ESTUDANTES DE DOUTORAMENTO NO SEU CAMINHO PARA A INVESTIGAÇÃO MULTI E INTERDISCIPLINAR

DOCTORAL STUDENTS ON THEIR PATHWAY TOWARDS MULTI- AND INTERDISCIPLINARY RESEARCH

ESTUDIANTES DE DOCTORADO EN SU CAMINO HACIA LA INVESTIGACIÓN MULTIDISCIPLINARIA E INTERDISCIPLINARIA

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RESUMO

Introdução: Atualmente são necessárias abordagens interdisciplinares para responder aos desafios técnicos e socioculturais mais críticos e complexos de partilha de conhecimento no mundo. Este artigo pretende analisar um curso de doutoramento que ocorreu na Universidade de Uppsala no outono de 2018.

Objetivos: O objetivo deste estudo é descrever o processo de aprendizagem conjunta de estudantes de doutoramento no seu caminho de exploração de pesquisas multi e interdisciplinares.

Métodos: Recorrem-se a uma abordagem qualitativa tendo sido utilizadas como fontes empíricas estudos de literatura, pesquisas, observações, discussões em grupos focais, entrevistas e avaliações de cursos com os alunos, para além de documentação sobre o desenho do curso.

Resultados: O principal resultado do estudo foi o facto do curso ter dado aos alunos a possibilidade de aprofundar a sua compreensão sobre as barreiras e os benefícios da pesquisa multi e transdisciplinar através da interação e discussão com colegas e professores de diferentes disciplinas.

Conclusões: Sugere-se neste estudo que a multi e a interdisciplinaridade e até a undisciplinarity podem ser a forma de cooperar entre as disciplinas, aprendendo coletivamente e criando valor para os pesquisadores na solução de grandes problemas, na criação de algo novo e inovador, encontrando soluções e desenvolvimento futuro para o mundo. A tarefa dos educadores e agentes de aprendizagem, bem como dos formuladores de políticas é facilitar sistemas participativos e sistémicos de aprendizagem crítica e situações em que essas condições possam ser realizadas.

Palavras-chave: multi e transdisciplinaridade; aprendizagem individual e coletiva; ensino superior; criação de valor

ABSTRACT

Introduction: Interdisciplinary approaches are necessary today for meeting the most critical and complex technological and socio-cultural challenges of knowledge sharing in the world. This paper aims at investigating a doctoral course that took place at Uppsala University in autumn semester 2018.

Objetives: The purpose of the study is to describe the processes of joint learning of doctoral students, on their pathway in exploring multi- and interdisciplinary research.

Methods: The qualitative approach was used, literature studies, inquires, observations, focus group discussions, interviews and course evaluations with students as well as documentation over the course design were all used as empirical sources.

Results: The major implication of the study is that the course gave students a possibility to deepen their understanding over the both barriers and benefits of multi- and transdisciplinary research by interacting and discussing with co-students and teachers from different disciplines.

Conclusions: It is suggested in this study, though, that multi- and interdisciplinarity and even undisciplinarity can be the way of co-operating cross the disciplines, learning collectively and creating value for researchers in both solving big problems, in creating something new and innovative, finding solutions and future development for the world. The task for educators and learning agents as well as policy makers is to facilitate participative and systemic critical learning systems and situations where these conditions can be realized.

Keywords: multi - and transdisciplinarity, individual and collective learning, value creation, research, university course

RESUMEN

Introducción: los enfoques interdisciplinarios son necesarios hoy para enfrentar los desafíos tecnológicos y socioculturales más críticos y complejos del intercambio de conocimientos en el mundo. Este documento tiene como objetivo investigar un curso de doctorado que tuvo lugar en la Universidad de Uppsala en el semestre de otoño de 2018.

Objetivos: El propósito del estudio es describir los procesos de aprendizaje conjunto de estudiantes de doctorado, en su camino en la exploración de la investigación multidisciplinaria e interdisciplinaria.

Métodos: Se utilizó el enfoque cualitativo, se utilizaron estudios de literatura, consultas, observaciones, discusiones de grupos focales, entrevistas y evaluaciones de cursos con estudiantes, así como documentación sobre el diseño del curso como fuentes empíricas.

Resultados: La principal implicación del estudio es que el curso brindó a los estudiantes la posibilidad de profundizar su comprensión sobre las barreras y los beneficios de la investigación multidisciplinaria y transdisciplinaria al interactuar y debatir con compañeros y profesores de diferentes disciplinas.

Conclusiones: En este estudio se sugiere que la multidisciplinariedad y interdisciplinariedad y incluso la indisciplinariedad pueden ser la forma de cooperar a través de las disciplinas, aprender colectivamente y crear valor para los investigadores, tanto para resolver grandes problemas como para crear algo nuevo e innovador, buscando soluciones y desarrollo futuro para el mundo. La tarea de los educadores y los agentes de aprendizaje, así como de los encargados de formular políticas, es facilitar los sistemas de aprendizaje críticos participativos y sistémicos y las situaciones en las que estas condiciones pueden realizarse.

Palabras clave: multi y transdisciplinariedad, aprendizaje individual y colectivo, creación de valor, investigación, curso universitario.

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INTRODUCTION

In an increasingly globalized and competitive world, with huge demands on common solutions to our global problems, we all have to face extremely complex reality, rapidly changing technologies and an exponential growth of knowledge. Against this background, it becomes more and more unlikely that a single individual, research group or organization possesses all of the knowledge required (Howells, James & Malik, 2003). In this context, knowing and understanding the drivers and barriers of knowledge sharing becomes an absolute prerequisite for the success of any collaborative effort, particularly in regard to issues of multi -and interdisciplinary research. Information technology experts have developed highly sophisticated tools such as groupware, discretionary databases, intranets, knowledge-management systems workflow technology to support the exchange of disciplinary insights across time and distance barriers. However, it has become clearer that technology is only one of the ingredients in successful knowledge exchange. The other, if possible even more important, requisite is that of a social and organizational environment which encourages or even enforces knowledge sharing. One important social environment is membership in any organizations and communities where people meet each other and learn both individually and collectively. There are, though, no two organizations that have undergone exactly the same history of learning experiences. Collective knowledge is hard to appropriate by third parties because of its supra-individual character. It is difficult to imitate because it is casually ambiguous, i.e. it is embedded in a complex network of formal and informal interpersonal relationships and in a shared and often unspoken system of norms and beliefs (Sanchez and Heene, 1997). Interdisciplinary research is acknowledged as having great potential to break through complex social problems and foster innovation (Stember, 1991; Elsevier, 2015). There are continued challenges to the realisation of interdisciplinarity within institutional settings today. Disciplines at universities has developed goals for academic and research endeavours, which has led to usual approach to both teaching and research development (Stember, 1991; McLeish and Strang, 2014). Collaboration demands call for the open exchange of ideas, challenging the personal and institutional boundaries, acting to maintain a sense of ownership and authority over territories of knowledge. It is no surprise that an interdisciplinary agenda can generate both passionate enthusiasm and also defensive opposition within large complex organisations such as institutions. Nevertheless, funding council priorities and agendas increasingly require collaboration or interdisciplinarity, thus pushing universities towards a partnership-based approach to research (McLeish and Strang, 2014). Moreover, interdisciplinarity and collaboration is itself potentially more lucrative to countries, being associated with higher levels of patent applications, stronger relationships with industry and a greater chance of new knowledge to solve wicked problems (Elsevier, 2015; United Nations, 2015). Not surprising in this scenario, national governments are now purposively attaching much greater strategic importance to capacity-building decisions and investment.

Policy focus is increasingly on resource allocation for research and development, the formation of human/intellectual capital through education and training, the necessary management and institutional arrangements (intellectual property and producer services), and the ability to capture and apply these intellectual products (Turpin & Garrett-Jones (2000). Indeed, this strategic focus and resulting expenditure are now seen as critical to national geo-political positioning. Today, the production and dissemination of knowledge, often referred to as research and development, is viewed as a public asset. This changed perception of the role and importance of higher education has gone hand-in-hand with calls for greater institutional accountability and responsibility. Once perceived as the training ground for professionals, universities are increasingly being treated more like other organizations and professionals more like workers (Slaughter and Leslie, 1997). This has meant more emphasis on and questioning of institutional mission, outputs, and value for money. As higher education institutions have reorganized and restructured themselves to meet these new challenges, the academy has also come under pressure. The content of academic work, the role of faculty, the balance between teaching, research and service responsibilities, are, arguably, being restructured, reconfigured and redefined. For academics within traditional universities, pressures for accountability and social relevance are challenging what many have valued as their autonomy and academic freedom. Faculty within newer colleges and institutes have come under different pressures, most notably to spend more time conducting research. For both groups, participation in research teams, research output and earned research income are now critical metrics for academic recruitment and promotion, and the privileges and opportunities that flow (Slaughter and Leslie, 1997). At Uppsala university demands for interdisciplinary cooperation is visible e.g. through statements in some policy documents. In Uppsala University objective and strategies, UFV, Universitetsförvalting, (in eng.University Administration) 2013/110, is encouraged that research collaboration across subject boundaries within the university and with external actors is to be stimulated and structural barriers to such collaborations are to be removed. Also, The Doctoral Student Forum aims to organizing events that have a multi-disciplinary approach, in order to strengthen collaboration between young researchers in the Uppsala Forum environment. The ultimate goal is to foster cooperation on projects of an interdisciplinary nature (DSF, 2019.) This paper aims at investigating a doctoral course that took place at Uppsala University in autumn semester 2018. The course, Philosophy of Science and Qualitative Research Methods, was given at the Department of Engineering Sciences, Uppsala University, at the division for Quality Sciences. Historical grounding and contemporary approaches was designed to offer the doctoral students a deeper understanding of different disciplines in general and multi- and interdisciplinarity in particular. The course included both theoretical and practical exercises in order to create knowledge over the multi- and interdisciplinary research. The course had also a multi- and interdisciplinary design with both teachers and doctoral students from different academic backgrounds by fostering communication across academic domains. The purpose of this study is to describe the processes of joint learning of doctoral students, on their pathway in exploring multi- and interdisciplinary research.

1. THEORETICAL PERSPECTIVES

1.1 Disciplinarities

Institutions are usually defined as sets of conventions, norms and formally sanctioned rules constructed by societies that coordinate and regulate human interactions (Vatn, 2005). Disciplines can be understood as institutions that coordinate the production of knowledge. Generally, disciplines contain a set of instructions on how to generate knowledge including subject definitions, conceptual approaches, cognitive structures, goals and norms (Klein, 1996). Such constructs constrain the research activity that occurs within disciplinary spheres (Petts et al., 2008). According to Good (2000) disciplines are historical entities that can be seen as changing frameworks organising scientific activities. Disciplines are used to address well-defined issues but they are transformed over time to the extent that the initial logic and practices of a discipline may disappear (Good, 2000). In the process of specialization, disciplinary silos were formed, and there was little, if any interest in communication or integration in between. In the late twentieth century transformation of these silos may have been accelerated by a re-contextualisation of disciplines, a weakening of disciplinary boundaries and an alteration of identities, which all led to changes in canons, codes and categories of knowledge production processes (Klein, 1996). There are many different definitions of varied kinds of multi- and interdisciplinarity, mostly designed to capture what is felt to be degrees of interdisciplinarity (Griffin et al. 2006). Multidisciplinarity is defined by Stock and Burton (2011) as thematically organized rather than problemoriented. Disciplinary boundaries are not crossed, but rather different disciplines are considered in parallel. Interdisciplinarity, in turn, integrates perspectives, information, data, techniques, tools, concepts, and/or theories from two or more disciplines. While earlier definitions of transdisciplinarity focused on overarching theories that transcended traditional disciplines (Berger, 1972; Lattuca, 2001), the term has more recently taken on a meaning that includes a broader range of stakeholders, including practitioners and the public in its focus on solving authentic problems (Klein, 1996). Transdisciplinarity can then be considered as a process of collaboration between scholars and non-scholars on a specific real-world problem (Walter et al., 2007). Undisciplinarity, again, can be seen as a problem-based, integrative, interactive, interconnected, emergent, reflexive science and process which involves strong forms of collaboration and partnership (Robinson, 2008). Researchers have also pointed to the difficulties of drawing boundaries between disciplinarity and interdisciplinarity as forms of knowledge production (Klein, 1996). For example, researchers do not necessarily share the same understanding of interdisciplinary research (Vincenti, 2005). Aram (2004) observes that interdisciplinary research derives from the confluence, fusion or synthesis of disciplinary knowledge and from the re-definition of the disciplines. Others argue that the re-imagination of disciplines is already occurring as disciplines are now producing numerous specialisms, often overlapping and intermixing across social and natural sciences (Ramadier, 2004; see also Klein, 1996). However, despite possibly changing roles, Klein (1996) insists that disciplines continue to bear core elements of current forms of knowledge production. Such views suggest that disciplinary and interdisciplinary research may be closer than is commonly understood. More recently, interdisciplinary research and collaboration among scientists has increased significantly. The reasons for such a rise are varied. Interdisciplinary research may be regarded as: the result of changes associated with knowledge-based economies (Hicks and Katz, 1996); a necessary turn away from reductionist approaches to scientific progress (Lessard, 2007); a response to the challenges of an increasingly complex world (Latour, 1998) an approach to refine tools for practical work (Hukkinen, 2003); or a complementary element to ongoing specialisation in knowledge production (Weingart, 2000). Formerly unchallenged knowledge and expertise hierarchies may be called into question by a wide array of scientific communities and the public (Klein, 1996). Individual researchers or groups of researchers can expand or break the boundaries of disciplines to different degrees and hence facilitate interdisciplinary research, even though interdisciplinary research is mediated by the structures of power that draw the boundaries between disciplinary and interdisciplinary research (Klein, 1996). Therefore, one could understand interdisciplinary research as occurring in the 'border areas' between disciplines (Klein, 1996). However, in practice, the borders may be more amorphous than anticipated. Bibliometric research reveals that there exists substantial boundary-crossing between disciplines in terms of authorship of publications and readership (Pierce, 1999). Lau and Pasquini (2008) assert that disciplinarity and interdisciplinarity can be seen as something under constant negotiation. Challenges to interdisciplinary researchers emerge from the working practices of those individuals who strongly adhere to the institutions of a discipline and their operation within organizations. In his structure of scientific revolutions, Kuhn (1962) provides a detailed account of the process of knowledge reproduction through textbooks and the reproduction of knowledge in higher education institutions. Disincentives resulting from academic reward structures and evaluation procedures, almost entirely developed along disciplinary lines, constitute serious barriers to interdisciplinary research (Vincenti, 2005; Lau and Pasquini, 2008). For example, one of the vehicles for the reproduction of disciplinary institutions is the educational process. Education is produced through a series of formally sanctioned rules, exams, research projects, and practical work, all within the contours of particular disciplines.

Such institutions have been commonly identified as one of the main obstacles for interdisciplinarity (Frs, 1962). Single-discipline education is still predominant in higher education. Once education is completed, the researcher will be encouraged to remain within a single discipline by a range of disciplinary institutions such as: the dominance of disciplinary publishing for career advancement (Griffin, 2006) the review processes of funding proposals (Griffin, 2006) and the performance indicators used within

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university departments (Bourke and Butler, 1998). Some research suggests that researchers may struggle to obtain recognition for interdisciplinary research from traditionalist research institutions, such as scientific journals (e.g. Tress et al., 2006).

Undisciplinarity due to Celaschi, Formia and Lupo (2013) allows us to be more disruptive which is needed for imagination and action towards the unknown. Undisciplinary is a reaction to the struggle of mixed disciplinary approaches and the conflicts it can bring. It is based on 'the long-standing concept of the unity of knowledge, according to which the ultimate goal of scholarship is to provide an integrated and unified understanding of all knowledge' (Robinson, 2008, p. 71). Marshall and Bleecker (2010) argue that the key of healthy academic environment is that we learn to coexist beyond disciplines. Undisciplinarity is a habit of working and approach to creating and circulating culture that can go its own way, without worrying about working outside of what histories-of-disciplines say is proper work. It is undisciplined, meaning new knowledge is created rather than incremental contributions to a body of existing knowledge (Celaschi, Formia and Lupo, 2013). Research shows that early career researchers feel the need to describe their own work as clearly demarcated within a discipline that has long historical roots, in order to gain legitimacy among their senior colleagues (Haider et al, 2018). When viewing interdisciplinary work, scholars then tend to try to squeeze it into their own discipline or create a new discipline (Robinson, 2008). This development is in contradiction to what is considered to be necessary for sustainable academic development. (Kates et al. 2001; Komiyama and Takeuchi 2006; Leach et al. 2010). Robinson (2008) argues that this need of staying within one discipline will never enable you to engage with the real and complex problems of the world. What Robinson (2008) calls issue-driven interdisciplinarity or undisciplinarity, refers to the studies of academics that are more interested in creating forms of knowledge that are inherently useful rather than creating a discipline that primarily focuses on its theoretical or epistemological claims. Undisciplinarity doesn't supress facts about the real world and its plurality to be able to satisfy a discipline but welcomes them for consideration (Robinson, 2008). Undisciplinarity is more interested in reaching across disciplines for a particular purpose rather than filling gaps between them (Robinson, 2008).

Interrupting the structures of existence (in this case the existence of academia as a disciplinary sector) could lead to a transformation towards long-term relationships and create a process where 'we learn to travel together differently in a foggy road – with the stamina for the long-haul rather than a desire for quick fixes'.This ontological critique on education and thinking around global challenges shares the vision of undisciplinarity in academia in a way that both ask questions about how we could experience existence substantially differently to what we already know before or have been taught 'because solutions articulated from within the system itself will ultimately result in more of the same'.

1.2 Learning individual – learning group

Learning, as a concept, has been looked at from various disciplines and perspectives throughout history, including both individual and collective learning. As a result, the concept of learning is used to cover a wide society of ideas (Minsky, 1988). In this article, though, there is no attempt to give a full overview of the results of conceptual richness (for an overview, se e.g. Lundgren, Säljö and Liberg, 2014). Instead, the choice here is theories that can bear relevance to the perspective on learning in multi- and interdisciplinary settings. Especially interesting are those perspectives that address joint processes of learning. It is further assumed that creation of the values is a learning journey. To implement creation of values in any group, it is necessary to tag on to collaborative culture.

Creation of collaborative culture requires creative thinking in solving problems, leadership, knowledge management, institutionalized learning, experiential learning, communication, quality management, and continuous improvement in a group or an organization (Roser et al., 2013). Theories of individual learning are crucial for understanding organizational learning. Psychologists and educators have studied individual learning for decades, but they are still far from fully understanding the workings of the human mind. Likewise, the theory of organizational learning is still in its embryonic stage (Lundgren, Säljö and Liberg, 2014).

Group learning is more complex and dynamic than a mere magnification of individual learning. The level of complexity increases tremendously in the change from a single individual to a large collection of diverse individuals. Issues of motivation and reward, for instance, which are an integral part of human learning, become doubly complicated within groups. Although the meaning of the term "learning" remains essentially the same as in the individual case, the learning process is fundamentally different at the group level.

In the early stages of a group's existence, group´s learning is often synonymous with individual learning because the group consists of people and has minimal structure. As a group grows, however, a distinction between individual and group learning emerges, and a system for capturing the learning of its individual members evolves. Collective, collaborative and collegial learning are terms often used in the context of joint learning processes. Collaborative learning can be considered as a special type of phenomenon, where the starting point is that all learning is based in social activities. (Johnson et al., 2008). According to Granberg and Ohlsson (2016) there is a difference between collaborative and collective learning consisting of that in collaborative learning there is group of individuals trying to learn something together but without to specify or clarify the social context. In collective learning, however, it is decisive to try to achieve a common understanding. Ohlsson (1996) notes, that the collective learning shapes how the individual perceive their practical work and thereby shape the collective learning potential of individual experience. It is important for the collective learning that the experiences are described in the collective so that the community can jointly problematize and

reflect on the experience (Ohlsson 1996; Wilhelmson, 1998). To summarize the aspects of learning above, it can be stated that learning is valued in this study by incorporating both individual and collective learning processes, preferably in balance. Collective learning can then be seen as one of the tools and arena for the acquisition of these knowledge and skills. Interdisciplinary knowledge can even be seen as creation of interdisciplinary values. Hence, it can be interesting to learn more about the processes included in value creation.

1.3 Processes of creation of values

Co-creation or creation of values are the concepts often used in business and management literature and research (Vargo, Maglio and Akaka, 2008). However, this described relationship between the customer and the provider of the product can also be transferred to describe a relationship between a student and a university teacher as well as any group leader and members of the group. In this relationship, the course leaders lead and invite the member into learning process, by continuously following up the process. But how does this co-creation of values emerge in practice, both individually and in collective meaning? Meaning making as a concept is described in psychology, as a process of through which people construe, understand, or make sense of life events, relationships, and the self. (Ignelzi, 2000) Through meaning-making, persons are retaining, reaffirming, revising, or replacing elements of their orienting system to develop more nuanced, complex and useful systems. (e.g. Gillies, Neimeyer and Milman, 2014) The term is widely used in constructivist approaches. (e.g. Dorpat and Miller, 1992) and in educational psychology (Ingelzi, 2000).

Sensemaking, however, has been described as a process by which we give meaning to our collective experiences. It is often formally defined as the ongoing retrospective development of plausible images that rationalizes what people are doing (Weick, Sutcliffe and Obstfiel, 2005). The concept was introduced to organizational studies by Karl E. Weick in the 1970s and has since had an impact on both theory and practice. The concept was intended to favour a shift away from the traditional focus of organization theorists on decision-making and aiming towards the processes that constitute the meaning of the decisions that are enacted in behavior. Research on sensemaking has become an important issue in organizational studies and has been growing as more researchers seek answers to how meanings are created in organizations (Hernes and Maitlis, 2013). Weick identified seven properties of sensemaking. Identity and identification, retrospection, people enact the environments they face in dialogues and narratives, sensemaking is a social activity, sensemaking is ongoing process, people extract cues from the context and people favour plausibility over accuracy in accounts of events and contexts (Weick, 1995).

These theoretical aspects, presented above, are used in this study as a foundation for analyzing and understanding the processes involved in the interaction and cooperation between group members and course leaders, specially working with the issues of multi- and interdisciplinarity. Furthermore, these processes can be considered as a framework for understanding the complexity of learning on issues of interdisciplinarity in any group context.

2. COURSE DESIGN

Students' learning and teaching at the university level, is often focused on the theoretical and disciplinary knowledge. There are seldom opportunities for a more creative and imaginative approach, though. It is not often students have the opportunity to explore something new by using their theoretical knowledge, creativity and fantasy. The course Philosophy of Science and Qualitative Research Methods was given on autumn semester 2018 at the Department of Engineering Sciences, Uppsala University, division for Quality Sciences. Historical grounding and contemporary approaches were designed to offer the doctoral students the possibilities to get a deeper understanding of different disciplines in general and multi- and interdisciplinary research in particular. The way to achieve this was through letting students in a structured manor take part of scientific literature and inspiration seminars given by experts in different fields. The course offered an overview of the historical development of philosophy of science and an introduction to contemporary research methods, including academic writing.

Its purpose was to assist Ph.D. students to broaden and sharpen their understanding and practical skills of philosophy of science and qualitative research methods in the light of their own dissertation work. Participants, in the course, were seven PhD students, of which two were of foreign nationalities and rest of them Swedish. All the students were studying at Swedish universities, three of them at Uppsala university, but came from different departments and four in other Swedish universities. The subjects they were writing their theses on varied from natural sciences to humanistic subjects. Topics represented in the group were business administration, biology, quality engineering, technology and computer science.

The course consisted of three two-day blocks. For each block, specific theme with readings, guest lectures, seminars and writing exercises was assigned. During the first block, the point of departure was a critical examination of how science has emerged over time and inquiring into central questions and approaches within philosophy of science by answering the questions: what types of problems and questions are foundational to the way we look upon different scholarly work today? Then the relevance of these problems, questions and frameworks for today was explored in general but also more specifically through each participant's research efforts. The second and the third two-day block consisted of exploration of different qualitative research methods. The course was offering opportunities to gain a richer understanding of how different methods can be used. Guest lectures were

presenting and discussing the methods they are using themselves. The course participants could also have the possibility to try out different methods. Exercise in form of interviews with three senior researchers, familiar with working interdisciplinary, were designed for the students in order to widen their understanding over the multi- and interdisciplinary research in practice. These results were then transcribed and then discussed during a seminar. Toward the end of the course it was focused on academic writing, the activity it is spend so much time working on, but still, discussing about so little. Different discipline's different writing traditions were thus explored.

3. METHODS

In this study the qualitative approach was used, literature studies, inquires, observations, focus group discussions, interviews, examinations and course evaluations with students as well as documentation over the course design were all used as empirical sources. Concepts drawn up from the theoretical framework, presented above, were applied as method and tools for analysing the group prosesses, e.g. disciplinarities, learning, group dynamics, co-creation of valurs etc.

In the following, synthesis and evaluation over the barriers and facilitators for working towards interdisciplinary research are highlighted through learning experiences expressed by the doctoral students.

The course design provided as a structure that encouraged openness, and reflexivity for, and insights into, multi- and interdisciplinary scholarship built on experiential insights through experts, litterature and discussions in group. The survey provided was an so called interquest (hybrid of the interview and inquery, sent by email) with only open questions over the background and experiences of those studying the course. Interviews, completed by the student, with the senior researchers were navigation aids to practical processes within multi -and interdisciplinary research. Three senior researchers from different scientific disciplines got interviewed by students over their experiencies working multi- and interdisciplinary. Further on a senior researcher was having a half day seminar about working in multi- and interdisciplinary research teams within EU, in the projects of multinational settings. The results of these data are presented in the following section and analysed by using the theoretical findings on processes on learning and value creation. In this study, it was first engaged in a phase of open coding of data material without explicit regard for their theoretical contribution. Upon further analysis, the following sub-themes were distinguished through datacollection. Students 'earlier experiences of multi- and interdisciplinary research, benefits and barriers, future approach towards and learning processes towards multi- and interdisciplinary research. These dimensions are not distinct, but highly interconnected.

4. RESULTS AND ANALYSIS

- **Earlier experiences in working with multi- and interdisciplinary teams?**

The students seem to have varying degrees of knowledge and experience of multi- and interdisciplinary research. Some already write their theses interdisciplinary. Others say that they want to work interdisciplinary but have found it difficult to find partners to co-operate with. Again, some other says to have more than ten years of experience in this through studies that have combined several different disciplines. Most of the students have been involved in a project where different disciplines have been cooperating. These projects have been about combining topics such as computer science and gender studies. Everyone has had only positive experiences with such cooperation.

- **Benefits and barriers for conducting multi- and interdisciplinary research?**

The positive aspects with multi- and interdisciplinary research, according to the students, consist of being able to learn from each other, see more holistic over the problems, be able to conduct wider research, use each other's methods, be able to see different perspectives on problems and become more creative and innovative. As challenging is experienced the solid disciplinary structures that make cross-border research more difficult. It might also be troublesome to get research grants, publish the multi -and interdisciplinary research in journals and find relevant feedback from colleagues who do not participate in the projects, was stated by the students. All this can be negative for the continuing academic career, believe students. Some of the students highlighted the possible conflicts caused by power structures, rivalry between different institutions or researchers, issues of identity, different interests and interpersonal relationships etc. Also, supervision of doctoral students can become problematic to organize when working over disciplinary boundaries.

- **Future approach towards multi- and interdisciplinary research?**

All students stated that they will work multi- and interdisciplinary in the future in different ways and to different degrees. Some work more or less interdisciplinary already with their doctoral theses, others see good opportunities in the future by writing articles together with researchers from other disciplines. Some claim that they feel uncertainty when using theories and methods that they are not familiar with from their own disciplines, even if they are curious about them at the same time. A student points out that working multi- and interdisciplinary is the only way to create a better, common world.

4.1 Learning in the course

Using the data collection from survey, focus group interviews, evaluations, course design and observations, it is possible to conclude, that doctoral course of Philosophy of Science and Methods in Multidisciplinary Research has been promoting students' learning. Students found that their skills for communication, interaction and reflection has been sharpen and developed increasingly. The skills for working together have also been improved. Students are also aware of the complexity of learning in groups compared studying individually. However, learning in a group is perceived as more rewarding in the long run. It provides broader knowledge when you can share the experiences of others.

The students also state that they can change their positions during group discussions because they are open to the opinions of others. According to students, there is a need of some symmetry between participants in the group, but at the same time the groups cannot be too homogeneous. This course, however, was including students from several different disciplines. This was not experienced by anyone as problematic, nothing that threatened group dynamics. Students are telling that they are used to work in different groups during their education. Working in groups gives more opportunities for solving the problems, according to students. While working as a group, students like to treat the problems at a practical level. They can then achieve a common understanding of phenomena in the whole group. They also pointed out the importance of reading several articles in order to explore several perspectives on multi- and interdisciplinarity. Supporting course design, experienced by the student, was composed by different methods including external lectures, seminars, readings and not at least exercises (interviews, role plays etc.) and discussions in group. Specially the discussions over the ontological and epistemological issues were interesting and rewarding according the students. It was beneficial for learning outcomes that both teachers and course participants came from different disciplines. They could then share different, discipline-specific experiences and conventions to each other's. Some of the students felt it frustrating not having knowledge enough of perspectives of multi- and interdisciplinarity and philosophy to be able to discuss the issue in a more deeper way. Also, of importance, has been enthusiastic and committed teachers and guest lecturers. Some of the students were very critical of their own contribution in the group because of insufficient time use, due to poor preparations for the tasks or due to the lack of background knowledge. Others, again, pointed to their own way of taking too much place in the group and talking too much. One of the students stated being at the beginning of doctoral studies and saw it as an obstacle to a more contribution in the group. None of the students thought that they contributed to any major scope of the group's learning. Students are further talking about the learning outcomes in the course and point out theoretical foundation they have received in the course of multi- and interdisciplinarity. Awareness of the challenges but also the benefits have been highlighted in the course. Also, deeper understanding for their own multi- and interdisciplinary research, at the moment, is taken up as a learning in the course. Still, there is one student who claims that the course has not given any new knowledge of practical character what so ever. Individual learning is the base for all joint learning. The students' statements testify that the complexity of learning increases with group learning. This both motivates and rewards learning.

The subject of multi- and interdisciplinary can feel overwhelming at the beginning as the whole group reflects on their disciplines, but when the group gets to know each other better, the group becomes an asset for learning. The way this student group learned is similar to a combination of collegial and collaborative learning. The students felt that what created the most learning in the course was the meetings with senior researchers who shared their practical experiences of multi- and interdisciplinary research and international cooperation. Prerequisites, according to Dixon (1994) for collective learning and value creation are: interaction, communication and reflection, structure of the organization, organizational culture, working methods and ways to inform and communicate. The course design seems to provide good conditions for collective learning and co-creation of values in the student group. Students feel free to express their thoughts in seminar discussions, evaluations, through exercises and examinations. The group size (seven students) enables and requires an equal participation in group discussions (Ohlsson 1996; Wilhelmson, 1998). The students are not familiar with each other and perhaps this makes them curious about each other's personalities and their disciplinary work and research. Student statements show the maturity of the group in working and learning collectively. They have learnt and understood that diversity in the group can be developing and that the benefits of the group is to be preferred in order to get work done. Students are talking about balancing between permissible and impermissible borders in their group working processes (Ohlsson, 2004). Students also state that there is a need, in long run, to restructure the group in between, to form new constellations, to introduce new members or to break the roles of the group in order to gain group dynamic needed. This is even important for avoiding so called groupthink where the group desires for harmony or conformity and when this then is resulting an irrational or dysfunctional decision-making outcome. Group members try to minimize conflict and reach a consensus decision with critical evaluation of alternative viewpoints. But all in all, these things are depended of the actual working tasks.

CONCLUSIONS

The interplay and group learning between actors in group can be seen as a platform or an arena for possesses of learning and value-creation. The discussions and the interaction with other members of the group do not only create value for the individual itself but also for the whole student group. Group members can then be seen as co-producers of values. This value-creation process includes several other processes and seem to be an important part of learning processes. The learning process is fundamentally different at the group level. To sum up the results presented above, there are important factors which are relevant and seem to support learning towards working and studying multi- and interdisciplinary.

- There need to be a certain awareness of the level of complexity of collective learning in group compared with learning as an individual process.
- Learning needs to be seen as a social process during which individuals can change their way of thinking about something.
- Learning towards multi- and interdisciplinarity should be connected to both individual as well as groups' identities. It is also decisive to achieve a common understanding over learning goals in the group.
- It is necessary with synergy, based on interaction and communication which generate new common beliefs. Learning in group context requires certain symmetry between the participants.
- There is a requirement of awareness of that collective learning can shape how the individuals perceive their practical work and thereby is shaping individual experience potential.
- It is further important that the experiences are described in the collective so that the community can jointly problematize and reflect on the experiences.
- Both individual and collective processes have a dynamic character. The on-going co-construction of permissible and impermissible borders are in progress within both processes.
- It is also significant to develop action strategies for how the collective knowledge can be used to create collective expertise.
- Furthermore, processes of value-creation include demands of that something needs to be explained in group. Reasonable explanations occur to the event and are spread through communication. Speculation becomes universal but may not be accepted at once. Then a consensus occurs around what has happened.
- Consequently, inter- and transdisciplinary approaches can then take place.

However, embarking upon an interdisciplinary endeavor as an early-career scholar poses a unique set of challenges: to develop an individual scientific identity and a strong and specific methodological skill-set, while at the same time gaining the ability to understand and communicate between different epistemologies. Because most participants in interdisciplinary ventures are trained in traditional disciplines, they must learn to appreciate differing of perspectives and methods. An interdisciplinary program may not succeed if its members remain stuck in their disciplines and in disciplinary attitudes. While much has been written on the philosophy and promise of interdisciplinarity in academic programs and professional practice, social scientists are increasingly interrogating academic discourses on interdisciplinarity, as well as how interdisciplinarity actually works and does not work in practice. Some have shown, for example, that some interdisciplinary enterprises that aim to serve society can produce deleterious outcomes for which no one can be held to account (Hall and Sanders, 2015).

FUTURE RESEARCH

A lot remains mysterious about the factors that facilitate or impede successful collaborations across disciplines in multi- and interdisciplinary endeavors. Moreover, interdisciplinary science creates new challenges for philosophy of science. A problem that is widely discussed in the literature on interdisciplinarity but underappreciated in philosophy of science is that in interdisciplinary science there are often multiple (sometimes conflicting) norms and values, differing ideas about what constitutes good science. There is no single means of accounting for or describing the means by which these negotiations take place; they must be studied and described in the contexts in which they are occurring, with careful attention to the features of the context and the subtleties of interaction between scientists. That is, we cannot fully understand the dynamics of interdisciplinary science without examining how good science is understood and enacted by actual scientists working within these new settings.

This is a matter of understanding how values are enacted in ordinary contexts of science practice. However, because ideas about what constitutes good science are tied up with what it means to be a scientist, at least a good or competent one, ideas about how science is to be done implicate identities as well as values. Greater attention needs to be given to disciplinary identity and how this implicates epistemic value, and more broadly, how identity cuts across different types of values. This requires, in turn, a focus on the epistemic affordances of different disciplinary positions/perspectives.

Among the questions to pursue is whether there are ways to talk about identities that are good for science and science education, that are analogous to discussion of values that are good for science (e.g., Douglas, 2009).

It is suggested in this study, though, that multi- and interdisciplinarity and even undisciplinarity can be the way of co-operating cross the disciplines, learning collectively and creating value for researchers in both solving big problems, in creating something new and innovative, finding solutions and future development for the world. Further work is needed for a better understanding

of the role of learning towards multi- and interdisciplinarity. We need knowing what kind of types of mental models that are favorable, which models are appropriate for representing dynamic complexity of learning multi- and interdisciplinarity; we need methods with which we can capture the understanding of such complexity as well as means through which new learning for multi- and interdisciplinarity can be transferred to the research communities. The task for educators and learning agents as well as policy makers is to facilitate participative and systemic critical learning systems and situations where these conditions can be realized. In order to carry out changes in multi - and interdisciplinary research, with all the perspectives in mind, the research communities should focus on promoting what is called collective learning. Learning journey towards multi- and interdisciplinarity seem to need both individual and collective learning processes.

ACKNOWLEDGEMENTS

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