

## External Funding of Doctoral Education: Background and Reflection

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External funding of doctoral education is becoming increasingly common in Sweden. Here I discuss how this practice may cause tensions between the learning outcomes in the Higher Education Ordinance and the practice of doctoral education. Employment on externally funded projects tend to marginalize some components of education that traditionally have been considered fundamental for third cycle students, and creates more complex roles for both students and supervisor. These can have both positive and negative consequences for student-supervisor relations that warrant further study. The increased reliance on external funding to support students also raises fundamental questions about the form, content, and aims of doctoral education.

*Key words:* Doctoral education, external funding, Higher Education Ordinance, doktorandutbildning, finansiering, projektfinansiering, Högskoleförordning, UKÄ

### INTRODUCTION

The activities at Swedish Universities are increasingly funded externally by national and international research councils (e.g., Vetenskapsrådet, VR) and private foundations (e.g., the Knut and Alice Wallenberg Foundations, KAW). External funding of research projects has been the norm in the natural sciences for a long time but this model is becoming common also in the social sciences and, to a lesser extent, in the humanities (Hetel, Møller, & Stamm, 2015). Even within the natural sciences an increasing range of university activities are funded externally rather than internally.

One example is doctoral education. Whereas PhD students' research projects have traditionally been supported financially by external grants (usually to the main supervisor or the student), it is now very common that also PhD student salaries are covered by external funding (Handal & Lauvås, 2008). A survey at Lund University (LU) conducted in 2007 (Holmström, 2013) reported that at least 60% of PhD students at the Faculty of Natural Sciences are funded in full (ca 40%) or in part (ca 20%) by external sources. These figures are even higher at the Faculty of engineering. In the social sciences approximately 50% of PhD students are funded externally whereas external sources contribute to the salary of fewer than 25 % of students in the humanities.

By and large, this external funding for PhD student salaries comes from grants awarded to one or several Principal Investigators (PIs) with the purpose to conduct a specific research project; not grants with the primary aim to support doctoral education. Funding to support students is typically included as a salary post, which is subject to assessment on the same grounds as any other post in the application (e.g., postdoc, research assistant). The duration of the project funding can be shorter or longer than the duration of a PhD.

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Artiklar är kollegialt granskade. Övriga bidragstyper granskas av redaktionen.

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ISSN 2000-7558

The increased reliance on external funding could shape doctoral education in several different ways (Elmgren, Forsberg, Lindberg-Sand, & Sonesson, 2014). Here I discuss the extent to which funding educational activities through external project grants may create tensions in supervisor-student relationships, students' abilities to fulfil the learning outcomes stipulated in the Higher Education Ordinance (HEO) and the content of doctoral education programmes. The approach here is descriptive rather than prescriptive, but an attempt is made to outline possible responses to the issues that are raised (under the assumption that at least some of the points of tension do apply). The perspective is one from the natural sciences, specifically biology, but the topics apply to greater or lesser extent also to technology, the social sciences and humanities.

#### EXPECTED OUTCOMES OF DOCTORAL EDUCATION

Each level in the education system has expected outcomes for students passing the degree. The expected outcomes of doctoral education in the HEO are presented as learning outcomes, including acquisition of in-depth knowledge about the field of research, and transferable skills that may be of benefit in a variety of contexts outside of the subject area (Appendix 1). The outcomes are structured under three headings: *Knowledge and Understanding*, *Competence and Skills*, and *Judgement and Approach* (Appendix 1). Learning outcomes in the HEO are very general and apply across subjects, but further details or specifications may be included in the General Study Plan for each doctoral programme<sup>1</sup>. The emphasis is on acquisition of the ability to conduct research and education, reflecting that, historically, doctoral education primarily served to educate the next generation of academics.

Whether or not a doctoral programme fulfils the HEO depends on to what extent students can demonstrate to have met the intended learning outcomes. The emphasis on abilities and capacities rather than products, achievements and the like (except for the demand that there should be a written dissertation) can be seen as a weakness or a strength, depending on perspective. On the one hand, it may reduce the risk that the education becomes overly focused on products, such as publications, which may not accurately reflect student knowledge and intellectual abilities. On the other hand, a failure to further specify subject expectations in the General Study Plans can make it very difficult to assess if students meet reasonably set expectations for the degree. For example, without a more detailed General Study Plan it may be difficult to assess if Biology students have 'demonstrated the capacity' for 'scholarly analysis and synthesis' in sufficient detail to be awarded a PhD.

Both academics and students are generally quite skeptical as to whether or not students in their doctoral programmes meet the expected outcomes of the HEO (Holmström, 2013). However, the published literature suggests there is limited discussion of if, and how, doctoral students are suitably assessed in Sweden (see Elmgren et al., 2014). In practice, decisions regarding whether or not the qualifications for a PhD have been met are often left to supervisors and the official assessment of research skills based solely on the content of the thesis. The latter is naturally heavily influenced by the research project.

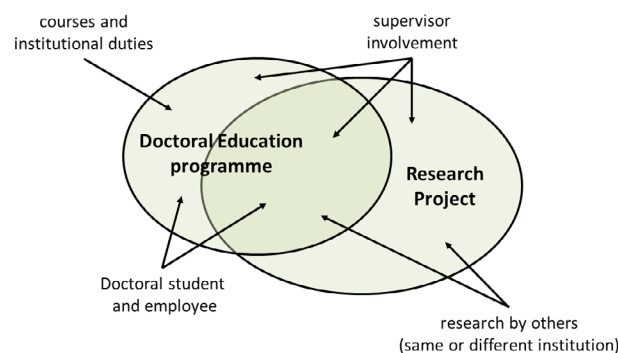
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1 A reading of the General Study Plans at LU (available online at [www.lu.se](http://www.lu.se)) suggests that few PhD programmes take this opportunity. Instead, the outcomes in the HEO are typically repeated with no or very minor specification of what, for example, 'broad knowledge', 'familiarity', 'ability to make a significant contribution' and other generic statements should correspond to within a particular subject.

### EXTERNAL FUNDING: TENSION BETWEEN THE HEO AND THE REALITY OF DOCTORAL EDUCATION?

How may an increased reliance on external funding influence supervisor-student relations, how well students will achieve the HEO learning outcomes, and how well they can be assessed? The doctoral education programme consists of two parts, the PhD course and the research project (Fig. 1). The student is expected to complete the programme and gain a high level of knowledge of the subject and general scientific training by following an individual study plan. This involves course work but the student should also acquire knowledge and know-how through a research project and complete a dissertation on a suitable topic within the subject.

Students are formally employees of the university and external funding means that a part of their salaries is covered by funding awarded to a single Principal Investigator (PI) or a team of PIs (Handal & Lauvås, 2008). In some situations, these projects are large consortia involving several PIs at different academic institutions and perhaps spread across many countries. As a consequence, the student typically only performs a part of the research project and completion of even this part often depends on input of several, sometimes many, other individuals (Fig. 1).



*Figure 1. The doctoral education programme defines the boundaries for the student's activities, which includes a research project. External funding of doctoral education leaves both student and supervisor with multiple roles and responsibilities to different actors (e.g., individuals, institutions and funding agencies).*

External funding of doctoral education puts the lecturer or professor in two roles; as supervisor of the student and as PI of the project on which the student is completing her dissertation (Fig. 1). This increases the mutual dependence between student and supervisor. Students become increasingly reliant on the supervisor to facilitate interactions within the project that benefit the student. Supervisors on their hand become increasingly dependent on students for their own research. The consequences of these dependencies may be both positive and negative (Elmgren et al., 2014; Handal & Lauvås, 2008).

#### *The supervisor*

Doctoral student supervision is associated with a number of benefits to academics. Sometimes supervision comes with certain prestige and social status within departments. Universities usually make it a formal requirement to have supervised doctoral students to completion before one can apply to promotion to senior lecturer and professor. Doctoral students may also contribute to the

supervisor's own research (Elmgren et al., 2014), and this role becomes more important when funding for students is external since students are often directly employed on the supervisor's research project, resulting in joint publications that benefit both parties.

External funding means that the overall research project on which the student conducts her thesis typically has been conceived and outlined by the supervisor (rather than being developed by the student). This may influence how supervisors perceive the student (Elmgren et al., 2014). Firstly, as an employee the doctoral student becomes an important source of labor. Many PIs in the natural sciences rely on others to complete data collection, analyse data, and draft manuscripts. Although PhD students will be naïve with respect to each of these aspects of science when they begin their studies, having successfully entered the third cycle suggest that they should have the ability to constructively contribute to research beyond tasks typically assigned to research assistants. Furthermore, since the research project is part of an education, many supervisors expect students to put in more hours than they expect from a technician. The working hours of students are unclear (and not easily quantified<sup>2</sup>) and academics sometimes express a concern that the psychology of turning the doctoral education into an employment blurs the distinction between students and support staff (a changing perspective that may apply to both students and PIs).

One possible consequence of having doctoral students employed with project funding is that supervisors pay more attention to their students, their performance, and progress in research-led aspects of education. This will tend to make the student-supervisor relation resemble apprenticeship learning with 'product supervision' (Handal & Lauvås, 2008; Linden, 1998), i.e., a type of education that focuses on the quality of the product of the PhD in the form of papers or the dissertation. Conversely, aspects of education that do not directly bring benefits to the research project may be marginalized, perhaps leading to less emphasis on the process by which science is conducted and learning is enabled.

Student involvement in PI-led projects may also have other effects on supervisor-student relations. Funding rates well below 20%, which is the norm today, imply that many academics struggle to conduct any form of research that is costly in terms of consumables or staff. Lecturers and professors sometimes also need to fund part of their salaries through external grants. Consequently, student failure to fulfil the researchers' expectations or to deliver what the project needs may also have repercussions for the PI's future research career (and that of other researchers involved in the project), which typically relies on maintaining a high output in terms of research quality and quantity. This conflict may be particularly likely for early career researchers, who often rely more heavily on a single project and for whom the consequences of low productivity may be more severe (e.g., failure to get tenure).

### *The student*

From the student's perspective, working within an externally funded project can have both positive and negative consequences. Being integrated into a research group is seen as a very positive aspect of doctoral education among students (Holmström, 2013). Product-oriented supervision appears to promote supervisor interest in the student's work, its progress, and leads to a number of positive effects in terms of training, access to research networks and support to develop technical skills (Handal & Lauvås, 2008) – all of which should positively contribute to

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2 Students at LU self-report an average of 45 hours per week (Holmström, 2013).

the ability to reach the HEO learning outcomes. As the PI focus for project outcomes typically is on publications (at least in the natural sciences), a student with a product-oriented supervision may also end up with a CV that is competitive relative to students receiving a supervision more focused on process. In fact, the very limited data that exist suggest that students may be more focused on product than process compared to their supervisors (Kandiko & Kinchin, 2012), making a product-oriented supervision align with student preferences.

On the negative side, the strain that may result from poor performance or conflicting perspectives by supervisor and student on the progress of the project or student work ethic may cause overt psychological stress. There are examples of students who have been exploited by supervisors and who have not been given sufficient credit for their work in terms of publications or recognition. However, there does not appear to be any data to objectively assess how widespread this is and if it is a major source of stress. In fact, one could read self-reports to support that students doing their research within their supervisor's research project are less vulnerable as they score higher on many indices of student satisfaction than those with independent projects (Holmström, 2013)<sup>3</sup>.

External funding may also directly impact on how well students are able to meet the HEO learning outcomes. One concern raised by academics is how external funding affects the potential for students to become 'independent scientists' rather than 'super technicians' (Handal & Lauvås, 2008). External funding of doctoral students means – at least on paper – that the research theme, aims and details of the research project have been decided and specified, typically by the future supervisor, well before the student enrolls in the doctoral programme. Being able to identify a research topic in need of investigation, specify its boundaries, and identify how it can be addressed in a productive way (e.g., what empirical or theoretical methods that are appropriate) is considered one of the key objectives of a doctoral education. They form the 'positioning' of one's research relative to an existing body of knowledge. The opportunity for positioning is largely lost with external funding. In the social sciences and the humanities – where external funding of doctoral education is more recent – this can be viewed as a major problem (Handal & Lauvås, 2008). The focus on positioning has probably been less pronounced in the natural sciences for some time, but similar concerns apply.

A limited opportunity for positioning one's research may make students less aware of how outstanding research problems are identified, how these relate to other related problems, how specific questions are formulated, and how and why certain approaches are deemed more promising than others to answer those questions. These aspects are important parts of the scientific process. Students in the natural sciences can have rudimentary views of how science works and can be unfamiliar with basic issues in the philosophy of science (Kampourakis, 2013a, 2013b; Matthews, 1994). For example, doctoral students may not reflect on how knowledge is formed or hold naïve views on scientific progress that are philosophically problematic, inaccurately represent the history of scientific progress, and that do not reflect how students actually conduct their own research projects. The process of positioning may also raise ethical issues and thus help students to become aware of the broader context within which their research is embedded.

These considerations suggest that a transition towards more externally funded projects where problems and approaches are defined by the supervisor before the student becomes involved are

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<sup>3</sup> The analysis is, however, confounded by subject area (i.e., students in the natural sciences are both more likely to be employed on project funding and more satisfied with their education).

particularly likely to compromise the first two outcomes under *Competence and Skills*, and the outcomes under *Judgement and Approach* in the HEO (Appendix 1). These are indeed considered by supervisors to be outcomes that are particularly unlikely to be met within current doctoral programmes (Holmström, 2013). Interestingly, students on scholarships may be better placed in this respect as their research role is likely to be less well defined from the outset. However, students on PhD scholarships come from a separate pool of prospective students, which will make it difficult to tease out causes of any difference in skills acquired, performance, and post-PhD careers.

#### *Implications for the assessment of doctoral students*

Although the possible tensions described above typically are yet to be substantiated by data, it is possible that the dual roles for both parties – student/employee and supervisor/PI – make it more difficult to judge the student's contribution to the work presented in the thesis, which is the main mechanism for assessment. The average number of authors on a representative sample of PhD theses in ecology and evolution at Lund University published between 2013 and 2015 are 4.8 (the maximum number of authors on a single chapter is 19)<sup>4</sup>. In fact, one may question whether or not publications provide a suitable estimate of student achievement under external project-funded PhD positions. Within a larger project, the contribution of each participant is often very difficult to assess a priori and, with large projects consisting of multiple integrated parts, externally funded projects cannot always carry the expectation that the PhD student should be first author on the papers that she contributes to. The only thing that can probably be taken for certain is that the PI (usually the same person as the supervisor) is likely to have substantial influence on, and control over, the structuring and writing of the major papers coming out of the project (in Biology this is a position that is typically indicated by last-authorship; Tscharnke, Hochberg, Rand, Resh, & Krauss, 2007). The conflicts regarding authorships will not be discussed here, but it suffices to say that funding PhD students through PI-led project grants is not likely to reduce these conflicts and that authorship may be an increasingly unreliable measure of at least some student qualities, such as the ability to position the research and write papers. In this context, it could be seen as worrying that the thesis content, and in particular the chapters rather than the general introduction and discussion, plays such a large role in student assessment and in shaping future careers of PhDs in academia.

#### IS THE PHD EDUCATION OLD-FASHIONED?

There are many potential reasons for reconsidering the nature of doctoral education, including changes in the job market, skills required, and how research is funded (e.g., Cyranoski et al., 2011; Gould, 2015; Lee, 2013; McCook, 2011). As discussed above, external funding may create new roles for supervisors and students and challenges with respect to fulfilment of the expected outcomes in the HEO. If so, we may wish to contrast two broad categories of responses.

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<sup>4</sup> The average number of chapters/articles in those PhD theses is 5.1 (N = 24 PhD theses). For a representative sample of theses in the same subjects at LU for the period 1993-1995 the average number of authors is 2.9 per paper and an average of 6.5 chapters (N = 14 PhD theses). The differences can to some extent be explained by the growth of genomics, but also PhD chapters without genomic data appear to have more authors today than 20 years ago. A systematic study of this in the context of assessment of doctoral students could be informative.

The first is to accommodate changes in the funding landscape while sticking to the learning outcomes. Because doctoral education consists of both educational and research activities (Fig. 1), a mixed funding model may relieve some of the tensions discussed above. Some departments have indeed implemented a general policy of mixed funding, for example to cover 50% of the PhD salary, expecting the other 50% to be covered through PI grants. There are two ways to view this situation. One is that the department co-funds research projects of individual PIs. The other is that individual PIs co-fund the Department's education programme. Both perspectives have merit and needs to be considered when making decisions about the future of doctoral programmes. For example, how much PIs are expected to be willing to contribute towards PhD salaries – rather than employing postdocs or skilled research assistants – is an open question<sup>5</sup>. It seems likely that the forms of shared funding and the target student numbers will become increasingly important issues for departments. Funding doctoral students on external project grants may also call for a revision of the basis for recruitment of students. Finally, it may also affect external funding itself if academics become less inclined to employ doctoral students on their grants (while the government wants to maintain doctoral student numbers). It may be necessary to revise funding schemes to make employment of doctoral students more attractive, or to implement grant calls intended to support students on projects that they help to develop, thereby increasing the emphasis on HEO learning outcomes.

An alternative response is to conclude that the HEO outcomes no longer are realistic given the constraints on higher education and the needs of society, and that the classic PhD therefore should be replaced with a more modern version (Cyranoski et al., 2011; Gould, 2015; McCook, 2011). New forms of doctorates are indeed appearing to meet the demands of the 'knowledge economy' (Boud & Lee, 2013; Cyranoski et al., 2011). For example, undergraduate education is often insufficient to provide the skills needed for workers in the biotechnology industry, which require practical know-how and an ability to make use of new technology (McCook, 2011). At the same time such jobs may not require the skills associated with identification and formulation of new research problems. It has therefore been suggested that doctoral education should be more focused on methodology and technical know-how, and how to continuously improve this know-how, rather than the conceptual skills traditionally expected of university researchers (McCook, 2011). In fact, if supervisor opinions regarding what outcomes LU students actually achieve upon completion of their PhD are accurate (Holmström, 2013), this may already be a fair description of the doctoral education in at least some areas of the natural sciences in Sweden. It is unclear whether or not such a system also could provide sufficient flexibility to provide high-quality training for those who will continue in academia, unless we implement a doctoral programme structure that enable students to move along different trajectories.

#### CONCLUDING REMARKS

On paper, funding doctoral education through external project grants appears to cause tensions that may shape how well students meet the HEO learning objectives. However, without data we cannot confidently assess if any of these concerns truly apply or if they are exaggerated. The benefits of externally funded doctoral students remain equally speculative. If we want to move

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5 It is also worth noting that changes in the job market, favouring postdoctoral researchers and technicians, may have consequences for the career paths of academics, a topic currently discussed intensively.

from speculation to action we will need data that can form the basis for any reform to the current PhD. In the meantime, it would seem appropriate that departments invest some time to discuss what their doctoral programmes are for, what the learning outcomes should be for their subject, and how to assess if students meet these outcomes. Creative solutions and the maintenance of high-quality doctoral education are likely to be facilitated by exposing the logic behind contemporary ways to balance external and internal funding of both education and research.

#### ACKNOWLEDGEMENTS

I am grateful to Anders Sonesson, Tobias Nilsson, Per Lundberg and a number of colleagues for discussions and Per Lundberg and the editors for helpful comments on the manuscript. I am also grateful to the Knut and Alice Wallenberg Foundation for funding.

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APPENDIX I. FROM THE HIGHER EDUCATION ORDINANCE, ANNEX 2  
QUALIFICATIONS ORDINANCE FOR DOCTOR OF PHILOSOPHY ([HTTP://WWW.HSV.SE](http://www.hsv.se)).

**Scope**

A Degree of Doctor is awarded after the third-cycle student has completed a study programme of 240 credits in a subject in which third-cycle teaching is offered.

**Outcomes**

*Knowledge and understanding*

For the Degree of Doctor the third-cycle student shall

- demonstrate broad knowledge and systematic understanding of the research field as well as advanced and up-to-date specialised knowledge in a limited area of this field, and
- demonstrate familiarity with research methodology in general and the methods of the specific field of research in particular.

*Competence and skills*

For the Degree of Doctor the third-cycle student shall

- demonstrate the capacity for scholarly analysis and synthesis as well as to review and assess new and complex phenomena, issues and situations autonomously and critically
- demonstrate the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively, and to plan and use appropriate methods to undertake research and other qualified tasks within predetermined time frames and to review and evaluate such work
- demonstrate through a dissertation the ability to make a significant contribution to the formation of knowledge through his or her own research
- demonstrate the ability in both national and international contexts to present and discuss research and research findings authoritatively in speech and writing and in dialogue with the academic community and society in general
- demonstrate the ability to identify the need for further knowledge and
- demonstrate the capacity to contribute to social development and support the learning of others both through research and education and in some other qualified professional capacity.

*Judgement and approach*

For the Degree of Doctor the third-cycle student shall

- demonstrate intellectual autonomy and disciplinary rectitude as well as the ability to make assessments of research ethics, and
- demonstrate specialised insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used.

*Research thesis (doctoral thesis)*

For the Degree of Doctor the third-cycle student shall have been awarded a pass grade for a research thesis (doctoral thesis) of at least 120 credits.

*Miscellaneous*

Specific requirements determined by each higher education institution itself within the parameters of the requirements laid down in this qualification descriptor shall also apply for a Degree of Doctor with a defined specialisation.