studies have been conducted in the context of the United States and the United Kingdom. But as the earlier research has noted, doctoral education is highly context-specific. In particular, the doctoral system used in the United States relies on structured programs, providing doctoral students with a totally different experience than the Finnish system, which relies on individual programs that allow students much more freedom with their studies. Besides, the supervision practices in the United States and in Finland differ greatly. Whereas the committee practice is used in the United States, in Finland the single supervision practice is widely used, while on rare occasions a second adviser may be nominated. Further, in the light of earlier studies the discipline has been seen to affect doctoral students' study experience (Chiang 2003; Pole 1998; Zhao et al. 2007). Therefore, this study aims to explore doctoral education through one single case study focusing on students' experiences of supervision and peer support, as well as investigating their individual study paths to gain a better understanding of students' experiences of different kinds of sources of support during their doctoral studies in the context of industrial engineering and management.

From the five different aspects of doctoral education, supervision has been one of the most studied issues in doctoral education and, furthermore, is considered as being the most important factor affecting the study experience that lies at the core of doctoral education (McAlpine & Norton 2006). Although there have been many studies on supervision from the students' perspective (Girves & Wemmerus 1988; Kluever 1997; Armstrong 2004; Zhao et al. 2007), there is a lack of empirical evidence of different student groups' experience of supervision, specifically part-time and full-time

students. Further, these studies are mainly from a quantitative perspective, being conducted on a survey basis. Therefore, there is also a need for more empirical evidence of a qualitative nature, giving a better insight into students' experiences of supervision and examining different student groups' experiences.

While the supervision system in the social sciences is mainly based on single supervision, there are also some cases where joint supervision practices have been used. There are only a few studies that focused on joint supervision practices in an individual study program and therefore a better understanding is needed of the reasons and actual practices within joint supervision. The main interest is in what kind of support students get within joint supervision practices.

Although supervision has been seen as being the key factor affecting the student experience, recent studies suggest that besides the supervisor, there are also other sources of support that are important for doctoral students (McAlpine & Amundsen 2011; Stubb et al. 2012). McAlpine & Amundsen (2011) name family members, friends, and peers as also being important sources of support. Devenish et al. (2009) also emphasize the importance of peer support. However, more empirical studies describing the practices of peer support in contemporary doctoral education systems with a tradition of individual study programs are needed.

3. Research questions

The research interest that combines the five papers of the thesis is the aim of contributing to the literature on promoting doctoral studies by providing perspectives that extend the current literature. The main focus of this research is on doctoral students' experiences of support during their doctoral studies in the field of industrial engineering and management. This research aims to gain an understanding of what kind of practices in supervision and in doctoral education do promote doctoral studies according to student evaluation. The overall research questions are:

1. What kind of practices in supervision and in doctoral education do promote doctoral studies according to student evaluation?,
2. How do different doctoral student groups differ in their support needs?

As stated earlier, the doctoral education system involves many different aspects. The five papers deal with different aspects of supporting doctoral studies. The first one addresses personal study planning in doctoral education and its implications for promoting doctoral studies. The second and third papers address the importance of supervision practices during doctoral studies. The fourth paper investigates how peer groups can support doctoral studies. Finally, the fifth paper investigates what the issues are that promote or delay different study processes. The five papers involve interrelated studies, and each study involves specific research questions, as described below.

Paper 1: "Personal study planning in doctoral education"

In individualized doctoral programs, doctoral studies are organized in a flexible manner, and doctoral students can agree on their unique studies with the professor. Personal study planning has been considered as one possible solution to help students in selecting and scheduling their studies, and in achieving shorter study times. Research is needed to explore various student groups' experiences of study planning, and to support faculty's work in promoting study planning in individualized doctoral programs. Therefore, this study investigates how doctoral students experience and use personal study plans in one university department, six months after it had adopted personal study planning. The aim is to answer the research questions:

How do doctoral students use and experience personal study planning?

How do doctoral student groups differ from each other in their experience of personal study planning and study satisfaction?

Paper 2: "Supervision in doctoral education in industrial engineering and management"

Effective supervision of research students is acknowledged to be a crucial factor in the successful completion of the PhD degree. The flexibility of doctoral education systems across Europe raises the question of how doctoral studies should be supported and supervised. Prior research has investigated both the faculty's viewpoint and that of the students towards supervision, with the emphasis being on factors associated with the progress of their thesis. Less evidence exists on the differences in supervision experiences across different doctoral student groups. This paper is focused on doctoral students' experiences of supervision and support, particularly in industrial engineering and management in one university department.

The aim is to answer the research questions:

How do doctoral students in IEM experience supervision in their doctoral process?

How do different student groups differ from each other in their supervision experiences?

Paper 3: "Joint supervision practices of doctoral thesis"

Recent literature on higher education has stressed the need to re-theorise the transformed nature of doctoral education and supervision. It has been noted that the complexity of supervision also makes the practices of joint supervision increasingly important in assuring the quality of doctoral education. Joint supervision, or co-supervision, refers to a practice where two or more supervisors advise one student during their doctoral study path. While the critical role of supervision has been widely accepted, joint supervision has attracted less attention in the literature. Therefore, this study aims to contribute to the literature on joint supervision practice and the supervisor's professional work from the perspective of doctoral students. It aims to answer the research questions:

How do doctoral students experience joint supervision practices?

How do doctoral students perceive the work of their supervisors, if receiving joint supervision?

Paper 4: “Communities of practice supporting doctoral studies”

Previous studies claim that students should have an opportunity to engage with practicing researchers and a community of peers, experts, and others. This paper draws on the experiences of three small groups of doctoral students in order to illuminate the importance of communities of practice in doctoral education in terms of students’ perceived experiences of doctoral study in the context of industrial engineering and management. In this paper the aim is to address two main issues. The aim is to answer the research questions:

> What kind of experiences do doctoral students have of participating in small groups and in which ways has this participation contributed to their doctoral studies?
>
> How did the participating doctoral students experience the development of the study group?

Paper 5: “Different types of doctoral study processes”

Becoming a doctor can be viewed as a highly personal and unique experience, which is why many factors influence the completion or non-completion of the doctoral degree. The attention in previous research has been on the students’ characteristics, and the role of the university faculty in promoting degree progress. Therefore, more research is needed on the alternative routes that doctoral students take as part of flexible doctoral education. The purpose of this study is to increase understanding of the different types of doctoral students in industrial engineering and management, and their different study processes. The aim is to answer the following research questions:

> What kinds of individualized doctoral processes do doctoral students go through?
>
> What kinds of factors promote or delay the progress of doctoral studies?

4. Research design and methods

4.1. Research design

The aim for this study arose from a development project in doctoral education in one department of industrial engineering and management. While development issues were focused on, there was a wish to hear the students' own voices (see Golde 2000). Therefore the intention of this study is to understand doctoral education from the doctoral students' perspective, relying as much as possible on doctoral students' views of doctoral education (Creswell 2003), and therefore pragmatism was adopted as the paradigm adopted in this study. Pragmatism also allows the researcher to accept philosophically that there are singular and multiple realities (Feilzer 2010). The pragmatic paradigm suited this study, because, as Feilzer (2010) states, it "allows the researcher to be free of the mental and practical constraints imposed by the forced choice dichotomy between post-positivism and constructivism". Furthermore, while using the pragmatic paradigm the researcher is able to use an appropriate research method or technique (Feilzer 2010), and has permission to study areas that are of interest, embracing methods that are appropriate and using findings in a positive manner (Creswell 2003). However, this must be done in harmony with the value system held by the researcher (Creswell 2003).

The case study approach is most relevant when studying phenomena emphasizing the context, in this case industrial engineering and management (Bryman 1989; Eisenhardt 1989). As noted earlier, doctoral education is highly dependent on the context, and so, because the aim was to explore in depth the experiences of doctoral students within one department, the single case study was applied as a research strategy in this study. The single case study also explores a bounded system through detailed data collection (Merriam 2009), here the doctoral students' experiences of doctoral education in one department of industrial engineering and management. In this single case study the case selection was based on researcher's in-depth local knowledge. This means that the researcher has rich knowledge of setting and circumstances, and thereby offer reasoned lines of explanation (Fenno 1986). Further, the case selection is based on the instrumental case study approach, which uses a particular case to gain insight into an issue or theory, in this case the doctoral students and experiences of support (Stake 1995).

Furthermore, the mixed methods approach was adopted as a research strategy in order to gain deeper and broader mixes leading to more generative, insightful understandings of doctoral education (Greene & Caracelli 2003). Moreover, as Tashakkori and Teddlie (2006) point out, pragmatism justifies the use of mixed methods and mixed methods studies. Mixed methods research acknowledges the value of both quantitative and qualitative research methods (Feilzer 2010). It also acknowledges the knowledge produced by such research in furthering our understanding of society and social life (Feilzer 2010). Therefore, because wanting to get information how many doctoral students feel, think or act in a particular way, the quantitative research method, the questionnaire survey was appropriate to measure that. On the other hand, as this study aimed to understand the students' experiences in more depth, the qualitative research methods, the interviews provided the tool to access that information.

At the beginning of this study (Figure 2, phase I) the combining of qualitative and quantitative methods involved equal status for each and a parallel design, where both the quantitative and the qualitative approaches are used about equally to gain an understanding of the phenomenon under study (Tashakkori & Teddlie 2006). In phase I the parallel mixed methods design approach was used to generate numerical and narrative data that answered the questions relating to doctoral students' experiences of supervision and their overall experiences of doctoral studies. A questionnaire survey was conducted to get information about the students' experiences of supervision and personal study planning. At the same time thematic interviews with selected doctoral students took place that focused on doctoral studies in general. For studying the experiences of personal study planning, the personal study planning formats were analyzed using qualitative content analysis. Phase II of this study (Figure 2, phase II) aims to gain a greater in-depth understanding of two issues, and therefore the qualitative approach was selected for the two studies that were conducted.

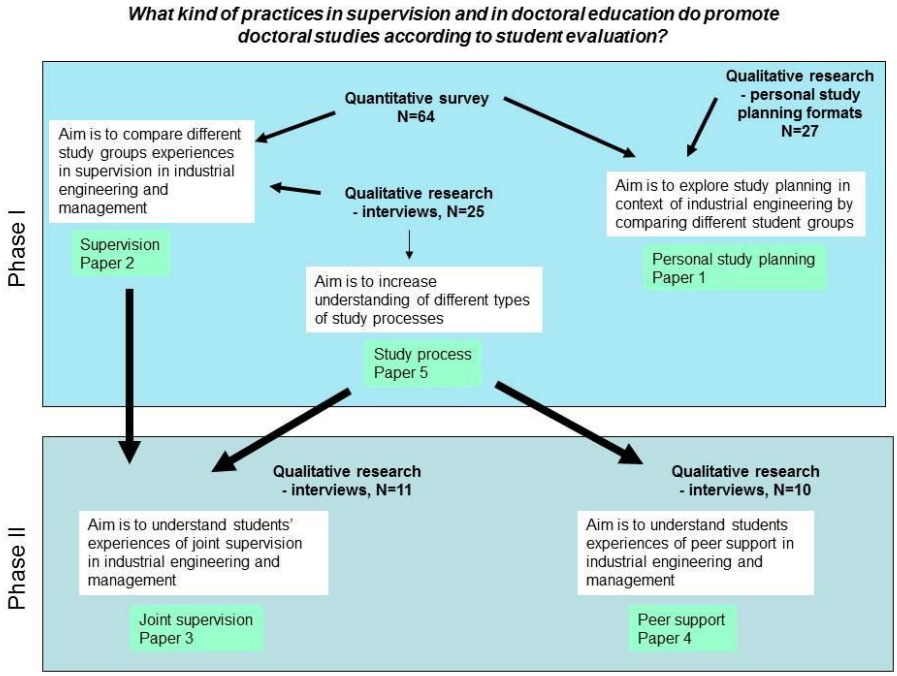

Figure 2. Research design

4.2. Case study

In this study the case refers to doctoral education in one department of industrial engineering and management in Finland. There are five university departments in Finland where education in industrial engineering and management is provided aiming for technical degree, being Aalto University (earlier Helsinki University of Technology), Tampere University of Technology, Lappeenranta University of Technology, University of Oulu, and Åbo Akademi. Aalto University has provided the education on industrial engineering since the 1908, although industrial engineering and management became an independent department in the year 1996. Earlier, the education and research of industrial engineering and management were organized as part of the Department of Mechanical Engineering, and named the Institute of Production Economics, consisting of the laboratories of Industrial Management, Work Psychology, and Information Processing Science. In 1987 the Laboratory of Information Processing Science was transferred to the newly launched Department of Computer Science. With the organizational restructuring of Helsinki University of Technology in 1996 the status of the Institute of Production Economics was upgraded to the Department of Industrial Engineering and Management, now complemented by

the Institute of Strategy and International Business (Olkkonen 1997). At the time of the study, during the years 2008-2009, the department was part of the Faculty of Information and Natural Sciences of Helsinki University of Technology. Since the beginning of the year 2010, the department has been a part of the Aalto University School of Science.

Besides being one of the oldest industrial engineering and management units in Finland, the department is the biggest one when completed doctoral degrees are considered. When the amount of completed doctoral degrees in industrial engineering and management in the five universities are examined during the years 2002-2011, the results show that the 43% of doctoral degrees completed were awarded in Aalto University (Table 2). At the time of the study, there were over 150 active doctoral students at the department. Therefore, for the single case study, the Department of Industrial Engineering and Management in Helsinki University of Technology was a convenient choice.

Table 2. Doctoral degree completed in industrial engineering and management[2]

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*T*
HUT	13	17	9	10	7	11	9	15	17	13	121
TUT	1	3	8	9	-	6	6	4	6	4	47
LUT	5	5	5	6	10	9	7	7	5	10	69
UO	0	1	3	2	3	5	3	8	6	7	38
ÅA	-	1	-	1	1	-	-	2	1	1	7
Total	**19**	**27**	**25**	**28**	**21**	**31**	**25**	**36**	**35**	**35**	**282**

HUT Helsinki University of Technology, TUT Tampere University of Technology, LUT Lappeenranta University of Technology, UO University of Oulu, ÅA Åbo Akademi

At the time of the research, during the years 2008-2009, in the department, prospective doctoral candidates applied for the doctoral program once a year and the applications were reviewed, prioritized, and decided upon by the faculty. Doctoral students organized their own funding either through a research team in the department or nearby research institutes, or through industrial employment or scholarships. The doctoral program was organized in a flexible manner, and doctoral students could agree on their unique studies with the professor; these were based on an individual

[2] Sources: The Finnish Doctoral Program in Industrial Engineering and Management, Annual Report 2005, Annual Report 2007, and http://legacy-tuta.hut.fi/DPIEM/dissertations.html

study plan. The traditional apprenticeship model of doctoral education, with an informal-to-formal working alliance between a supervisor and a doctoral candidate, was in use in the department. There were 16 professors in the department whose responsibility it was, among other things, to supervise doctoral students. Additionally, an additional supervisor might be nominated for the student if the thesis topic or methodology required expertise other than that of the supervisor. In the department, both full-time and part-time doctoral studies were possible, with similar degree requirements. However, full-time doctoral students were expected to complete their doctoral degree in four years, whereas part-time doctoral students' degree completion goal might vary between four and ten years. A majority of doctoral students (almost 70%) took their doctoral studies on a part-time basis whilst employed by another organization.

The department was also a member of one of the oldest Graduate Schools in Finland, namely the Finnish Doctoral Program in Industrial Engineering and Management (FDPIEM). As Dill et al. (2006) noted, the practices in graduate schools in Finland vary. Since its beginning the FDPIEM has prioritized funding for those students that are in the finalizing phase of their doctoral thesis. Therefore, instead of granting funding for each student for four years , only up to 8 students yearly got their funding from the FDPIEM, meaning that one student got from 4 to 8 months' funding from the FDPIEM.

4.3. Data collection and analysis

The five papers in this dissertation thesis use four sets of data (Table 3). One of the sets of data is a survey questionnaire conducted in 2008, and the other three sets are interview data gathered during 2008-2009. The interview data, which were analyzed using qualitative methods, were collected as follows: a set of 25 interviews in 2008, a set of 11 interviews in 2009, and finally a set of 10 interviews in 2009.

Paper 1 focuses on personal study planning, using the questionnaire data as a starting point. It follows the sequential explanatory design of mixed methods, where the quantitative data are collected and analyzed, followed by the collection and analysis of qualitative data (Creswell et al. 2003). The quantitative data, the survey questionnaire, represented the priority, while the role of the qualitative data, the

personal study planning formats, was to assist in explaining and interpreting the findings of the primarily quantitative study (Creswell 2003).

Paper 2 also uses the data from the questionnaire survey, focusing on the students' experiences of supervision. In addition, Paper 2 also contains qualitative interview data. The aim was to use a mixed methods strategy by integrating the information from the quantitative survey and qualitative interviews into the interpretation of the overall results. The two methods in this study were given equal priority, and an attempt was made to confirm and cross-validate the findings within a single study with two different methods (Creswell et al. 2003).

For Paper 5, where doctoral students' study processes were under investigation, the qualitative research approach was adopted. Qualitative researchers are interested in understanding the meaning people have constructed, that is, how people make sense of their world and the experiences they have in the world (Merriam 2009).

The research interview respondents organized their replies into long stories forming the sequential and structural features characteristic of narrative accounts (Riessman 2007). People tend to make sense of experience by casting it in narrative form (Bruner 1991), so the narratives are stories of lived experiences (Patton 2002). As the narrative approach uses the stories as data, the use of a narrative research method to explore the different study paths of doctoral students was selected. In this study the narrative approach was used in data analysis, to be precise, a comparative approach interpreting similarities and differences among doctoral students' study path stories (Riessman 2002).

While supervision in general was studied in Papers 1 and 2, a need appeared for a greater understanding of the issue, to be precise, joint supervision practices. Therefore more qualitative interview data were collected that focused totally on students' experiences of joint supervision during their studies. The study is reported in Paper 3. The qualitative research approach was selected in order to gain an understanding of the meaning supervision has for the doctoral students. The meaning is constructed by the doctoral students as they engage with the world they are interpreting (Merriam

2009). The data were analyzed using qualitative content analysis (Miles & Huberman 1994).

The results of supervision in Papers 2 and 5 showed another interesting issue not studied earlier in this study, namely peer support. As with Paper 3, in Paper 4 too the qualitative approach was selected in order to gain an understanding of the meaning peer groups have for doctoral students during their doctoral studies. Therefore, interviews with doctoral students were conducted to get more information about the peer support students may have during their doctoral studies. The data were analyzed using thematic analysis (Boyatzis 1998).

Table 3. Summary of the research questions, research design, and data

	Paper 1	*Paper 2*	*Paper 3*	*Paper 4*	**Paper 5**
Title	Personal study planning in doctoral education	Students' experiences of supervision in doctoral education in IEM	Joint supervision practices in doctoral education – A student experience	Communities of practice supporting doctoral studies	Different types of doctoral study processes
Specific research question	1. How do doctoral students use and experience personal study planning? 2. How do doctoral student groups differ from each other in their experience of personal study planning and study satisfaction?	1. How do doctoral students in IEM experience supervision in their doctoral process? 2. How do different student groups differ from each other in their supervision experiences?	1. What kinds of experiences have doctoral students encountered in joint supervision during their doctoral studies? 2. What kinds of joint supervision practices do doctoral students describe? 3. How do doctoral students perceive the work of their supervisors?	1. What kind of experiences do doctoral students have of participating in small groups and in which ways has this participation contributed to their doctoral studies? 2. How did the participating doctoral students experience the development of the study group?	1. What kinds of individualized doctoral processes do doctoral students go through? 2. What kinds of factors promote or delay the progress of doctoral studies?
Research design	Empirical, quantitative, qualitative	Empirical, qualitative, quantitative	Empirical, qualitative	Empirical, qualitative	Empirical, qualitative
Data	Doctoral student survey data (n1=64 ; RR*=31%), and returned personal study plans of doctoral students (n2= 27)	Doctoral student survey data (n1=64 ; RR=31%), thematic interviews (n3=25)	Thematic interviews (n5=11)	Thematic interviews (n4=10)	Thematic interviews (n3=25)
Student groups	Newcomers – oldtimers; average – advanced study planners	Part-time – full-time; newcomers – oldtimers; beginners – proceeders - achievers	Full-time – part-time	Full-time – part-time	Full-time, part-time, graduated
Data analysis	Statistical testing, content analysis	Statistical testing, qualitative content analysis	Qualitative content analysis	Thematic analysis	Narrative analysis
Data collected by	Miia Martinsuo, Erika Sassi, Katja Lahenius	Miia Martinsuo, Erika Sassi	Katja Lahenius	Katja Lahenius	Erika Sassi

5. Empirical results

The empirical research of this dissertation included five original studies reported in five peer-reviewed publications. Within this section these five publications are reviewed in terms of their specific research logic and key results. The aim of this study was to explore in depth the experiences of doctoral students in doctoral studies within one department, using the single case study strategy and using both quantitative and qualitative research methods.

5.1. Paper 1: Personal study planning in doctoral education

The study proposal arose after personal study planning was adopted in the department. Six months after its adoption a questionnaire including issues related to study planning was conducted. Because empirical evidence on adopting, using, and experiencing personal study planning in doctoral education was missing, the purpose was to study how doctoral students experience and use personal study plans. In particular, the interest was in how different student groups differ in their experiences of personal study planning and study satisfaction. The personal study planning format provided by the department was used as the additional data while the usability of that format was being evaluated.

The first research question inquired how doctoral students use and experience personal study planning. The aim was to find out if the doctoral students had adopted study planning and if they had used the format provided by the department. According to the survey results, the overall experiences with study planning were rather positive regarding the status of study planning, its feasibility in terms of the schedule, and faculty support for it, supporting the findings of earlier research (Annala 2006). The respondents were less satisfied with the usability of the template offered for study planning. To judge from the analysis of the returned study plan forms, the templates did not necessarily support the students' needs fully, which was reflected in the large proportion of students modifying the template[3] for their own use.

[3] For the study planning template, see Appendix 1.

Second, this study explored differences between newcomers and oldtimers and average and advanced study planners and identified some differences in control variables and in study planning, study satisfaction, and the initiation and progress of their thesis. The results revealed that, despite different backgrounds and study experiences, differences in study planning between newcomers and oldtimers were not found. Instead, it was discovered that advanced study planners tended to be more satisfied with most aspects of study planning, their studies in general, and the initiation and progress of their thesis than were average study planners. As advanced study planners consistently had more favorable experiences with most aspects of study planning, study satisfaction, and the initiation and progress of their thesis than average study planners, the results suggest that strong study planning is associated with study satisfaction. The present findings lend support to the context-dependency of study planning, suggested in prior research (Fry et al. 2002; Clegg & Bradley 2006a)), and the need to modify and update the study plan when studies progress (Fry et al. 2002). The matching study planning experiences between newcomers and old-timers may indicate that the different student groups have been able to fit study planning to their unique needs.

Key findings:

1. Students had a positive attitude towards personal study planning.
2. Advanced study planners were more satisfied than average study planners.
3. The results of this study highlight students' skills of planning their studies, scheduling them, and taking responsibility for their own learning.

5.2. Paper 2: Students' experiences of supervision in industrial engineering and management

It has been recognized that supervision is one of the most important factors affecting doctoral students' study success. Therefore, the second study focused on the experiences of doctoral students of supervision. The data for this study contain both survey and interview data which were obtained during the development project in the department. The study compared different student groups' experiences of supervision: full-time students vs. part-time students, newcomers vs. oldtimers, and beginners vs. proceeders vs. achievers.

The results suggest that full-time and part-time doctoral students and students in different stages of their research differ from each other in their supervision experiences. The interviews highlighted the capabilities of full-time doctoral students who were progressing well to seek and get support from multiple sources, and the part-time students' low degree of perceived support in the early phases of their doctoral process, noted earlier in the research (Martinsuo & Teikari 2008). The questionnaire study largely confirmed the findings gained in the interviews. The findings thereby lend support to earlier research that emphasizes strong support needs in the early phases of the thesis work (see Abiddin & West 2007; C. J. Pole et al. 1997) .

Key findings:

1. Full-time and part-time doctoral students and students in different stages of their research differ from each other in their experiences of supervision.
    a. Full-time students experienced enough supervision, part-time students lacked supervision.
    b. Newcomers – oldtimers: no different experiences
    c. Beginners – proceeders – achievers: different experiences:
        i. beginners perceive a lower degree of instructors' and peer and network support than achievers,
        ii. beginners perceive a lower degree of peer and network support and task support than proceeders;
        iii. proceeders perceive a lower degree of instructor support than achievers.
2. Full-time doctoral students who are progressing well have capabilities to seek and get support from multiple sources.
3. The part-time students perceived lower levels of support in the early phases of their doctoral process.
4. Doctoral students should get more support and guidance in the early stages of their studies, and the supervisor is the most appropriate person to provide that.

5.3. Paper 3: Joint supervision practices in doctoral education – A student experience

After the survey and interviews with selected doctoral students, the issue of joint supervision in the department was acknowledged. As supervision had been noted as an important factor for doctoral students' success, the question arose of what kind of joint supervision practices existed in the department and students' experiences of them. The findings of this study propose that during the dissertation thesis process two or more people can share the supervisor's professional work. Halse and Malfroy (2010), who studied the professional work of supervisors, found five facets that

describe the work: the learning alliance, habits of mind, scholarly expertise, techné, and contextual expertise. The results of this study indicate that these facets can be offered by more than one supervisor, depending on the supervisee's needs. For example, the principal supervisor can take care of the whole process of the doctoral studies or just concentrate on the administrative issues related to the dissertation thesis, while the additional supervisor can offer more focused knowledge and skills to guide and advise doctoral students on the academic content of their thesis. This confirms the notion described by Halse and Malfroy (2010) that joint supervision, advisory panels, or committees in universities will be important in universities in the future.

The results of the study demonstrated three different approaches to joint supervision practices: Complementary, Substitutive, and Diversified. The Complementary supervision and Diversified supervision practices both use the principal and additional supervisors' expertise during the doctoral process in a similar way to committee supervision (see Burnett, 1999), while the Substitutive supervision practice stresses the support and expertise of the additional supervisor. Therefore, the results indicate that there are different practices in joint supervision in doctoral education, which seem to be related to doctoral students' needs for additional resources during their doctoral studies (Frame & Allen, 2002) and especially the scholarly expertise they require (Halse & Malfroy, 2010).

Key findings:

1. Three approaches to joint supervision: the Complementary supervision approach, the Substitutive supervision approach, and the Diversified supervision approach.
2. Students can seek outside supervision support independently, and therefore too much responsibility is laid on students.
3. Student groups: no differences in joint supervision experiences.

5.4. Paper 4: Communities of practice supporting doctoral studies

The study was inspired by the pilot group focused on doctoral students who felt they needed more support with their studies. The pilot group was formed by a senior scientist, who invited part-time students to participate in a study group. Two other known study groups were also under investigation. Therefore, this paper draws on the

experiences of three small groups of doctoral students in order to illuminate the importance of communities of practice in doctoral education in terms of students' perceived experiences of doctoral study. A qualitative methodology was used to explore students' experiences of participating in small groups and ways in which this participation had contributed to their doctoral studies. The data were gathered through thematic interviews (N=10).

The findings of the study suggest that communities of practice, according to students' experiences, can have a positive effect on doctoral students' experience and therefore support their doctoral studies. Especially in the context of an individual research approach to doctoral education (McAlpine & Norton 2006), communities of practice in the form of study groups can offer additional support to doctoral students (Chiang 2003), and create channels for students to achieve greater contact with the scientific community.

Key findings:

1. Different kinds of study groups can play an important role in students' positive experience and sense of belonging to a broader scientific community.
2. Peer students can provide additional support during the doctoral studies.
3. Student groups: part-time students need help with making contacts with their peers.

5.5. Paper 5: Different types of doctoral study processes

The flexible doctoral education system enables doctoral students to complete their studies in a unique and personalized way. The aim of this study was to explore doctoral students' study paths in the department, and investigate the factors affecting the progress and delays during their doctoral studies. Therefore interviews with selected doctoral students and doctors were conducted. The results suggest that there are three groups of study processes that doctoral students go through in industrial engineering and management: the Project Manager, the Wanderer, and the Hobbyist. These three groups differ clearly in the doctoral students' experiences of support and supervision during their specific doctoral processes. The Project Manager process demonstrated meta-cognitive skills that are characteristic of self-regulated learners: the student is motivated, can plan his learning, and is also able to self-monitor and regulate his learning (see Pintrich 2000; 2004). Further, the results suggest that all the

study process groups have the potential for success, as well as the danger of suffering from delay, but in different ways. The students' resources and goal-orientation in doctoral studies need to be high to promote the students' degree progress. Students with good resources in terms of financial, social, and mental support (e.g., Peura 2008) and students with clear goals set in their studies (e.g., Maher et al. 2004) appear to make the best degree progress within a reasonable time frame. The results indicate clear opportunities of influence for the faculty in the form of offering clear pre-defined research objectives for students, and allocating funds for full-time doctoral studies, which thereby directs and promotes the path towards the Project Manager-type doctoral process.

The interviews highlighted that self-management skills and a strong commitment have a powerful impact on a student's behavior and development. The results affirm that students that act as self-regulated learners acknowledge their responsibility in making learning meaningful and monitoring themselves. Further, the results indicate that doctoral students with different doctoral processes differ in the ways in which they manage problems and risks faced during doctoral studies. Each of the alternative study processes revealed the need for more structure and follow-up in doctoral studies in some way. A doctoral study system that allows quite considerable freedom for the students also creates requirements for the students to act as independent knowledge seekers and creators. As Gardner (2008) states, the students need support in the process of transition to becoming independent researchers. The existing structures and persons supporting the transition promote this process. Especially in the early phases of studies, guidance and support are expected (Gardner, 2008).

Key findings:

1. There are three groups of study processes that doctoral students conform to in industrial engineering and management: the Project Manager, the Wanderer, and the Hobbyist: they vary according to the student's working methods, use of supervisory and peer support, and goal-orientation.
2. Student groups: part-time students have difficulties in making progress: time resources, problem management
3. Students need guidance and support, especially in the early stages of their studies.
4. Students need to gain self-management skills and help with them during the process of becoming independent researchers.

5.6. Summary

The overall findings of this study can be summarized by stating that all doctoral students need support and guidance during their studies, but especially in the early stages (Table 3). The findings showed that different student groups experienced different kinds of support. The experiences of part-time students and full-time students were particularly different: part-time students perceived themselves as receiving lower levels of support than full-time students. The advanced study planners also differed from the average study planners in terms of their perception of the support they received. Beginners also perceived themselves as receiving less support than achievers and proceeders. The results indicate that departments should create systematic structures to offer doctoral students guidance and support, for example a more systematic structure in supervision. Further, the findings indicate that the students need to take responsibility for their own studies, be committed, and have enough time resources to complete their degree. To help students to become independent scholars departments should also pay attention to helping students to gain self-management skills.

Table 3. Summary of findings.

	Paper 1: *Personal study planning in doctoral education*	***Paper 2:*** *Students' experiences of supervision in doctoral education in IEM*	***Paper 3:*** *Joint supervision practices in doctoral education – a student experience*	***Paper 4:*** *Communities of practice supporting doctoral studies*	**Paper 5: Different types of doctoral study processes**
Specific research question	1. How do doctoral students use and experience personal study planning? 2. How do doctoral student groups differ from each other in their experience of personal study planning and study satisfaction?	1. How do doctoral students in IEM experience supervision in their doctoral process? 2. How do different student groups differ from each other in terms of their supervision experiences?	1. How do doctoral students experience joint supervision practices? 2. How do doctoral students perceive the work of their supervisors, if receiving joint supervision?	1. What kind of experiences do doctoral students have of participating in small groups and in which ways has this participation contributed to their doctoral studies? 2. How did the participating doctoral students experience the development of the study group?	1. What kinds of individualized doctoral processes do doctoral students go through? 2. What kinds of factors promote or delay the progress of doctoral studies?
Student groups	Newcomers – oldtimers; average – advanced study planners	Part-time – full-time; newcomers – oldtimers; beginners – proceeders - achievers	Full-time – part-time	Full-time – part-time	Full-time, part-time, graduated
Key findings	Students had a positive attitude towards personal study planning. Advanced study planners were more satisfied. The results of this study highlight students' skills of planning their studies, scheduling them, and taking responsibility for their own learning.	Full-time and part-time doctoral students and students in different stages of their research differ from each other in their supervision experiences. Full-time doctoral students who are making good progress have capabilities to seek and get support from multiple sources. Part-time students perceived themselves as receiving less support in the early phases of their doctoral process. Doctoral students should get more support and guidance in the early stages of their studies, and the supervisor is the most appropriate person to provide that.	Three approaches to joint supervision: the Complementary supervision approach, the Substitutive supervision approach, and the Diversified supervision approach. Students can seek outside supervision support independently, and therefore too much responsibility is laid on students. Student groups: no differences in joint supervision experiences.	Different kinds of study groups can play important roles in students' positive experience and the sense of belonging to a broader scientific community. Peer students can provide additional support during the doctoral studies. Student groups: part-time students need help with making contacts with other peers.	Three groups of study processes that doctoral students go through in industrial engineering and management: the Project Manager, the Wanderer, and the Hobbyist: varied in terms of student's working methods, use of supervisory and peer support, and goal-orientation. Student groups: part-time students have difficulties in making progress: time resources. Students need guidance and support in the early stages.

6. Discussion

6.1. Doctoral students' experience of support

The objective of this research was to contribute to the question of how doctoral programs or departments could support doctoral students during their studies by answering the question of what kind of practices in supervision and in doctoral education do promote doctoral studies according to student evaluation. This study was able to find doctoral students' different experiences of support during their studies in the context of one university department that has relied on the individual study program structure. This context is different from the Anglo-American one, which has been well represented in recent research related to doctoral education. As the previous research had identified several sources of support for doctoral students during their studies, this study focused on three of them: supervision, study planning, and peer students.

This study described a doctoral education system at the departmental level with a tradition focusing on a unique and individual approach to doctoral education that relies mainly on the dyadic relationship between supervisor and student. The earlier studies were mainly conducted from a positivist perspective (Girves & Wemmerus 1988; Kluever 1997; Zhao et al. 2007); this one, however, provides not only quantitative but also qualitative empirical evidence of students' experiences of supervision. In the line of the previous research (Peura 2008; Pole et al. 1997; Chiang 2003) the results of the studies that concentrated on students' experiences of supervision showed that in an individual study program, as in the context of this study, the supervisor or supervisors are the most important sources of support. Although supervision has been one of the most studied issues in doctoral education (McAlpine & Norton 2006), this study broadens the understanding of the supervision by providing empirical evidence of different student groups' experiences of supervision, namely part-time students vs. full-time students. The findings of this study revealed that full-time students who progressed well had better capabilities for seeking and getting supervision support, and therefore experienced more support from their supervisors than the part-time students. Moreover, the part-time students perceived themselves as receiving less supervision support, especially in the early stages of their doctoral process, which supports the findings of Martinsuo (2007),

when she studied delayed studies of part-time students. Further, the full-time students also sought support from the wider scientific community, which implies that they had the skills and capabilities to take responsibility for their own study process. This is in line with the previous research on undergraduate students (Heikkilä & Lonka 2006; Pintrich 2000) and doctoral students (Maher et al. 2004), which indicated that full-time doctoral students were active participants in their academic performance.

The individual structure of doctoral education emphasizes supervisor-student relationships as being at the core of doctoral education. Supervision practices differ because the practice of supervision has been based on the assumption that once a doctor has experienced the process by himself, he is able to supervise others, suggesting that supervisors automatically become effective supervisors themselves once they have completed their doctoral degree. As a result, supervisors often repeat the master/apprentice approach to supervision they themselves experienced as students (Manathunga & Goozée 2007). However, the earlier research has identified problems associated with single supervision practices. Therefore, as Malfroy (2005) suggests, the supervision practice should be seen in a more collective way. While the earlier research on supervision gave less attention to joint supervision practice, this study brought new insights into the support that students experienced when they had more than one supervisor proposing three different practices of joint supervision. The results of the study highlighted several benefits that students experience when they had more than one supervisor. Students can get support from multiple sources and the additional supervisor can provide special knowledge and competence, as Spooner-Lane et al. (2007) earlier recognized. The joint supervision practice also ensures that students have access to at least one senior researcher at any time (Frame & Allen 2002). While using the joint supervision practice, part-time students in particular could benefit by gaining a greater feeling of contact with the department or doctoral programs.

McAlpine & Amundsen (2011) suggest that besides the supervisor, there are also other sources of support that are important for doctoral students. They name family members, friends, and peers as being important sources of support. This study also provided a deeper understanding of the experience of support provided by peer students, and therefore supports the findings of earlier research on the importance of

peer support during doctoral studies (Devenish et al. 2009; Martinsuo & Turkulainen 2011). Peer students, who have been almost completely neglected by departments and doctoral programs, can provide students with support in many ways, both mental and scientific. Additionally, the findings of this study showed that the experiences of peer support of the full-time and part-time students were varied, as the full-time students have better opportunities to be in contact with peer students and therefore develop activities that support their learning. The study groups formed by the full-time students provided a community which acted as a source of both academic and social support.

This study demonstrated the support needs that doctoral students have during their study path. Although it identified differences between student groups in their support needs, common support needs for all different student groups can be identified. As the earlier research has suggested (Abiddin & West 2007; Peura 2008), effective supervision is important for the successful completion of the degree; students need advice and guidance in doing research. This study demonstrated that advice and guidance are especially important in the early phases of the doctoral study path, something not highlighted in the previous research. Doctoral students that have a clear goal for their study path and sufficient support to help them to achieve this goal will be most likely to make effective progress with their studies, as the Project Manager's study path in this study demonstrated.

6.2. A doctoral student and self-regulated learning

This study has demonstrated how the student's own activity in an individual study program has broadened the sources of support for students. As noted earlier, the individual study program allows considerable freedom for students to take responsibility for their own studies, and also for supervisors to take or not to take responsibility (Frischer & Larsson 2000). The joint supervision practices were mainly the results of the students' own activity in seeking more guidance and advice during their doctoral studies. This indicates that those students had good self-regulation skills, because self-regulation is not an individualized form of learning, but it includes self-initiated forms of social learning, such as seeking help form other persons, for example, peers and teachers (Zimmerman & Schunk 2011). Further, the study on peer support highlighted the full-time doctoral students' capability to seek support from

study groups. Earlier research has shown that self-regulated students often form supportive social environments, for example by joining study groups (Hadwin, Järvelä & Miller 2011). Further, the study of the different study paths that students take in industrial engineering and management also highlighted the students' responsibility for their own learning, and the fact that students' good self-regulated learning strategies support that. Especially the students' capabilities in managing challenges and problems during their doctoral studies seem to affect the progress of their studies, something also noted by McAlpine and Amundsen (2011).

As the previous research has shown (Clegg & Bradley 2006b), personal study planning is a relevant tool in doctoral education; the findings of this study proved that personal study planning was a source of support for doctoral students, because strong study planning was found to be associated with study satisfaction. When they use personal study planning as a tool for reflective learning (Annala 2007), the doctoral students are setting their personal goals proactively and engaging in a self-regulatory cycle for monitoring and adapting their functioning (Zimmerman & Schunk 2011). According to the findings, personal study planning provides support for both part-time and full-time doctoral students.

As doctoral studies are more individualized in nature, there is a need for greater responsibility on the part of the student than in undergraduate study (Gardner 2008). As regards academic support, at the beginning of the studies supervisors should pay attention to students' self-regulated learning strategies in order to recognize those students without good self-regulated learning strategies, because they need more guidance and help to develop their skills and knowledge in learning, as Boekaerts (1997) noted. Therefore, it should be noted that the students should get support to develop these skills in the early stages of their studies so as to become autonomous students that are capable of identifying and searching for the most appropriate support during their studies (Sambrook et al. 2008). At the moment individual study programs relying on the single supervision practice do not support this kind of action. The supervision is seen more as providing scientific and mental support to students, not developing those self-regulated learning skills that would help students to complete their degree in the recommended time frame. However, Mullen (2011) demonstrated how mentoring can promote self-regulated learning and success in doctoral students.

According to her study, the self-regulation processes enable students to control their cognitions and emotions during learning experiences. Especially part-time students would benefit from the development of their self-regulated learning skills, for they need to manage not only their studies but also their working life. All in all, the results of this study indicate that in order to follow a successful doctoral study path, students should act as active agents managing their own study process, for students who display initiative, intrinsic motivation, and personal responsibility achieve particular academic success (Zimmerman 1990).

6.3. Industrial engineering and management as a context of doctoral studies

This study investigated the experiences of doctoral students in the context of industrial engineering and management. Therefore, it raises the question whether the students' experienced were different from the students of other disciplines. The results of this study show, that the students' experiences on supervision were similar to the students in education and social science (Chiang 2003; Gardner 2007), but also similar to the natural science and engineering (Chiang 2003; Pole et al. 1997). This highlights the nature of industrial engineering, that there are traditions from both the engineering and social science. Some students work in the environment similar to engineering, working as team members, with close interaction with their supervisors, while the other students work like in education and social science, with less frequent interaction with their supervisor, almost in isolation, feeling less supported than the engineering students. Usually, the full-time students were the ones that worked in the research projects at the department, while the part-time students worked outside department, without intensive contact to their supervisor or the scientific community.

This differentiation between full-time and part-time students also occurred with the students' experience of peer support in industrial engineering and management. As Devenish et al. (2009) noticed the peer support during the doctoral studies seems to be a hidden, unnoticed practice of doctoral studies. The full-time doctoral students had experiences of peer support, due to the better chances to networking with the peer students than the part-time students. The full-time students had opportunities to organize study groups, and share their thoughts of research during the coffee and lunch breaks. Therefore, it must be noted that the amount of the part-time students is high in industrial engineering and management. These students do their doctoral

studies while working in industry or other organizations. However, as earlier research has shown, students need the sense of belonging to the scholarly community during their doctoral studies (Pyhältö et al. 2009). Networking with peer students would help part-time students to get support for their studies as shown by Devenish et al. (2009).

Further, part-time students usually have only one supervisor during their doctoral studies. Therefore, there might not be a link between their daily work and science. In Sweden, PhDs aiming for a career outside university, the co-operation with industry in doctoral educations has been promoted, meaning that the doctoral students share their time between a university department and a company (Wallgren & Hägglund 2004). In this model of industrial doctor, that can be seen as a professional doctorate according to Kehm's (2009) classification, the dissertation project is expected to have a strong connection to the company involved. There is a supervisor from the university, and in particular informal advising is often shared between the university and the company (Wallgren & Hägglund 2004). This kind of model that would unite the dissertation work with the daily work of part-time students, might also help them to deal with their scarce time-resources to put their studies as reported by (Martinsuo & Teikari 2008).

6.4. Practical implications

This study has practical implications for the departments and doctoral programs that are the providers of doctoral education when developing their doctoral education practices. At the moment the doctoral education system in universities in Finland is a facing enormous change, one of the reasons being the changes in the financing structure of the universities. While earlier the organization of doctoral education was on the departmental level, in the future the organization will be on the school level, in doctoral programs. As noted, there are disciplinary differences in doctoral education. On the school level, there are many disciplines, each with its own unique nature that must be recognized when organizing the future doctoral education system.

The findings of this study highlight the fact that students need support from the beginning of their studies in an individual study program of doctoral education. The

undergraduate system has developed practices to increase student retention that could be adopted by doctoral education as well. Tinto (2009) suggests that academic and social support is what promotes retention, at least on the undergraduate level. He states that a few students enter the university insufficiently prepared for the requirements of university studies. For them, the availability of academic support, for instance, in the form of tutoring and study groups, and social support in the form of counseling and mentoring are important conditions for their continuation at the university. For social support, departments or doctoral programs should establish educational communities that actively involve students with other members of the institution (Tinto 2009). These kinds of communities could be the class of the year community. This could be established by organizing a mandatory course for first-year students in the first semester including several group tasks and group assignments.

When considering joint supervision, it would be beneficial to consider the practices of joint supervision. As seen in this study, when all the supervisors work with the doctoral student equally, there are greater benefits for all the parties involved. For the supervisors the joint supervision practice has been seen to enhance professional development. Reflection on another's practice does not solely have to stem from exposure to 'good' practice; exposure to poor supervision can provide insights into the ways that one wants to practice as a supervisor (Spooner-Lane et al. 2007). All in all, joint supervision should be encouraged in doctoral education where supervisors have many students to supervise or when the students need specific methodological or research field knowledge.

The results of this study showed how personal study planning, which has been a successful tool for students in undergraduate education, could also be implemented in doctoral education. For some supervisors personal study planning might seem to be another bureaucratic system imposed in a top-down manner. However, instead it should be seen as an instrument for the student to manage her/his own learning and study process, and also a tool for supervisors to guide and advise their students during the doctoral process. As the earlier research on personal study planning has emphasized, personal contacts between students and professors are an important form of support (Clegg & Bradley 2006b), because the plan should be reviewed and

updated regularly (Fry et al. 2002) to act as a reflective tool for learning (Annala 2007).

As mentioned earlier, social support is important for student retention. This study provides empirical evidence on the practices of peer support in a contemporary doctoral education system with a tradition of an individual approach. Recently, Walker et al. (2008) argued that doctoral education needs to prepare students for collaborative work, because today and in the future there are and will be more complex problems to solve, which call for multiple perspectives and collaboration. In doctoral education this means peer mentoring in the form of study groups, student-led workshops, team groups, or dissertation writing groups (Boud & Lee 2005). As the findings of this study suggest, peer students can provide support to each other in the sphere of the competencies needed in the scientific community. For example, peer students can provide support while learning the practices of academic discussions. Departments or doctoral programs might also consider designing student tutoring systems, in which experienced doctoral students could share their knowledge with new students and with those who are experiencing challenges and delays, as proposed by Maher et al. (2004). The tutoring system would facilitate students' ability to receive academic and social support from their peer students throughout their doctoral study path. The tutoring system would benefit both student groups: part-time and full-time students. Especially the part-time students would benefit from the tutoring system, because of the increased contacts with the scientific community, which might reduce their feeling of being isolated.

6.5. Evaluation of the study

This section provides an assessment of the study, as well as considerations related to the researcher's role and the data analysis.

As Merriam (2009, 209) states, "all research is concerned with producing valid and reliable knowledge in an ethical manner". There are numerous criteria to assess the rigor of a case study; usually the model of science has used the positivist tradition (Gibbert et al. 2008), where the tests to measure the quality of case study research are construct validity, internal validity, external validity, and reliability (Yin 2002, 33). However, in this study a large amount of the data collected is qualitative in nature.

Sandberg (2005, 43) notes that when using positivistic criteria when justifying the results of qualitative approaches, there is a problem with the underlying ontology and epistemology, which are not accurate. Mixed methods research has also been criticized for neglecting the philosophical grounds and mixing different philosophical positions (Creswell & Plano Clark 2010). The philosophical assumptions behind the mixed methods research design rely on a pragmatic worldview; the nature of reality addresses singular and multiple realities, and the epistemology relies on practicality (Creswell & Plano Clark 2010). Mixed methods research has gained critics for its marginalization of qualitative frameworks, while favoring quantitative ones (Holmes 2006, ref. Creswell & Plano Clark 2010). However, in this study the qualitative interpretative framework dominated, because the research questions required a qualitative approach.

As this study combines quantitative and qualitative research methods, the use of evaluation criteria for mixed methods research is relevant. However, Creswell & Plano Clark (2010) note that at the moment, there is no specific set of criteria for the evaluation of mixed methods research. However, there are several different sets of criteria that could be used for evaluating the quality of mixed methods research. Bryman, Becker, and Sempik (2008) found in their mixed methods study of researchers' perceptions for the quality criteria for mixed methods research that there were four themes concerning criteria that can be applied to mixed methods studies. First, the used of mixed methods needs to be relevant to the research questions. In this study, the general research questions investigated doctoral students' experiences of support during their doctoral studies, and how different student groups differed in terms of their experiences. In investigating these questions, both quantitative and qualitative research approaches were relevant, because these research problems needed to be studied through multiple phases of research that included multiple types of research, and the individual studies in one case needed to be enhanced through adding a second method, as in Paper 1 (Creswell & Plano Clark 2010).

Second, there needs to be transparency about the mixed methods procedures. This means that the researcher, as in all research, should be transparent about the nature and the content of the procedures she/he employs (Creswell & Plano Clark 2010). Therefore, in this study the research processes have been described in detail in each

individual research paper in order to ensure transparency. Third, the findings need to be integrated or mixed, not left as distinct quantitative and qualitative findings. In this study the integration occurred during the interpretation phase of the study, after the quantitative and qualitative data had been collected and analyzed separately.

Fourth, and finally, a rationale for the use of mixed methods needs to be provided. The purpose of using mixed methods research design in this study was, as Bryman (2006, p. 106) suggests, "completeness, which refers to the notion that the researcher can bring together a more comprehensive account of the area of inquiry in which she is interested if both quantitative and qualitative research are employed". Further, through different kinds of data collection strategies, as well as the use of different data analysis methods, the inquiries were linked by a common concern, namely to understand the doctoral students' experiences, and also how those experiences were associated with their doctoral studies and their progress.

Considerations related to the researcher's role

Qualitative research is fundamentally interpretive: the researcher makes an interpretation of the data, the researcher filters the data through a personal lens that is situated in a specific sociopolitical and historical moment (Creswell 2003). Therefore, it is important to identify the biases of the researcher and monitor how they may be shaping the collection and interpretation of data (Merriam 2009). Also while using both the quantitative and qualitative methods, according to Smith (1997, pp. 77, ref. Bazeley 2004) "the inquirer is the instrument, all information flows through a single perspective". Here I will reflect on my background and experiences, so the reader can evaluate my biases or emotions that may have affected my interpretations.

As the perspective of the position of the researcher shapes the research, my position is shaped by my background in education. Education, in general, occurs through any experience that has a formative effect on the way one thinks, feels, or acts. Therefore, while investigating support in doctoral education, I wanted to focus on the issues from the students' perspective and to study their experiences of support. I focused on the individual level, for I shared the constructivist approach to learning that emphasizes the active role of the learner in a certain social context or learning environment.

I am certain that the multiple roles that I have had during this research have affected the choices made during the research process. I have been a doctoral student in the department since the year 2000 and worked in different research projects. For the last three years I have been working with issues related to doctoral education in the department, first as a researcher in a development project and later as a postgraduate study coordinator. Therefore, while being an active member of the research context, I have special knowledge about the context of this study. Second, being a peer student to the research participants has had an effect, especially during the data collection phase. My good relationship with some research participants has been an advantage: I am considered reliable and easy to talk to. However, being too familiar with the participants has also brought some disadvantages, such as during the interviews, when I did not ask enough further questions, and some issues have been taken for granted.

I have also used qualitative research methods earlier while working as a researcher in the department. As Tashakkori and Teddlie (2006) point out, one reason for a researcher to use certain research methodologies is the researcher's own competences. Therefore, in this study, although both quantitative and qualitative research methods were used, I had the main responsibility for the qualitative methods used. Therefore, in every paper there is at least additional material in the form of qualitative material. My background as a researcher has also affected the data collection, as I conducted several research interviews in my earlier studies, although on different topics, but they did focus on individuals' experiences of different phenomena.

Considerations related to data and data analysis

There are three considerations related to data in terms of validity and reliability. First, the data used in this study were collected during a development project related to doctoral education at the department. The data collected during the first phase of this study were designed and collected by two other researchers before I participated in the project. However, while designing the research questions for Papers 1 and 2, as well as for Paper 3, I took an active role. The data collected for Papers 3 and 4 were designed and collected by myself alone.

Second, the qualitative data were analyzed by me only, except in Paper 5. As Merriam (2009) proposes, using multiple investigators would promote validity and reliability in

qualitative research. However, protecting the confidentiality of the participants is one of the most important issues when reporting qualitative results (Kvale 1996). Therefore as promised to the participants in order to secure their anonymity, in the studies of Papers 1, 2, and 3 the other researchers did not participate in the data analysis while the transcripts were being coded. However, the reliability of the analysis was tested with a dialogic reliability check (Kvale 1996), when the co-authors of Papers 1, 2, and 3 discussed the categories and their contents with me.

Third, the qualitative data analysis used in this study includes multiple methods: content analysis, thematic analysis, and narrative analysis. The reason for using different analytical methods relates to the nature of the research questions in each study. The research questions guided the selection of the method for the data analysis. In Paper 1 qualitative content analysis was the most appropriate method for data analysis while the personal study planning templates were under investigation. In Paper 2 content analysis was also used to seek repeated patterns and underlying themes in the interviews, and the transcripts were consistently coded for the supervision experiences of doctoral students. In Paper 3 the qualitative content analysis approach was also selected for the data analysis, in which the purpose was to understand the doctoral students' perceptions of joint supervision. However, in Paper 2 thematic analysis was selected to draw out the experiences, meanings, and the reality of the interviewees concerning the study groups and support experienced from peers. In Paper 5, while the students' unique study paths and factors promoting or delaying them were being investigated, narrative analysis was adopted. This analytical approach enables the voice of each narrative to be heard, generating a representation of the whole research material.

6.6. Limitations of the study and future research

The individual papers included in this study all have their specific limitations, which are discussed in detail in the papers. However, two main considerations should be paid attention to when analyzing the findings of this dissertation. First, the results of this study are highly contextual. As noted earlier, doctoral education is highly contextual in nature, with departmental and disciplinary characteristics. This study focuses only on one department in Finland. Therefore, the findings may suffer from department- and discipline-specific biases. Future studies could investigate the

students' experience of support in different contexts, for example, in other departments and disciplines, and also in other countries. Second, the results of this study provide a snapshot of students' experiences of their doctoral studies at a certain point in time. As noted, the doctoral journey includes different times, some positive and some less positive (Phillips & Pugh 2005; Peura 2008), meaning that the journey can include many different emotions, from misery and anxiety to happier ones, depending on the situation and events at any given point in time. Therefore, the experiences of doctoral students represent the exact time when the research was carried out.

While this study has given an insight into one department's doctoral education, there are several avenues that future research could take. First, there are different aspects of the system of doctoral education, and this study focused only on some of them. This study emphasized the students' own voices and their experiences in doctoral education, but there are other parties that affect the doctoral education system. Future research should get perspectives from all the parties involved in the supervision, including the supervisor or supervisors and students, in order to get a deeper insight into this complex practice.

Second, this study focused on the support that departments or doctoral programs can offer. However, the earlier research also noted that friends and family are important sources of support. Therefore, to broaden the perspective outside academia could expose new sources of support for doctoral students. In particular, part-time students who conduct their studies and research outside the scientific community might find other sources of support important (see Martinsuo 2007). The workplace and one's manager can be a source of support, as can other communities. Therefore, future research should also concentrate on the other sources of support than those provided by the scholarly community, and their effects on the study process should be investigated.

7. Conclusions

This dissertation research was motivated by the need to investigate the different sources of support that doctoral students have during their doctoral studies, in order to provide departments and doctoral programs with a deeper understanding in order to support their students in the timely completion of their degrees. Despite the limitations discussed earlier, this study makes an important contribution to the literature on doctoral education and the support students need during their doctoral study path, suggesting that that besides the single supervisor, doctoral students have other sources of support during their studies that have not been widely discussed in previous studies, such as study planning and peer students and an additional supervisor. Further, this study highlighted the different support experiences and needs of different student groups. Part-time students' poor resources and experience that they received less support from academia mean that their studies are conducted under totally different conditions when compared to the support and resources enjoyed by full-time students. This study also highlights the students' role as active learners, acting as self-regulated learners acknowledging their own responsibility for making learning meaningful and monitoring it. Practical implications for the developers of doctoral education practices that are based on the findings of this study are introduced. As doctoral education is a complex system and this study only covers some of the issues related to it, future research opportunities are also represented.

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