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1. Abstract

This study investigates the role of courses in PhD programmes. It compares five different research groups' views at the Faculty of Engineering, Lund University, Sweden. The views of supervisors vs. doctoral students are further contrasted.

2. Introduction

Courses play a vital role in PhD programs at the Faculty of Engineering, Lund University (LTH). A large part of the PhD programs are dedicated to courses, in some cases up to half of the program. The difference in course requirements for different research subjects at LTH is illustrated in Figure 1. Red and green bars show the number of research subjects that require a particular number of credits for a Licentiate and Doctoral degree, respectively. In this case study, we investigate a number of aspects related to courses in PhD education at LTH: What roles do courses play in the PhD education? What is the value of courses? What kinds of courses do students follow? How are courses integrated with research? How do students find courses? As a basis for our discussion, we have performed five different cases studies, one at each of the departments of Automatic Control (AC), Combustion Physics (CP), Engineering Logistics (EL), Ergonomics and Aerosol Technology (EAT), and Packaging Logistics (PL). By interviewing supervisors and PhD students, we gained insight into how the main stakeholders in PhD education reason about courses − both perspectives are of interest, in particular given the focus on courses in most programs.
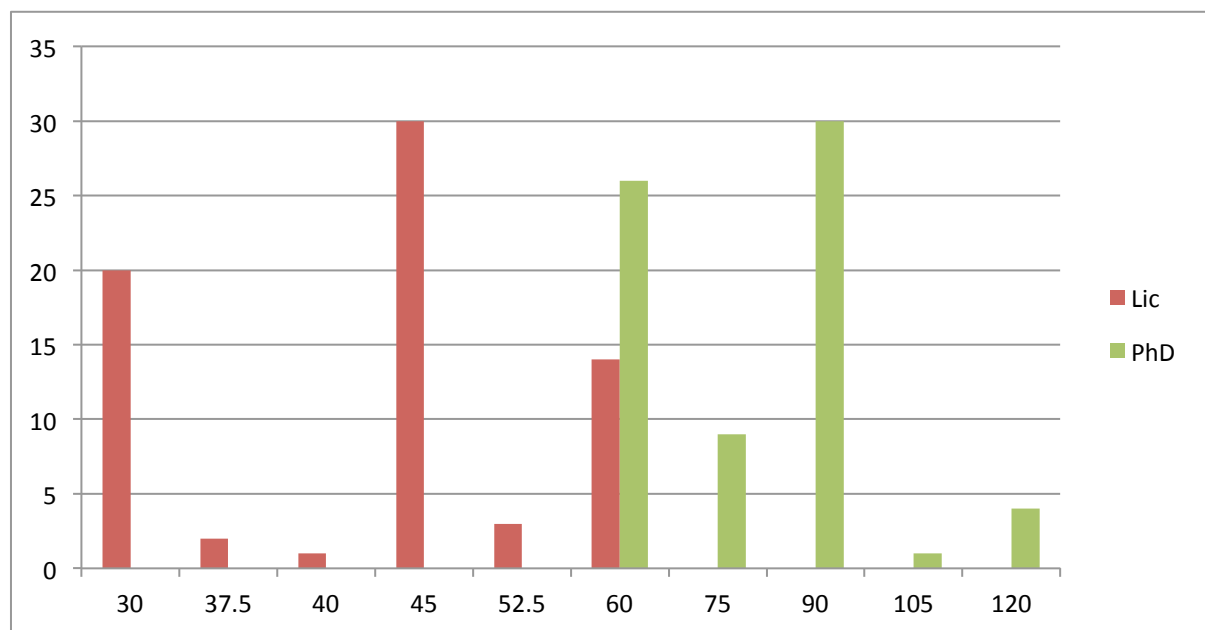

Figure 1 Course requirements in research subjects at LTH (HP).

3. Methodology

To explore the role of courses in the PhD education, a case study was performed. The main reason for conducting a case study is to gain an in-depth understanding of a phenomenon being studied [1]. The case study method was also considered appropriate since it is an emerging empirical topic with a lack previous investigations and literature. According to Ellram [2] "A case study methodology [. . .] provides depth and insight into a little known phenomenon".

In this investigation, a holistic multiple-case study was conducted [cf. 3]. The role of courses in the PhD education was explored in five cases. These cases were primarily chosen based on the authors' affiliation, enabling data access and opportunity to use the authors' previous observations and insights into the research groups. To gather data, semi-structured interviews were conducted with PhD students and supervisors. The PhD students interviewed where at different stages in their education and the supervisors experiences ranged from one to more than 30 years of experience. Table 1 summarizes the number of individual interviews carried out. The collected data was put through a within-case analysis resulting in "case study writ-ups for each site [4]". The five case descriptions from the within-case analysis are presented in the following section. Finally, a cross-case analysis was carried out to identify patterns among the cases.

Table 1. Individual respondents interviewed in the case study.

	AC	CP	EL	EAT	PL	Total
PhD students	6	5	5	5	4	25
Supervisors	4	2	3	2	3	14

4. Case study descriptions

For each case, the context (research group) is briefly presented followed by description of how PhD students and supervisors view the role of courses in PhD education. Table 2 explains the required amount of higher education credits for a Licentiate or a PhD degree at the five research groups. Table 3 specifies the current number of PhD students and supervisors at the investigated research groups.

Table 2. Required amount of higher education credits for a degree.

	AC	CP	EL	EAT	PL
Licentiate	120	120	120	120, 120	120
Courses	60	≥37,5	60	60, 40	60
Thesis	60	≥60	60	60, 80	60
PhD	240	240	240	240, 240	240
Courses	120	75-120	120	90, 75	90
Thesis	120	≥120	120	150, 165	150

Table 3. PhD students and supervisors at investigated research groups.

	AC	CP	EL	EAT	PL
PhD students	31	24	12	14	11
Supervisors	11	7	5		5

4.1 Automatic Control

The department reached a position as a world-class research institution in the field of AC in the 70s and 80s. Today, the research at the department ranges from fundamental theory development in systems science, e.g., distributed control and estimation, to industry applications. Applications include robotics, process control, combustion engine control and

networked control systems. The courses taken by PhD students can be roughly divided into three categories. Firstly, the department offers a number of core courses (four to five) on a regular basis, which most PhD students follow. These courses typically consist of a series of lectures, exercises and a take home exam. Secondly, courses are given at the department based on the interests of the department faculty or visiting guests. These courses are often given in the form of short courses or a series of seminars. Thirdly, PhD students take courses at other departments at LTH, e.g., at the department of mathematics or the department of computer science. In some cases PhD students can convalidate courses from their master's degree, if they are considered to be of relevance to the research subject by their supervisor.

Supervisors

All interviewed faculty describes the process where PhD students selects courses as informal and largely driven by the individual students. The supervisors do not seem to take active part in the students' choices but rather provide advice and support. This view is emphasized by the lack of formal requirements to take mandatory courses in the PhD program. Four main drivers that influence the selection process were brought forward: *i)* what courses are offered at the department, *ii)* student peer input in course selection, *iii)* individual needs of students in their research projects, and *iv)* student personal interests. As for iii), individual needs are met by courses at other departments, e.g., theoretically oriented students often take courses in mathematics and students in projects oriented towards software may take courses in computer science. The individual freedom in the course selection is considerable.

Supervisors agree that the two main roles that courses in the PhD program is to provide students with knowledge needed to perform their research as well as with broader knowledge in the field. The role of the core courses offered by the department is to provide students with theoretical and practical skills in the field of automatic control. In general, supervisors are confident that the core courses serve their purpose; all students in the program get the required knowledge in the research subject. Also, most supervisors think that the needs in terms of courses to support students' research are fulfilled. However, when it comes to composing a good course package to give a broad education in control, the common view seems to be that this is very much up to the individual student. One supervisor also raises the issue that the department itself or the neighboring departments cannot always offer suitable courses needed to support the PhD students in their research projects.

PhD students

The interviewed PhD students' description of the process of choosing courses does not differ significantly from that of the supervisors. What courses the department offers seems to be the single most influencing factor for what courses students select. Most of the interviewed students emphasize the individual freedom to choose courses that they experience in positive terms. A common comment is that courses should serve a two-fold purpose: on one hand to provide broad knowledge in the main research subject and in related subjects and on the other hand to provide knowledge needed to carry out research. The descriptions of what role the courses *actually* play in their PhD program differ, however. One of the interviewed students said *"I see the courses as a way of preparing myself for an industrial career"*. Another one argues *"I take courses where I believe I will be inspired in my research"*. Despite the differences in the descriptions, almost all of the interviewed students claimed that in practice, the main focus in the course part of their education has been on broadening their knowledge rather than taking in depth courses directly supporting their research. In some cases, this seems to have lead to a situation where students found themselves doing double course work: taking courses for credits and learning material on their own because it was needed in their research, but without getting course credits. When asked about their priorities for future

course preferences a majority of the interviewed students answered that they would prioritize courses that supported their research.

Summary

The students' choices of courses at the department of AC are characterized by a large degree of freedom to tailor the course package to individual needs and preferences. Supervisors and students convey the same view in this respect. The actual choices are governed by what courses are offered at the department, by individual interests and concrete needs to carry out research. In practice, the freedom enjoyed by the students seems to result in individual course packages mainly focusing on broad knowledge in the research subject and related subjects. Despite the relatively large course requirement, students and supervisors agreed that no or only a small decrease in the requirement would be appropriate. It is interesting to note that none of the interviewed supervisors or students mentioned pedagogical courses, although all PhD students take at least one introductory course in the subject.

4.2 Combustion Physics

The division of Combustion Physics sprung form the division of Atomic Physics in the 90's and has two major research directions; one in chemical kinetics and one in laser diagnostics. Most of the financial support is external and the tie to industry is strong, especially with companies such as Siemens, Volvo and Scania. The research is therefore to a large part applied or application driven. The division, however, has also one part that is more fundamentally oriented, working with more fundamental studies and development of techniques to be applied in a more distant future. In the general study plan for physics the total amount of courses to be taken must not be less than 75 credits and not exceed 120 credits. CP is more specific on each of these, see specifications in brackets:

- 15 (15) credits of fundamental physics courses to ensure breadth
- 7,5-22,5 (7,5) credits of general courses, not directly associated with the subject such as, programming, communication skills etc.
- 37,5-52,5 (37,5) credits relevant for the thesis work - depth

The Department of Physics permits the students to convalidate up to 30 credits from their Master, the supervisor and the Dean of Studies have to approve on the convalidated courses.

Supervisors

There are no mandatory courses, however, master courses given by the division are considered a policy to take (if not taken during the Master), expressed in the quotes "*It should be a living discussion throughout the program – in order to fit the students' need and "toolbox"; and that "the courses are chosen in accordance with the general study plan". All students were aware of this but sometimes it is not clear in which category a certain course fits, but "one course might fit into one category for one student and in another for the other student depending on the project", meaning that a discussion concerning each course is vital. The purpose of the courses is seen as a way to document the knowledge and skills that is needed during the PhD and in order to fulfil the requirements for a finished PhD (i.e. theory, methods and transferable skills such as communication and writing skills), "They aid and guide the students and help them to focus" and "It helps to fulfil breadth and depth, gives both overview and detailed knowledge, but can also act to increase the students' network between departments and even faculties". The role of the courses is seen as a way to help the students get started and to give them an overview, later to stress certain skills and knowledge, both important for the thesis work but also for preparing the student for a life after the degree. All supervisors state a need for more PhD courses, and that an incentive is needed to prepare those courses. They also felt, that a way to make PhD courses visible across LTH would help

in the process, however, nobody wants standardized courses, they should in general be flexible in order to fit the need of a specific student.

Students
When choosing a specific course the students have a common approach, it should, to a large extent, be courses that are vital to their research project. They all state breadth and depth as being important objectives but one student clearly states "*I seek breadth, not only in physics but I also look for courses that I think will be of use after I'm done here at the university*", meaning that transferable skills and project management skills are important. Most students start with Master courses related to the subject in order to establish an overview of the field, the way courses are chosen are then shifted towards more specific courses and courses with transferable skills. Several of the students are critical to the courses, e.g. PhD students saying that "*The courses have mostly just increased the workload without being of much help*", as well as "*I've gotten a better breadth but in general I haven't had much use of the courses. The depth is gained through papers and discussions*". It is easy to spot some frustration, the general feel among the students are that the research is their first priority and that the courses are not worth the effort. All the students pointed out the lack of PhD specific courses with more flexibility. Most of them also pressed that it would be helpful to have some sort of overview of the PhD courses given at the University especially by collaborative departments.

Summary
The views of the supervisors and students are very similar in many respects. The students find the courses. The courses are then chosen through a discussion with the supervisor. For the students there seem to be a clear pattern where master courses are chosen in the beginning (breadth), together with pedagogical courses, and later more specialized courses (depth) together with courses focused on communication skills and project management. Both students and supervisors address the lack of courses directly directed towards PhD students, more flexible both from a timetable and a content point of view, and a system to find these courses (on a department level or perhaps on a faculty level). The students and supervisors agreed upon that the course requirements of 75 credits is the absolute upper limit, the students thought 60 credits would be more suitable, as they claim that many of the skills are acquired along the way anyway. As one supervisor put it, "*After five years of courses we know how to pass a course, it's asking the right questions and formulate the problem that you need to learn, that's where the research lie*".

4.3 Engineering Logistics
The division of Engineering Logistics has about 30 employees, of which about 5 act as supervisors and 10-12 are PhD students. Much of the financial support is external and comes through various projects with industry, regional and national governmental bodies and authorities. Much of the research is industry or transport policy driven. In the general study plan for engineering logistics courses make ½ of total credits (120/240) within the PhD education. These are divided between three categories: methods, core "logistics" courses, and transferable skills (communication incl. pedagogical skills). Credits can also be given for project work that is not a direct part of a thesis. The Department of Industrial Management and Logistics requires at least 60 credits of courses in the student's major (production economics or logistics) prior to admittance, otherwise complementary courses are required. All students are required to take a licenciate degree on the way to their PhD.

Supervisors
Supervisors refer to a number of frameworks guiding the choice of doctoral courses, including the general study plan of the department, the national (Swedish) course curriculum in

logistics, the plans of a former graduate school in logistics (even though it ceased to exist) and course frameworks also at other universities in Sweden. That said, there are practically no specific courses required and no programme of courses given on a regular basis. It is up to doctoral students to suggest courses to be taken, which is seen as a way to strengthen their independence. Courses are often given ad hoc at various places, requiring frequent amendments of original individual study plans (ISPs). A specific problem is the sole availability of social science methods courses, delimiting students to using those.

Generally, supervisors stress the importance of courses to increase the breadth of knowledge within the field of logistics. This goes as far as to see the thesis itself representing in-depth knowledge, and not encouraging students to take (many) courses that are directly applicable to their research problem, also as to avoid duplications of credits within PhD studies. Further important aspects of courses are networking, introduction to the research community but also the documentation of the skills and knowledge of doctoral students for their further career. Courses in "transferable skills", methods beyond the ones students use and pedagogical courses are encouraged as to "learn the trade" and develop a "researcher mindset". Acquiring factual knowledge is stressed the least, instead, courses are seen as a "scheduled time for reflection". Whilst reading courses were not deemed appropriate any more, they were also seen as a way for supervisors and students to learn together.

PhD students
Doctoral students argued very differently from their supervisors for the choice of their courses. They were frustrated about a lack of structure, ad hoc arrangements, and the most about a lack of courses they felt would directly relate to their research topic. Considering that supervisors argue even against taking such courses it may reduce students' frustration to explain that position to them. Ad hoc arrangements are though indeed a problem, as students need to fit courses with their own teaching load and project work. This situation leads students to reflect on, how one of them expresses it, a *"trade-off between the credits needed and the quality [of courses]"*. Furthermore, doctoral students only argue for the need of factual knowledge acquired through courses. Whilst they acknowledge the networking aspect, this is not deemed important. *"There are other issues as well such as meeting others, discuss about the process, but one can do that in other places as well. Learning is more important."* Generally, however, courses are seen as an important part of PhD studies, even a "guiding line", and most doctoral students would take them even if they wouldn't need to.

Summary
There is a large degree of freedom of selecting courses in EL. This is on one hand seen as flexibility and a way to foster independence, on the other hand as a hinder to plan studies, and even a reason for selecting some perspectives (methods) over others. There is a clash between supervisors focusing on broader knowledge while doctoral students wanting more courses that are relevant to their own theses. Another interesting aspect is the discussion of encouraging doctoral students to acquire "transferable skills" though delimiting them to very few actual credits the students can use of these in their ISP (e.g. max.3 credits of pedagogical courses). At the same time, courses are also seen as a way to document and prove the knowledge students acquired beyond their dissertation – both for finding a job in academia but even if a student drops out of the doctoral programme.

4.4 Ergonomics and Aerosol Technology
The department of EAT has two main research areas with PhD education – ergonomics, and aerosol technology, which are the names of the two compulsory doctoral courses. The department also designs special reading courses suitable to the research of one or a few

students. The division of EAT has fourteen PhD students. Nearly all PhD students at EAT complete a licentiate degree as a step towards a PhD.

Supervisors

All supervisors argue that there need to be a balance between different types of courses and referred to the common study plan which define four fields; 1) Research methodology and scientific theory, 2) In-depth subject courses about the research field of EAT, 3) In-depth subject courses, and 4) Broad subject courses. All supervisors explain three important values of the courses: 1. Knowledge about the specific research question, 2. Knowledge about the process of becoming a researcher, and 3. Knowledge about how to communicate the research, arguing and discuss with students, researchers, journalists etc. The PhD education is considered a socialization process into the academy at several levels where you grow as a person and also learn "how the game is played".

Both the student and the supervisor present and discuss suggestions on courses and agree to include the suitable ones in the study plan. Many of the in-depth courses are designed by the student and the supervisor as a reading course, which is of benefit of both; "*We read and discuss the content, it's a win-win relation since I also update myself in the research field!*". Another aspect is "*It is also more convenient to let more experienced PhD students design a reading course, which also could be given again. Less experienced students' needs more "established" courses*". There are sometime uncertainties during the process and one supervisor suggests "*a PhD course (similar to the docent course) about the supervision process and the different responsibilities among the parties*".

PhD students

The PhD students highlight that there are different types of courses. (1) Courses that provide in-depth knowledge within the research topic are seen as the most important. All PhD students emphasize that these courses should be in the beginning of the education. As one student puts it "*these specific courses helps me to quickly reach the frontline of my research field*". Another common statement is "*these courses are necessary to perform my experiments and analyses*". (2) Courses providing broad knowledge are seen as broadening your horizon, expand the research domain and provide new perspectives on topics. Further courses are given in (3) methods and (4) pedagogy, but some PhD students also include transferable skills in this type of courses. These courses should preferably be in the end of the PhD education.

There are some compulsory courses, about the research field given by the EAT division and about communication and pedagogics given at LTH. These are easy to find, but the LTH courses are sometimes filled up with prioritized PhD students who have reached further in the PhD education. More urgent are the specific courses, however, and these are find by recommendations from the supervisors or colleagues. Many courses are found through the network of the PhD student's research group or their belonging to different competence centres, "*as a member of Metalund I can access and find suitable courses given within this competence centre*". Specific courses are often resolved as reading courses.

Summary

The PhD student applies to a course after a dialogue with the supervisor and the individual study plan is updated. However, sometimes students attend a course without a clearance from the supervisor which could result in difficult negotiations about the value of the course and how it fits into the individual study plan. Several students express an anxiety about the process, i.e. "*There was an uncertainty if the course should pass and the amount of credits even though it was already decided in the individual study plan. But I fought for it!*"

4.5 Packaging Logistics

Packaging Logistics is a relatively new research area in Sweden and internationally, and came into being due to a great need from companies and interest from society in general. The aim of the subject is to contribute to a sustainable society by integrating product and packaging development, innovation and supply chain management in the areas of technology, economics, and environment. As the subject is multi-disciplinary, the supervisors and recruited PhD students have a broad mixture of competences from engineering to business, economics, management and social sciences.

Supervisors

All supervisors argue that there needs to be a balance/mix, or portfolio, between different types of courses. The portfolio is made up by four fields: 1) research methodology and scientific theory (35-40%), 2) pedagogic and leadership courses (10-15%), 3) in-depth subject courses (30-35%), and 4) broad subject courses (15-20%). In what field a course is positioned depends on the individual student and the research topic. For example, if the students want to be involved in teaching, they need to take pedagogical courses. The selection of courses also depends on where students are in the PhD process. In the beginning, research methodology and broad subject courses are introduced, while at the end, leadership and in-depth subject courses are needed. Another aspect in course selection considered by the supervisors is to enable networking by have internal/national and external/international courses.

Supervisors highlight that the selection of courses is often discussed even before the ISP is drawn up. Supervisors see their role as guides: "*In the initial phase of the PhD process it is about guiding into the 'right' methodology courses*". At the same time, the responsibility is in the hands of the student: "*They have great freedom to take courses that fit them*". When it comes to courses that are tailor-made to students' needs, supervisors see the risk of the PhD process becoming "courseified": "*The risk/opportunity that the research becomes 'courseified', i.e. a part of the research, is made as/in a course. For example, there are courses where you write a draft of a paper*".

PhD students

The PhD students highlight that there are different types of courses. According to the students, there are multiple values of having courses in the PhD education. These values relate to three distinct scopes of the education: a specific activity (e.g. study or paper), the final thesis, or the process of becoming a researcher. One student underscored that, "*I choose the course that supports the work best right now or work that I have to do later in the process*". (1) The ones that provide in-depth knowledge in the research topic, are seen as the most important. Common statements among the students are: "*It must provide some value; move the research forward, broaden the perspective, etc.,*" and "*Help you in the research – make it easier*". (2) Others provide broad knowledge related to the research topic. According to the PhD students, these courses broaden one's horizon, expand the research domain and provide new perspectives on topics. (3) Further courses are in research methodology, which improve the students' knowledge and skills in using different research methods, techniques, and tools. The students emphasized that research process skills such as presenting and communicating research also are included in these courses. One PhD students also included pedagogical courses in this category. The distribution of the number of higher education credits among the three types of courses differs among the PhD students. However, all students claimed that they wanted more courses on their research topic.

The PhD students' main problem seems to be finding courses that fit their research topic and process. The underlying reasons for the problem are underscored by the following statement: "*I tried to get an overview of courses that I could take, but there is no summary of the different courses available*". Another student describes the problem by claiming, "*There*

are planned courses and there are ad hoc courses". The planned courses are located at LTH and are easy to access and have a high availability. The courses located outside LTH, however, are often identified in an ad hoc manner through word of mouth, networking, invitations, etc. A less evident value of courses is that of becoming a researcher. Even though the students mentioned this value, their focus was on the final thesis or on a research activity level. One course value, mentioned by all students, is meeting other researchers and expanding their research network. What the supervisors do, related to courses, seems to be limited according to the interviews with the PhD students. The supervisors act as sounding boards in finding courses and sources of information about which ones are mandatory.

Summary

The value of courses is not only the learning outcomes and networking opportunities. The courses also provide an understanding of what it means to become a researcher, understand the research community, and understand what research is and what it is not. The courses are also somewhat guiding, supporting their research process. One supervisor sees courses as a kind of formal and continuous assessment: "*You get a course certificate that shows you really have done something. They can gain motivation, since they can say, 'I have done something this year'*". Moreover, supervisors emphasized that the learning outcomes for a PhD degree are not only completing the thesis. Thus, the learning outcomes from doing the PhD thesis must be complemented by courses.

5. Results and discussion

In the cross-case analysis five interesting aspects where identified, all of which are presented and discussed in this section.

5.1 Types of courses

All departments required a number of different types of courses within their doctoral program. An important discussion evolved around the question whether the courses serve the purpose to acquire broad vs. deep knowledge, i.e. an overview over the subject of the PhD student, or courses tailored to her/his research topic. Interestingly, breadth was though delimited to a variety of courses in the subject only. The lack of Swedish language, society and industry courses was lamented, as in their absence foreign PhD students are difficult to include in industry projects (S2, EL). Generally speaking, doctoral students typically wanted tailor-made courses that would directly relate to their research topic. In other words, they were more interested in "depth" rather than "breadth", quite in contrast to their supervisors who saw a broad range of courses as a necessity to develop as a researcher. To which extent supervisors stressed this point differed though across departments.

Table 4: Courses palette across departments

Type of course	AC	CP	EL	EAT	PL
Methods		X	X	X	X
Breadth	X	X	X	X	X
Depth	X	X	(X)	X	X
Pedagogical	(X)	X	(X)	X	X
Leadership		(X)			X
Transferrable skills		(X)	(X)		

Table 4 illustrates the focus of the different departments in this study across a palette of course types. For example, AC did not place an emphasis on methods courses, which probably resulted from mathematical modeling being used as the sole method in this field. A breadth of courses was required throughout all departments. The question of depth varied,

however. At EL, the thesis itself was considered to cover the aspect of in-depth knowledge, while courses served the purpose to extend the knowledge base of doctoral students.

Which type of courses were taken first, differed across departments. AC, PL and CP started with broad knowledge, which was later narrowed down to more focused courses; EL focused on breadth (mainly), while e.g. EAT started with focused courses and then broadened the perspective. In CP students start with masters and pedagogical courses, i.e. compensating for previous lack of knowledge. Differences arise from the admittance process: at CP and EAT students start with a specific topic and need focused courses to get a head start in their research. In contrast to this, other departments allowed for PhD students to find their research topic within the first year, i.e. broader knowledge was needed to make an informed selection.

The question of pedagogical courses deserves further notice. At CP, EAT and PL they were considered an essential part of the course portfolio, while at EL doctoral students were encouraged to take pedagogical courses but could only use 3 such credits in their studies, indicating a lack of incentives for taking such courses. At AC, none of the respondents even mentioned pedagogical courses even though they are in fact part of the course portfolio. Other aspects of the course palette included leadership (though this only came up at PL) and transferable skills such as writing reports, communication etc. (at EL). It is though important to note that these are not to be found in any written study plan, rather, established procedures at the respective departments.

Generally, however, the palette of courses resembles the classical engineering model of "T-shaped people" (see [5]), i.e. acknowledge that both general and specific knowledge are required for a researcher career. That specific knowledge was less emphasized by supervisors resonates with the question of market qualifiers vs. market winners – one needs specific skills (in-depth knowledge, the thesis) to qualify for a researcher career but broader knowledge (of also other methods used, general knowledge about the subject) to succeed further.

5.2 Finding courses

Ad hoc courses and the problem of finding courses at the time of designing the individual study plan frustrate many supervisors as well as doctoral students. However, three reasons were cited for this problem:

a. A lack of incentive systems to arrange doctoral courses,
b. The ad hoc admittance of PhD students through industry projects not allowing for programme structures to be followed, and
c. The use of visiting researchers to give PhD courses.

The lack of incentive systems is best expressed in the quote "*There has to be an incentive to give PhD courses, today you don't get a single dime!*" (S1, CP) but was seen as a problem throughout. Unlike undergrad (in this case bachelors and masters level) courses, PhD courses didn't result in monetary rewards neither on personal nor departmental level. With the workload being as it is, that might be one reason not to develop new PhD courses. In other words, specialized courses were actually arranged but in most cases only as reading courses for the supervisor's very own PhD students, not for PhD students across departments. Ironically, this may lead to duplications of courses from the university's perspective simultaneously with their scarcity from the PhD students' perspective who wouldn't even know courses in their interest area are given at other departments. A change of incentive systems could thus result in a reduction of resources used for them across LTH at the same time as enabling better planning for students to take them.

5.3 Supervision

The selection of course that is to be included in a PhD education is characterized by a large degree of freedom tailored to individual student needs and preferences. However, this freedom have potential constraints related to supervision, course availability, and timing.

Some supervisors provide general guidance, others actively suggest courses, yet others negotiate with students, and in extreme cases PhD students just ask for permission and get clearance from the supervisor to take it.

Another constraint in the selection of courses is availability. Many students highlight the difficulty of finding relevant courses and many supervisors are aware of the problem. Some supervisors argue that the reason for this is that there are no incentives to give PhD courses. However, there are supervisors that arrange PhD reading courses, which often is of benefit for both parties since all involved learn together. Sometimes supervisors even permit more experienced PhD students design a reading course.

Timing is also a constraint in the course selection process. Students and supervisors highly recognise that planed courses are to be included the individual study plan. The timing of taking courses needed to fit with the long-term plan found in the ISP, e.g. when does the student plan/need to focus on courses vs. thesis work. An identified problem here is that some courses are found in an ad hoc manner. Thus, ad hoc courses require changes to the ISP.

5.4 Value of courses

The interviews show that there are multiple values of having courses in the PhD education. These could be arranged into four categories:
- *Formal criteria:* The general study plan sets the conditions for credits and course types.
- *Supporting the thesis:* These courses provide knowledge and tools applicable to the specific research field. If such courses cannot be found, a common approach is to design special reading courses.
- *Supporting the research:* General courses are given to broaden the knowledge of PhD students in their extended research field.
- *Prepare for a career after dissertation:* These courses focus on transferable skills.

As there often is a workload dilemma for the PhD students – they have to focus on their specific research question. Many students are therefore reluctant to spend time on courses that does not support the process of writing the thesis. The supervisors tend to have a more overview perspective and consider the PhD education as a socialization process into the academy at several levels where you grow as a person and into a role as a researcher.

5.5 Convalidation of courses

Convalidation of courses in the PhD program from a previous master's degree is allowed to some extent, and this possibility is also used at some of the studied departments. There are no formal rules for convalidation. Rather, LTH provides guidelines to departments that wish to offer convalidation to their students [6]. According to the guidelines, up to 50% of the course requirements may be fulfilled by convalidated courses. It is noted in the guidelines that only courses that are relevant to the research subject can be convalidation, and that this assessment is done by the supervisor. Also, the guidelines mention that convalidation of courses should not be seen as a means to shorten the PhD program.

At CP, there is a rule that stipulates that a maximum of 30 credits of courses can be convalidated, given that they are relevant to the research field. This kind of formal rule does not exist at e.g. AC. Nevertheless, course convalidation is rather common at the department. In contrast, at PL, convalidation is uncommon, and mainly allowed for courses in leadership and project management.

6. Concluding remarks

There is a general agreement that courses are an important part of the PhD programme. That said, there are differences in the view on their role and value. There are no agreements across departments whether the emphasis should be places on breadth or depth, not even how many course credits should be included in a PhD programme, nor which courses should be taken

first. The order in which courses are taken may though depend on the admittance process, students with given topics start with in-depth courses while students without such topics need the breadth to select a topic.

There is no general structure across LTH, but course types are reoccurring across departments. However, some departments may not include methods courses in their course palette if everyone uses the same method. Hence we conclude that there is no general course structure that could be followed across departments, though there are synergies in courses with transferable skills, methods, even some of the subject-specific courses. There is though no tool to find such synergies in the absence of visibility of courses at particular departments. What is more, there is no incentive system to give PhD courses, further reducing their visibility.

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