DG 12: Rethinking doctoral programmes in mathematics education

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Session 1: The goals and processes of doctoral programmes in mathematics education

The first session of the DG was intended to allow the sharing of features of respective doctoral programmes. In particular, the specific aims were:

- to increase understanding of the diversity of goals and processes for doctoral study in mathematics education;
- to allow reflection on common elements of doctoral programmes, and critical consideration of features that differ; and
- to facilitate identification of the best features of various programmes and support participants in reviewing their own approaches.

There were 35 participants from countries in Central America, US, Europe, Asia, Scandinavia, and Australia. The format of the first session was as a large group discussion on elements of the programmes of the universities of the participants. All participants were first invited to answer the following question:
What are the goals for doctoral programmes in your University? (for example., is priority given to candidates learning to engage in research, contributing to new knowledge, being inducted to academia?)

The main characteristics of the responses of the participants were their diversity. Given that there is a general acceptance of the equivalence of doctoral programmes internationally, the breadth of the responses was somewhat surprising. A strong theme in responses was that doctoral programmes were for the preparation of future researchers. Many programmes prescribe specific studies in methodology, and many sought to induct candidates to the relevant communities of researchers, including being an advocate for research. A second consistent theme was that many programmes had a particular emphasis on the preparation of future educators of mathematics teachers. Some programmes saw the doctorate as a pathway for future teachers of university mathematics.

Some programmes were conducted in predominantly mathematics departments, and others were in education departments. In the mathematics departments, there was requirement for at least some higher level studies in mathematics. The extent of the emphasis on preparation of future teacher educators seems dependent on whether the doctoral programme was located in mathematics or education departments. Some doctoral programmes were highly structured, with specific coursework, timelines, and assessment hurdles, while others were dependent on the vision of individual academics.

The second set of focus questions was:

- *What are the expectations for candidates' background for entry to doctoral programmes? (for example, what mathematics studies are expected, what practical education experience is required, are there pre-requisites for prior research?)*
- *What is the content, and what is the demand for coursework? (for example. are coursework studies core, and if so what are they, are they elective, if so from what range of courses?)*

Most programmes require a master degree for entry, and virtually all required some higher level studies in mathematics. The amount of coursework varies, in some places being a

high as 50% of the programme. Many places require assessments prior to completion that include mathematics education, mathematics, and some other education topics.

Session 2: Participants of doctoral programmes in mathematics education

The second session of the DG focussed on the participants in doctoral programmes in mathematics education, the doctoral candidates, the supervisors and teachers of doctoral courses.

Some of the questions that formed the basis of the second discussion were:

- *What academic and professional backgrounds should individuals admitted to graduate studies aiming at mathematics education research have?*
- *The doctoral candidate's ability to write is crucial for success. How can this ability be developed systematically during the programme?*
- *The choice of research problem is crucial, its limitations and precision is an important and difficult process. The importance of having a burning interest for what you are investigating is often critical for the doctoral candidate. What experiences do we have about these issues?*
- *How are doctoral supervisors educated and how can they develop their skills? What education for supervisors do we know about? What are the demands for supervisors in order to be accepted as such?*

In general it seems that most programmes seek candidates with strong mathematics, teaching experience, and knowledge of mathematics education. Many programmes require substantial mathematics studies for entry. Some programmes require a sample of writing, such as an article or a specially prepared report. Some programmes require teaching experience.

It was noted that some programmes emphasise the mathematics background and teaching experience at the end of the programme, and entrants who do not have one or the other are required to attain those experiences as part of the programme. There appear to be special entry provisions in some universities that allow, for example, experienced primary teachers entry to the programmes.

There are varying residency requirements, with some programmes requesting substantial on campus experience, others, particularly when supported by distance mode interactions have less stringent requirements. One distance mode programme has an annual 5 week residential component.

The Bologna model was mentioned (with 8 years of post school study to get a doctoral – 3 year undergraduate, 2 year masters, 3 year doctorate) although it was noted that it is unrealistically short for education doctorates. The pressure on universities to ensure candidates finish on time was noted, with substantial financial incentives in some universities.

There was extended discussion of aspects of doctoral supervision. In some universities, new supervisors are inducted into the process by a co-supervision process with an experienced supervisor that can be described as an apprenticeship. The importance of candidates and supervisors having compatible interests was noted. Some universities try to match supervisors with complementary strengths, offering a breadth of expertise to the candidate. In most places, candidates are encouraged to choose their own project, unlike in mathematics, where it is common for the professor to give the candidate a question. The notion of setting expectations for the candidate was mentioned.

There was considerable discussion on readiness for submission. Sometimes the committee chair makes the decision, in other places it is decided by the supervisors and the candidate. In one place candidates are required to give a seminar when the work is 90% complete. As part of this process, an international expert from the field is invited to read the thesis and interact with the candidate. Some universities require external examiners; some others require the examiners to be external to the department.

Session 3: Challenges and visions

Interestingly there was an increase in the number of participants attending the third session. A guideline question for this session was:
Should there be a common core of knowledge for doctorates in mathematics education?

There was general agreement with this proposition. Some of the topics mentioned that could form this core were:

- methodologies in mathematics education research;
- theory and history of mathematics and science;
- mathematics;
- didactics;
- knowledge of elementary mathematics from an advanced viewpoint.

A further guiding question was:
How can we advance international efforts to strengthen doctoral programmes in mathematics education?

Some suggestions included:

- having international examiners of doctoral theses;
- conducting research on commonalities and differences in emphasis and demand in doctoral programmes;
- fostering exchanges between faculty and students;
- proposing an ICMI study.

Overall the three sessions of the DG allowed the sharing of perspectives on doctoral programmes, and indicated that this is a topic in which there is substantial interest.

In the preparations of the DG a booklet was produced including the discussion document, an overview paper and the nine papers that were contributions to the work of the group. The full content of this booklet (Andzans, Bonka, & Grevholm, 2008) is available as a pdf-file at http://dg.icme11.org/document/get/303.

The nine papers represent doctoral programmes from many different parts of the world. We briefly mention the contributions here and ask interested readers to consult the full text of the booklet.

From University of Latvia Professors Agnis Andžāns and Līga Ramāna report experiences from a programme entitled *Modern elementary mathematics and didactics of mathematics*. Their conclusion is that the close integration of doctoral studies in didactics of mathematics with modern elementary mathematics has been a good service for both and has lead to improvements in education at several school levels.

The doctoral program in Korea in mathematics education, described by Sang Sook Choi-Koh, was first created in 1996 at the Graduate School of Dankook University of Education. The purpose of the 18 existing programmes is to provide society with professional educators. The curriculum of the programme is described.

Barbro Grevholm writes about the only existing doctoral programme in mathematics education in Norway and places it among programmes in the other Nordic countries and in relation to the Nordic Graduate School in Mathematics Education. See also www.nogsme.no.

Vena Long, Theresa Hopkins and Geri Landry in their paper write about a successful alternative to the traditional doctoral programme. A distance model is used for the delivery of courses in order to reach the targeted rural population. All types of assignments are possible using the technology in a strategic way. This innovative programme is now ready to be duplicated and replicated by others.

Robert Mayes and Patricia McClurg use complexity and uncertainty as drivers for programmes in mathematics and science education. They claim that the proposed PhD in

Mathematics Education incorporates cognates and apprenticeships that will engage the students as practitioners in a community of STEM scientists, mathematicians, and educators.

Michaela Regecová introduces us to doctoral programmes in the Slovak Republic. In Comenius University we find since 2006 a programme in *Theory of mathematics education*. The wish for the programme is to compare range and depth of mathematics content required and the manner in which research competence is acquired and to improve international cooperation.

Challenges and a vision for doctoral programmes are offered by Robert Reys in his contribution. He points out, that doctoral programmes in mathematics education vary greatly within and across countries and refers us to reports of such variations. Finding a common core of knowledge, which can prepare doctors in mathematics education for diverse careers is challenging. See also Reys and Dossey (2008).

Filippo Spagnolo introduces a programme in *History and Mathematics Education, Physics Education, and Chemistry Education*, which is an international doctoral programme offered by a consortium of 14 departments in Italy, Slovakia, Cyprus and Spain. The construction of the programme is described and related to the positions in the time scale of the programme.

Peter Sullivan discusses aspects of doctoral programmes at two Australian universities. The goals of the universities for the doctoral programmes both emphasise knowledge creation and research training. The key responsibilities for supervisors at Melbourne University are to facilitate the completion of the graduate research, monitor the quality, and assist graduates to develop transferable skills and prepare for their careers.

With a growing number of doctoral programmes in mathematics education and a growing need for new doctors in mathematics education there is an interest around the world to learn about doctoral programmes and compare experiences. The doctorates should be equivalent whatever country they come from. The issue of the quality of doctoral theses thus seems to need further investigation and discussion. It would be natural to follow up this DG with continued work at coming ICMEs.

References

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