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Doctoral Supervisors' conceptions of mathematics education research and mathematics education researcher

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Doctoral supervisors' conceptions of quality indicators of mathematics education research and of a mathematics researcher were investigated as a part of a more comprehensive study investigating a doctoral program (DP) at a Nordic university. The data set consisted of transcribed interviews with five supervisors, which were analysed by an inductive coding process. Findings revealed that supervisors' conceptions of quality indicators of mathematics education research were built on a major understanding, the Chain, which refers to the connectedness and coherence of research processes from the purpose until the conclusions. A mathematics education researcher should be able to perform this Chain and also have certain competencies such as knowing the field, being open-minded, and having communication skills, mathematics knowledge and classroom experience. The implications for DPs are discussed.

Keywords: Conceptions of research, conceptions of researcher, doctoral supervisors, doctoral programs

Introduction

Studies exploring the structure of doctoral programs (DP) in mathematics education have focused on numerical data in documents or gathered through surveys, the structure of the DPs in terms of courses (for example, Reys & Dossey, 2008; Reys & Kilpatrick, 2001), or the employment rates of graduates and evaluation of them in the context of their work (for example, Reys, 2006; Reys et al., 2007). While the effectiveness of mathematics education DPs is generally evaluated in terms of objectives, processes, course contents, and research opportunities (Grevholm et al., 2008), doctoral students' and supervisors' conceptions have not been sufficiently addressed.

Meyer et al. (2005, p. 227) define conceptions of research as “conceptualized beliefs, ideas or understandings” of doctoral students who have an active research engagement. Kiley and Mullins (2005) define conceptions of research as understandings of research and of the act of researching. In the field of mathematics education, conceptions are considered mental structures that include “beliefs, meanings, concepts, propositions, rules, mental images and preferences” (Philipp, 2007, p. 259). Combining these definitions, conceptions of research in the field of mathematics education can be considered as a collection of understandings about how mathematics education research should be done in terms of quality indicators it should have. Similarly, the conceptions of a mathematics education researcher can be considered as understandings about the person who is engaged in mathematics education research.

Exploring conceptions is important because conceptions are likely to affect individuals' learning of a concept, learning of acting in a certain way, or learning a profession, such as researching or being a researcher. For example, doctoral students' conceptions of research have been explored to some degree with the assumption that these conceptions affect how they learn during their studies and how

their research engagement could be (Meyer et al., 2005). However, doctoral supervisors' conceptions, which may affect their supervisory practices and may be indicators of what DPs emphasize, have been scarcely explored (Lepp et al., 2013).

In one of the rare studies, Kiley and Mullins (2005) asked doctoral supervisors working in various fields to define research, and then list characteristics of "good research" and "good researchers" in a web-based questionnaire that was distributed to the UK, South Africa, Australia, and New Zealand. They identified four major categories for the definition of research: technical, creative/innovative, integrating complexity, and new ways of seeing. Supervisors in these four broad categories addressed different but non-mutually exclusive characteristics of good research. In general terms, "technical" supervisors pointed to rigorous methodology, originality, integrity, and relevancy as the characteristics of good research. "Creative/innovative" supervisors addressed innovative characteristics; whereas supervisors in the "integrating complexity" group expressed the wide and complex nature of research; and supervisors in the "new ways of seeing group" stated that research should lead to new ways of seeing and doing. Kiley and Mullins (2005) also reported that supervisors pointed out quality issues for good research such as being rigorous and methodological, having high quality data, employing soundly based and appropriate methodology, and being correct, ethical, well-communicated, and significant for research and society.

Kiley and Mullins (2005) identified three non-mutually exclusive major categories of characteristics of successful researchers as expressed by supervisors: personal qualities, research skills, and intellectual qualities. Personal qualities refer to motivational characteristics and moral qualities such as being dedicated, willing to take responsibility and criticism, being ambitious, and being honest. Research skills include research process skills that one should have to complete the process successfully such as communication skills, being systematic, well-organized, skillful in methodology, and scientifically minded. Intellectual qualities are about being logical, curious, open-minded, independent thinker, knowledgeable, and problem solver.

These conceptions are part of how supervisors see supervision, and they have the potential to affect their supervision practices and probably their students' conceptions and progress in their studies; and they may even cause conflicts when the doctoral supervisor and student do not share the same conception (Bills, 2004; Kiley & Mullins, 2005). For example, supervisors may see the doctoral dissertation as an end product or a process where a doctoral student develops into a researcher, which may or may not coincide with the doctoral students' view and may result in problems in the supervision and dissertation process (Lepp et al., 2013). Therefore, it is possible that the mismatch between supervisors' and doctoral students' conceptions of research and researcher may lead to a lack of effective communication between the supervisors and students, unproductive progress in doctoral research, and eventually may result in leaving the doctoral studies for the doctoral students.

Doctoral supervisors' conceptions of the indicators that show the quality of a research study may guide their evaluation of doctoral students' research. Similarly, their conceptions of the competencies of a mathematics education researcher affect how they see the development of doctoral students. Documenting doctoral supervisors' and students' conceptions of research and researcher may reveal the reasons for tensions and difficulties that negatively affect the doctoral study process and

supervision. It may also provide a base for developing a common and working set of conceptions that will lead to an effective doctoral study for the students and the supervisors. Therefore, the present study tried to answer the following questions in a Nordic DP:

What conceptions do doctoral supervisors in mathematics education have about quality indicators of mathematics education research?

What conceptions do doctoral supervisors in mathematics education have about the competencies of a mathematics education researcher?

Methods

The study reported here is part of a more comprehensive case study where I investigated doctoral supervisors' and students' experiences and practices in a Nordic DP in mathematics education. The present study explored the conceptions of five doctoral supervisors. The supervisory experience of the supervisors ranged from 5 to 20 years. They had various research interests, and they have been working in or leading research groups in the research centre that mathematics education researchers in the DP were affiliated with. Each supervisor was either the main or second supervisor of at least four doctoral students. The ethical procedures were completed before the data collection.

The semi-structured interview protocol had 24 main questions about supervisors' experiences and conceptions of research, their views about the DP and its outcomes, and their supervision practices. The examples of the questions are: "In your opinion, what are the characteristics of a (high) quality mathematics education research?", "What are the competencies of a mathematics education researcher?", and "What competencies does this doctoral program expect its graduates to gain?" Interviews took 60-130 minutes and were conducted at the supervisors' offices. All interviews were transcribed verbatim, and the transcripts were read with a focus on the conceptions of quality indicators of mathematics education research and of the competencies of a mathematics education researcher. The inductive coding process (Miles et al., 2014) started with taking marginal notes in the first two readings of the interview data. These notes led to a list of draft codes for the first round of coding. A table of initial findings was constructed after the first coding of data for each participant under each major pre-determined theme: "quality indicators of mathematics education research" and "competencies of a mathematics education researcher." The construction of the table also provided an overview of the code-coded chunk pairs, consistency among the codes across the data, and a finalized code list. The second coding resulted in the findings documented below.

Findings

Quality indicators of mathematics education research

Supervisors were asked to elaborate on the characteristics of quality indicators of mathematics education research study. Four supervisors described one major theme that seemed to direct all research progress and additional characteristics. The major theme, *the Chain* (self-translation), as explicitly expressed and explained by these participants, addressed the connectedness and coherence across the research steps, from the purpose of the research to the conclusions that are drawn from the study.

Every part is connected, there is no disconnection... Sort of progression from the general purpose, research question, theory, methodology, method, analysis results, conclusions, discussions... Sort of more or less all the components of the study reported in a text.

[...] What is probably the most important thing is that the methodology and the results are in... They go together with the research question so that the methods used are appropriate in relation to the research question. And the results and mainly, the conclusions that are drawn from the study are valid and can actually be drawn from the results, and results can follow from the methods.

[...] and the whole chain there between the purpose, the questions, method... All the way to the what type of conclusions and results should we formulate so that those are reasonable and actually grounded on the data that you have.

One supervisor, who identified herself as “a teacher in [her] heart”, did not emphasize *the Chain* but addressed that there were two important indicators: combining qualitative and quantitative approaches to understand the phenomena better and drawing questions from the classroom reality:

I really like to look into questions that come from teachers’ or students’ perspectives. I am not that kind of researcher that reads about the theory and things. I really would like to see if the theory works in this context or that context.

Supervisors addressed other indicators often by emphasizing that a specific one is “important” for them in research. Some of them were expressed in relation to *the Chain*.

There are different aspects of it. But if I start somewhere, I would say... I think I start by looking at its aspects of methodology, in broader sense with its connection to the purpose [...] this is where I would start, methodology in the broad sense. But in general, I think the coherence of the study, which also connects to the methodology of the study.

[...] but I really like.. For the essential part is that operationalizing is really essential.

[...] the research topic should not only be interesting to the person who is doing it or a few persons, but should be important also. This is one of the things that I believe important for quality that it should be important both from scientific perspective to the goal of the project, to enhance our scientific knowledge. But also have a potential for being important for practice.

The findings revealed that there seems to be a common understanding of the quality indicators of mathematics education research among the supervisors. They addressed the importance of drawing valid conclusions from research findings that were found as a result of a research process where purpose, research questions, theories, and methodology take place in relation to each other. They referred to *the Chain* from time to time during the interviews.

Competencies of a mathematics education researcher

Supervisors expressed several competencies that a mathematics education researcher should have. When they needed some clarification, I indicated that the competencies may include knowledge, skills, values, and attitudes, or whatever they see relevant in relation to these constructs. Some of them indicated that most of the competencies are actually valid for any researcher. Being able to

perform *the Chain* and knowing and performing the steps of a research process were important for a mathematics education researcher. Thoroughness was emphasized by the supervisors.

To be able to carry out this kind of research, *the Chain*, to be knowledgeable about the components of the field, theories, methodologies, research results [...].

[A]t least to have knowledge about different research methods, potentially different theories or application of theories, or theoretical perspectives on frameworks of different types.

I think a researcher has to be really thorough and... I mean, there is some sort of having good basic structure of your work, being able to organize systematically, take care of all the stuff.

[A] good researcher should be someone who knows, who has a broad competence, for example in methods. I mean, we know we have researchers good in few methods, but not others. For example, you can be very knowledgeable about some of the qualitative research approaches but you cannot read or understand publications that are quantitative in their main approach. And that limits a researcher.

Knowing the field, being open-minded and creative, and being flexible were important in designing the research and performing it. Such competencies were important to making sound decisions during the research process.

You need to read a lot, you need to be acquainted with the research that has been done. What questions are out there, what questions are already answered so you don't do the same thing just once more.

And also, a really good researcher is interested, creative in the thinking and finding new areas, new issues [...] They have to be creative enough to find maybe new ways of investigating such research questions if they are new. [...]

[Be] open to other ways of doing things, not getting locked into a particular way... You can get stuck... You have to be able to take a step back and look at what's been going on and think about it... Ok, is there any other way to do this? Maybe we are going about this all wrong the way.

Researcher competencies were not only about knowing and performing the research process, but also being able to communicate this process to the research community. While written communication was important for self-critique, oral communication was related to the research knowledge and important for improving as a researcher within a community.

I also think that being verbal, being able to put into words whatever is that you are thinking is very important. Because if you can't do that it is so hard to share with the others... And explain, and also to be able to criticize what you are doing yourself... You can't have a look at what you are doing if you can't put into words.

You cannot involve yourself with high quality research discussion with others if you don't understand what they are doing. So, the broader you are [in relation to the research approaches], the more you could communicate with the research community, understand, and get insights from a lot of different approaches that could promote your own research.

Relevant mathematics knowledge and classroom experience were important for designing the study and understanding the data. Relevant mathematics knowledge is a strength when the researchers try to make sense of possible explanations for the findings. Classroom experience was important to have an intuitive understanding of what took place in the classrooms.

Maybe not in all areas, but in many areas of mathematics education, I think some good math skills, you know... And not just knowing how to do things, but something about what is the difficulty of types of math or knowing the options... Depends a bit on what you are working on, how important that is, useful...

I think it is really important if you have been there and worked with the students, and actually have some experiences of really struggling students who try to grasp mathematical concepts and the relationships.

I think it is difficult to only base your work on formal knowledge theories, frameworks, and methodology because all these so far away from complete understanding of teaching and learning. Teaching and learning is so complex that we cannot rely this formal approach. [...] If I see mismatch between the formal approach and the intuitive approach, then I need to be extra careful with the formal approach. And maybe the formal approach is not working. [...] I think to be able to use your experience and have a good intuitive approach, you need experience also from teaching and learning of mathematics.

Discussion

Findings revealed that there was a more unified conception of the research indicators among the supervisors, *the Chain*, where the progress of the research steps could be followed in relation to each other. It was important that the purpose of the research guides the research process and that valid conclusions are drawn from the findings, which are still in line with the research purpose. *The Chain* was the major quality indicator of a research study. Supervisors also listed individual indicators in relation to the methodology and the connection between the theory and the classroom. These findings seem to comprise what has been found before, such as rigorous methodology (Kiley & Mullins, 2005). However, the theory-practice connection may be prioritized as a quality indicator more for studies in the field of education. It is possible that the supervisors judge the quality of a research study with these conceptions and emphasize these indicators in their supervision of doctoral students. The conceptions here may address what experienced researchers want to see when they peer-review a research study for scholarly journals. Indeed, one supervisor indicated that he considered the lack of *the Chain* a very important problem and added that the editors of a well-known scholarly journal addressed the lack of such connectedness and coherence as the main reason for rejecting manuscripts.

The almost unified conception of the quality indicators of a research study could be related to the institutional goals for mathematics education research at this university as well as the scholarly practices at the mathematics education research centre. During the interviews, supervisors emphasized the importance of the bi-weekly seminars in the mathematics education research centre where researchers at any level presented their work, discussed the process with the other researchers, answered questions, and received criticism. The communication and evaluation of research in the seminars might have constructed more-or-less a common conception of the characteristics of quality

indicators of mathematics education research study. This may address the role of the social context where research practices and conceptions are discussed and may lead to more shared conceptions.

It is also possible to say that conceptions of doctoral supervisors in mathematics education are very similar to those found for a group of supervisors from different fields, probably because there is an implicit consensus on the fundamental quality indicators of research among both local and global research communities. However, in a field that combines multiple disciplines and fields, such as mathematics education or education in general, there would be more field specific conceptions of quality indicators such as connection to the practice in classrooms.

Supervisors' conceptions of the competencies of a mathematics education researcher, on the other hand, were more varied. Knowledge of methods and being able to skilfully manage the methods task were important for the supervisors. This was also related to *the Chain*; that the mathematics education researcher should be able to perform *the Chain* and build connection and coherence across the research process. However, this was not sufficient by itself. A mathematics education researcher should be aware of the field of study and be open-minded to making relevant decisions, which are also related to communication skills and receiving criticism. These competencies were mostly in line with the ones identified by Kiley and Mullins (2005) in their data.

In the most general sense, mathematics education researchers are expected to have knowledge and skills about mathematics education, psychology, sociology, mathematics and a critical research understanding (Presmeg, 2009). Supervisors' responses addressed a more elaborate description of a mathematics education researcher with reasons. Additionally, there are field-specific elements, such as having mathematics knowledge and experience in mathematics classrooms, within supervisors' conceptions of a competent mathematics education researcher. Supervisors working in fields that are fed by practice may prioritize characteristics that could be categorized as "experience in practice" in addition to Kiley and Mullin's (2005) categories. Supervisors may not expect the doctoral students to have researcher competencies from the beginning of their studies, but expect them to develop or improve these competencies throughout their studies. Therefore, their supervision may focus on guiding doctoral students towards these competencies.

The study revealed supervisors' conceptions that most possibly guide them in their evaluation of mathematics education studies and researcher skills. These may indicate the major conceptions in the DP that govern the experiences in the program. However, the findings are limited to one DP and its researchers and practices. There seem to be several further research outlets in this field. Other mathematics education DPs in different structures and in different countries could be investigated in terms of practices in the programs, conceptions of program supervisors and students, and how these conceptions reflect institutional and cultural factors. Additionally, mathematics education doctoral supervisors' and students' conceptions could be explored and compared to address the differences and similarities for a more productive doctoral education. Exploring and documenting conceptions could contribute to our understanding of DPs in mathematics education and designing experiences and opportunities for doctoral students to improve favorable conceptions that may guide their studies.

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