

Supervision of inter- disciplinary doctoral students

Pedagogiskt Docenturarbete

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BACKGROUND AND MOTIVATION

Here I will investigate how the increasing emphasis on inter-disciplinary research in the medical sciences has impacted the doctoral student-supervisor relationship, the current state of inter-disciplinary doctoral research at the Institute of Clinical and Experimental Medicine (IKE), and potential actions that can be taken at the individual and institutional level to promote effective inter-disciplinary doctoral research. My choice of subject is *motivated* by (i) my own experiences as a doctoral student in which my planned inter-disciplinary research program failed to function, resulting in an altered single-discipline doctoral thesis, and (ii) my need to supervise doctoral students performing highly inter-disciplinary research. The *goal* of this study is to improve my ability to be an effective and supportive supervisor of my Ph.D. students.

TOPICS OF INVESTIGATION

Specifically, I aim to address the following question:

Is the supervisor-student relationship structure at IKE compatible with effective inter-disciplinary doctoral research?

INTRODUCTION

The major health concerns facing Europe are multifactorial. Combating the increasing prevalence of diseases like type II diabetes requires not only improved treatment for patients but an understanding of the genetic, social and economic factors underlying obesity. Consequently, inter-disciplinary research is seen as essential to addressing many of the major healthcare challenges in Europe. Consequently, the need for inter-disciplinary medical research has become an increasing focus of major funding bodies over the last decade. For example, at the time of writing, the Swedish Foundation for Strategic Research (SSF) has announced the SEK 200 million Med-X call with the stated aim, “to stimulate collaborative multidisciplinary research within the area of MED-X; Medicine in convergence with IT, electronics, or materials research”. Another example of this profound shift in focus was the establishment of the Excellence Program for Inter-disciplinary Research (EPIR) at University of Copenhagen in 2013. The EPIR invested 640,000,000 SEK in funding 200 Ph.D. students to initiate inter-disciplinary research projects tackling a broad range of health and societal issues (Lindvig, 2018), with the aim of preparing the university and its researchers for the growing number of inter-disciplinary research initiatives to come for the EU over the next decade.

But what is meant by ‘inter-disciplinary research’ and how does it fit in to the largely mono-disciplinary structures of European universities. For the purpose of this study I have formulated the following definition of **inter-disciplinary** research: “*inter-disciplinary research involves integration of knowledge and methods from different disciplines to realize discovery in one of the participating disciplines*” (Biancani et al., 2018; Pohl and Hadorn, 2008; Stember, 1991; Vanstone et al., 2013; Zeigler, 1990). Thus, inter-disciplinary research requires ‘integration’ of knowledge and methods from different disciplines to generate novel results, as opposed to the integration of the results of knowledge and methods from separate disciplines; **multi-**

disciplinary research. The differences between collaborative modalities in medical research can be outlined as in **Figure 1** (Zeigler, 1990).

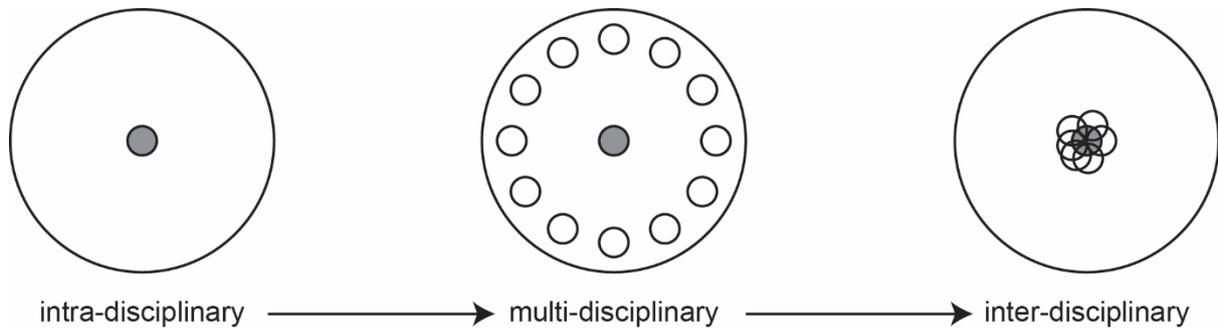


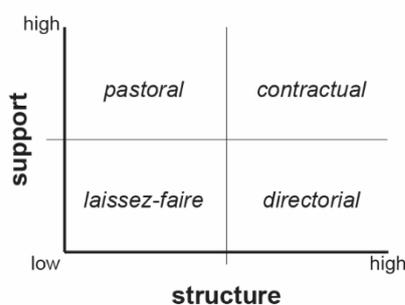
Figure 1. Degrees of collaboration across different disciplines. Grey circle represents the discipline containing the problem to be addressed. White circles represent actors or information from other disciplines. Distance between circles represents the degree of importance and involvement of disciplines in solving the problem (adapted from Zeigler, 1990).

The emphasis on inter-disciplinary research at national and European level has resulted in an increase in doctoral research theses that require collaboration across traditional discipline boundaries. However, the structures of the doctoral student-supervisor relationship have not changed to accommodate the unique challenges and opportunities presented by inter-disciplinary research (Blackmore and Nesbitt, 2008; Demharter et al., 2017; Lindvig, 2018; Vanstone et al., 2013; Wisker and Claesson, 2013). What are the risks facing doctoral students and their supervisors in performing inter-disciplinary research and what actions can be taken to adapt the student-supervisor relationship to the realities of inter-disciplinary research?

THE STUDENT-SUPERVISOR RELATIONSHIP

The doctoral student-supervisor relationship is key to doctoral success and has been an active area of research for decades, with several models of relationship structure proposed (Deuchar, 2008; Gatfield, 2005; Gurr, 2001; Hockey, 1996; Mainhard et al., 2009) (**Figure 2**). However, a general assumption of these models is a two-way relationship between one student and one supervisor, within single discipline, located within a mono-disciplinary structure such as a

A. Gatfield's supervisory management grid



B. Gurr's alignment of needs

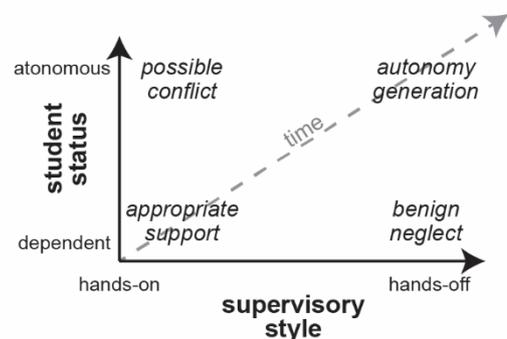


Figure 2. Common models of the student supervisor relationship. **A.** Gatfield's supervisory management grid using the variables of support and structure to map the state of a student-supervisor relationship during different phases of doctoral training. **B** Gurr's model uses the variables of student autonomy and supervisory style to predict the outcome of the relationship at different times during a Ph.D. student development.

department or faculty. Consequently, existing models need to be re-designed to incorporate extra variables due multiple active supervisors with (i) different supervisory techniques, (ii) different expectations of the student and (iii) differing degrees of engagement with the student at different times during their doctoral training (Vanstone et al., 2013). Indeed, several recent studies have attempted to identify actions that can be taken to maximize the success of inter-disciplinary doctoral research in mono-disciplinary institutions (Blackmore and Nesbitt, 2008; Demharter et al., 2017; Lindvig, 2018; Lyall and Meagher, 2012; National Academies (U.S.). Committee on Facilitating Interdisciplinary Research. et al., 2005; Vanstone et al., 2013; Wisker and Claesson, 2013). Here, I will summarize these actions and discuss their theoretical background, where appropriate:

Preparation: prior to advertisement of an inter-disciplinary Ph.D. position a committed team of supervisors should be formed. At conception, the supervisory team should discuss and agree on the following:

- *Expectations of the student:* expectations of the student's work-rate, production of published work, time-distributions across disciplines and time to Ph.D. completion should be clearly stated and agreed upon. More generally, as an inter-disciplinary student requires to be expert in more than one discipline, supervisors should be prepared for an extended early phase of knowledge acquisition than for a mono-disciplinary doctoral student.
- *Supervisory reward (authorship):* Publication norms can vary dramatically between disciplines. For example, senior investigators in mathematics will typically take first authorship on papers from their group, whereas last authorship is most prized by principle investigators within the life sciences. Moreover, how publication titles are valued (impact factor, conference proceedings, citation rate, type of citation) also differ between disciplines. Ideally, an agreed approach to publication of the student's research must also be decided prior to commencement of studies
- *Research communication:* How the student will present their on-going research must be formulated. Although the student will be performing work across discipline boundaries, they will typically present their work in meetings within mono-disciplinary structures (departments, faculties). Suitable inter- or cross- disciplinary platforms for research presentation should be identified or created (Blackmore and Nesbitt, 2008).
- *Administration:* All forms of university administration (HR, Finance, Purchasing, etc) are typically faculty or division based. A clear solution to administrative hurdles must be outlined in the initial project plan (Blackmore and Nesbitt, 2008; Lyall and Meagher, 2012; Vanstone et al., 2013).

Recruitment: the supervisory team must agree on the 'type' of student most appropriate for the proposed doctoral studies, as most will have qualifications in a single discipline following their undergraduate studies. Moreover, the supervisory team must also recognize the exceptional demands placed on inter-disciplinary doctoral students, specifically the **need** to be able to effectively communicate across the often profound 'cultural' barriers between disciplines from an early stage in their doctoral training (Blackmore and Nesbitt, 2008; Lyall and Meagher, 2012; Vanstone et al., 2013).

Doctoral training: Under doctoral training the supervisory team must be actively developed and maintained by frequent meetings and agreed updates to proposed project plans and perceived milestones. Attention must also be paid to the potential negative social effects of inter-disciplinary research on the doctoral student, which may feel a lack of connection to any particular group in the constellation, resulting feelings of exclusion and loneliness, which are heavily linked to attrition rate (Pauley et al., 1999). Indeed, a ‘supportive, personal, flexible and responsive’ relationship between at least one supervisor and student is critical in maintaining the student’s well-being and productivity (Halbert, 2015; Hockey, 1996).

Examination: The format of thesis produced must also be agreed on to allow clear guidance to be given to the student. Examination of inter-disciplinary doctoral students within the traditional ‘Humboltian’ model of higher education is particularly inappropriate; a single opponent, typically expert in a single discipline, examining a student expert in (i) multiple disciplines and (ii) the integration of those disciplines. Here it is important that the examination committee is carefully chosen such that gaps in knowledge of the opponent are addressed by the committee.

In addition to the actions of individual supervisory teams outlined above, changes at an **organizational level** are desirable to deliver truly inter-disciplinary doctoral training, including the awarding of university-wide Ph.Ds. that are independent of traditional faculty domains, administrative processes to facilitate inter-disciplinary study and supervision, and examination practices that allow the participation of multiple external examiners from different disciplines.

Interestingly, despite a solid body of research discussing the challenges and benefits of inter-disciplinary research few studies have attempted to quantify the amount and perceived success of inter-disciplinary doctoral research at European universities. To this end, I performed a survey of inter-disciplinary doctoral research at the Institute of Clinical and Experimental Medicine (IKE) within the medical faculty of Linköping University, Sweden. The goals of the survey were to:

1. Assess the extent of inter-disciplinary doctoral research taking place at IKE
2. Assess students satisfaction with supervision of inter-disciplinary doctoral research

Method

The study consisted of a short online questionnaire, sent to all current Ph.D. students at IKE on the 22nd August 2018. The questionnaire was short (7 multiple-choice questions) and anonymous to ensure maximum response rate. The questionnaire was sent to 200 current Ph.D. students at IKE. Responses were collected over a 72 hour period.

The questionnaire was structured as follows:

1. *Have you already undertaken your half-time review (Halvtidsseminarium)?*
Yes, No
2. *Do you consider your Ph.D. research to be inter-disciplinary?*
Yes, No

3. **How many different scientific disciplines does your Ph.D. research involve (i.e. Basic Biology, Bioinformatics, Physics, Advanced Statistics, Chemistry, Medicine, I.T., Programming, etc)?**
1, 2, 3, >3
 4. **Does your main Ph.D. supervisor have sufficient expert knowledge in all the scientific disciplines required by your research?**
Yes, No
 5. **Does your supervision constellation (main supervisor & co-supervisors) have sufficient expert knowledge in all the scientific disciplines required by your research?**
Yes, No
 6. **Do you feel that you are more expert than your main supervisor in any scientific discipline required by your research?**
Yes, No
 7. **How do you view inter-disciplinary Ph.D. programs?**
Positively, Negatively
- Comment on your choice:*

Results

A total of 78 responses were collected, representing a response rate of 38%. Of these, 64% considered their Ph.D. to be inter-disciplinary with 50% of respondents stating that their Ph.D. research spanned 3 or more disciplines. In interpreting these data, it is important to consider that individual perceptions of what constitutes a different ‘discipline’ will differ between students. However, it is noteworthy that 2 out of 3 current IKE doctoral students personally regard their Ph.D. research as being inter-disciplinary. To further understand how mono-disciplinary and inter-disciplinary doctoral students experience supervision at IKE response to questions Q4, Q5 and Q6 were broken down into the two student groups (**Figure 3**).

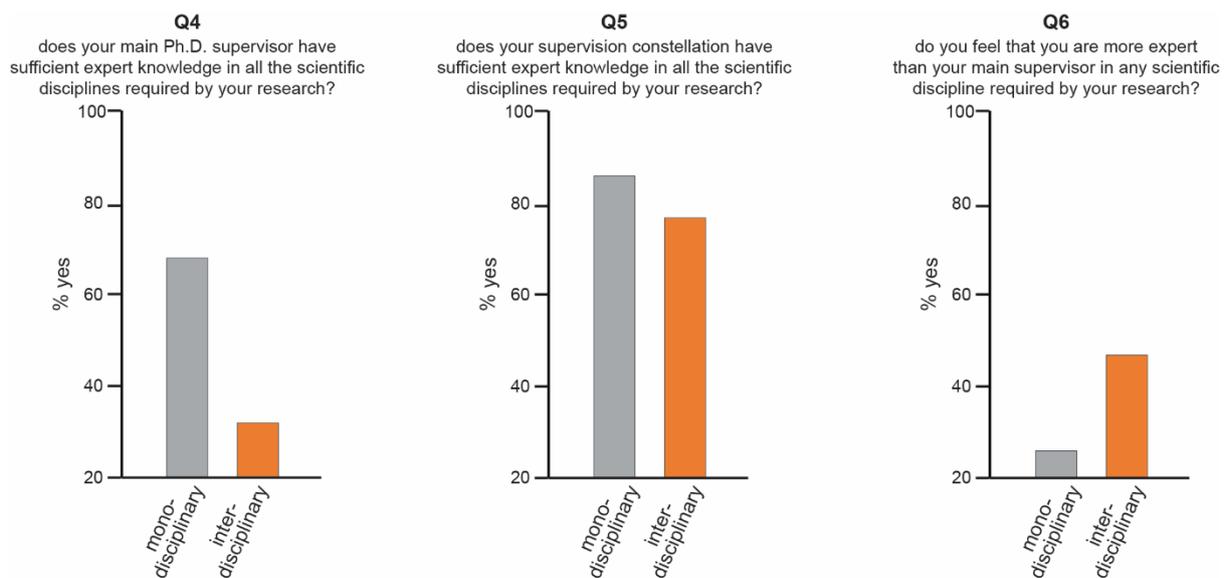


Figure 3. Doctoral student perception of supervisory expertise at IKE

Responses to Q4 and Q6 are in line with expectations, with inter-disciplinary doctoral students feeling they are often more expert than their main supervisor in at least one discipline of relevance to their research, with just 30% agreeing that their main supervisor has sufficient expert knowledge in all the scientific disciplines required by their research. This contrasts with mono-disciplinary doctoral students of which 70% agree that their main supervisor has sufficient expert knowledge in all the scientific disciplines required by their research. This finding reinforces the importance of complementary expertise in the supervisory committee of inter-disciplinary doctoral students. Notably, 77% of inter-disciplinary doctoral students felt that their supervisory team (main supervisor & co-supervisors) did have sufficient knowledge in all the scientific disciplines required by their research. This figure is close to the 83% reported for mono-disciplinary students, suggesting that the process of supervisory team creation and approval seems to function well at IKE, with regard to gathering the appropriate competencies required by inter-disciplinary studies.

Conclusion

Training research students, both at masters and doctoral level, is the part of my job I enjoy most. Good students are both challenging and inspiring, bringing fresh ideas and energy to a research group. As my research is highly inter-disciplinary, I have often encountered the problems of 'breadth versus depth', project 'ownership', feeling 'disconnected' from the group and 'authorship anxiety'. Here, I tried to understand the meaning of inter-disciplinary research, the challenges it can pose to the student-supervisor relationship and how avoid and deal with such challenges. Even within the confines of a traditional mono-disciplinary organization like LiU, I have identified several approaches that will help maximize the effectiveness and productivity of the inter-disciplinary doctoral students a hope to supervise over the next 20 years. The pedagogical challenges raised by inter-disciplinary doctoral research are unique and requires changes to the way in which the student-supervisor relationship is viewed and constructed as well as changes to organization structure both in terms of administration and the way in which universities, at their highest level, conceptualize and implement 'disciplines'. Though narrow, the brief survey results presented here show that inter-disciplinary doctoral research is common at IKE and that, on the whole, the supervisory teams involved in such research are well constructed with regards to knowledge. More detailed surveys addressing the inter-disciplinary student's perceptions of the student-supervisor relationship are needed as are investigations into the structural changes required to promote inter-disciplinary research at LiU. It will be interesting to follow the development of inter-disciplinary research training at LiU over the coming decades and how the university adapts to reap the benefits of a changing, ever more connected research environment.

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