Faculty of Technology and Science

Attachment to Curriculum for Doctoral Studies in Mathematics at Karlstad University

Approved by the Faculty Board of Technology and Science on 2 February 2011 and valid from 2 February 2011.

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Attachment to Curriculum for Doctoral Studies in mathematics with an emphasis on education. Approved by the Faculty Board of Technology and Science on 2 February 2011 and valid from 2 February 2011.

Curriculum Approval

The curriculum was approved by the Faculty Board on 2 February 2011. The PhD programme is offered to the extent permitted by available funding. General stipulations for PhD programmes are provided in the *Higher Education Act* and in the *Higher Education Ordinance.*

1. General Information

Since the dawn of time, mathematics has been the basis of thinking. Although intellectual in essence, the disciplinary development has been inspired by its applications in physics and technology. In recent decades the application potential has become even more prominent and today mathematics is extensively applied in physics, chemistry, technology, medicine, economy and other social sciences. Modern computer science is also based on mathematics and has contributed to the great expansion of the discipline.

Mathematics is a subject at all levels of the education system. The need for more and broader research on the learning and teaching methods in mathematics in Swedish schools is well documented. The demand for highly qualified teacher in mathematics and mathematics-specific teaching methodology in schools as well as higher education is growing.

This attachment to the curriculum describes doctoral studies in the specialisation Mathematics Education.

In accordance with Karlstad University's equal opportunities policy, gender issues are addressed throughout the programme. Doctoral students are also introduced to multi-disciplinary approaches and involved in interdisciplinary experiences.

2. Aims and Objectives

The general objectives of licentiate or doctoral studies in terms of knowledge and understanding, skills and abilities, and judgement and approach are specified as follows in the *Higher Education Ordinance, attachment 2, SFS* 2006:1053):

Knowledge and understanding

For a degree of Licentiate research students must

- demonstrate knowledge and understanding in the field of research, including current specialist knowledge in a defined part of the field and a deeper knowledge of scientific methods in general and of methods in the specific field of research in particular.

For a degree of Doctor research students must

- demonstrate broad knowledge in and systematic understanding of the field of research, together with deep and up-to-date specialist knowledge in a defined part of the field of research; and
- - demonstrate familiarity with scholarly methods in general and with methods in the specific field of research in particular.

Skills and abilities

For a degree of Licentiate research students must

- demonstrate an ability to identify and formulate issues, critically, independently and creatively, and proceeding with scientific precision; to plan a limited research project and other advanced tasks and to carry them out using appropriate methods within specified time limits, so as to contribute to the development of knowledge; and to evaluate this work;
- demonstrate an ability to clearly present and discuss research and research results in dialogue with the scholarly community and society in general, orally and in writing, in both national and international contexts; and
- demonstrate the skills required to independently participate in research and development work and to work independently in other advanced contexts.

For a degree of Doctor research students must

- demonstrate an ability to engage in scholarly analysis and synthesis and in independent, critical examination and assessment of new and complex phenomena, issues and situations;
- demonstrate an ability to identify and formulate issues, critically, independently and creatively, and proceeding with scientific precision, and to plan and, using appropriate methods, conduct research and other advanced tasks within specified time limits, and to scrutinise and evaluate such work;
- demonstrate, in a dissertation, their ability to make a substantial contribution to the development of knowledge by their own research;
- demonstrate an ability to present and discuss research and research results with authority, in dialogue with the scholarly community and society in general, orally and in writing, in both national and international contexts;
- demonstrate an ability to identify their need of further knowledge; and
- demonstrate a potential to contribute to the development of society and support other people’s learning, both in the field of research and education and in other advanced professional contexts.

Judgement and approach

For a degree of Licentiate research students must

- demonstrate an ability to make ethical assessments in their own research;
- demonstrate insight into the possibilities and limitations of science, its role in society and people’s responsibility for how it is used; and
- demonstrate an ability to identify their need of further knowledge and to take responsibility for developing their knowledge.

For a degree of Doctor research students must

- demonstrate intellectual independence and scholarly integrity and an ability to make ethical assessments relating to research; and

- demonstrate deeper insight into the potential and limitations of scholarship, its role in society and people's responsibility for how it is used.

Licentiate dissertation/doctoral dissertation
For a degree of Licentiate the research students must have received a pass grade on a scholarly dissertation of at least 60 ECTS credits.

For a degree of Doctor the research students must have received a pass grade on a doctoral dissertation of at least 120 ECTS credits.

Subject Specific Objectives
Upon completion of the programme, the doctoral students should be able to

- demonstrate specialised knowledge of the theories and methods related to the research area.
- demonstrate the ability to formulate, carry out and report on academic studies of conditions, processes and results of mathematical learning and teaching,
- demonstrate the ability to contribute to the development of the field in terms of research as well as education.

3. Admission Requirements

Applicants to doctoral studies must meet the general admission requirements as well as the specific admission requirements and be judged to have the ability otherwise required to pursue the programme successfully (*Higher Education Ordinance*, Ch.6).

3.1 General eligibility

A person who has earned a Master's degree of at least 240 ECTS credits of which at least 60 ECTS cr are studies at Master's level, or who in some other way in the country or abroad has acquired largely equivalent knowledge has general eligibility for admission. If there are special reasons for doing so, the faculty board may grant an individual applicant exemption from the general eligibility *(Higher Education Ordinance*, Ch.6).

3.2. Special eligibility for admission to doctoral studies in mathematics education

A person who has completed courses in mathematics and mathematics education totalling at least 90 ECTS cr, including a degree project of 15 ECTS at Master's level of relevance to the doctoral study specialisation, or who has Teacher Education qualifications according to earlier qualification system, has special eligibility for admission to doctoral studies in mathematics.

3.3. Transitional Provisions

Students who met the general admission requirements for admission to doctoral studies before 1 July 2007 shall be considered generally eligible for admission to the doctoral level until 30 June 2015 (SFS 2006:1053).

4. Admission Procedure

Applications for admission to doctoral studies are processed in accordance with the procedures prescribed by the Board of Karlstad University.

5. Selection

Candidates will be selected on the basis of their assessed capacity to successfully complete a programme at the doctoral level. In the ranking and selection of the candidates, special attention will be paid to previous studies, especially to the quality of independently documented research or development projects completed at Master's level in the proposed area. Special consideration will be given to the candidate's formal teaching qualifications or other equivalent pedagogical training and to teaching experience. Attention will also be paid the candidate's possibility to be present and partake in the departmental research environment.

6. Content and Outline

The doctoral programme can lead to a doctoral or licentiate degree. The doctoral degree requires four years of study, the equivalent of 240 ECTS credits, and the licentiate degree two years or 120 ECTS credits. The studies include course work as well as independent thesis work. To earn a doctoral degree, the candidate must complete 90 ECTS credits of course work and a dissertation of 120 ECTS cr. To earn a licentiate degree, the candidate is required to complete 50 ECTS credits of course work and a dissertation of 60 ECTS cr.

6.1 Courses

Mandatory courses for all doctoral students at Karlstad University must be included in the programme to the extent required by local regulations.

General mandatory course

For the **Licentiate** degree:
The History and Philosophy of Science, 7.5 ECTS credits

For the **Doctor's** degree:
The History and Philosophy of Science, 7.5 ECTS credits, and
Communicating Science, 4.5 ECTS credits

Subject Specific Courses

Doctoral-level courses in mathematics education, primarily consist of three parts in the areas of:

- Mathematics and the history of mathematics with scientific perspectives on the subject
- Learning mathematics and mathematics education as a research field
- Basic pedagogical theory of relevance to research in mathematics education and field-specific research methodology and theory.

There should be a balance between the parts. Courses are offered by Karlstad University or in conjunction with other universities. The courses are chosen in consultation the examiner and advisor with the aim of providing a solid foundation in mathematics and teaching methodology and preparing for the dissertation.

The students are required to participate in academic activities by attending mathematical seminars and guest lectures also in areas of little relevance to their course requirements. Students are also expected to actively contribute to seminars, for instance by presenting texts.

6.2 Doctoral and Licentiate Dissertations

Doctoral students are required to write a dissertation for a doctoral or a licentiate degree, Dissertations should either be a monograph or a unified collection of previously published papers in English. Candidates are required to defend their licentiate dissertation at a seminar and their doctoral dissertation at a public examination. Further information is provided by the policy documents “Doctoral Dissertation Requirements” and “Licentiate Dissertation Requirements”. The articles are expected to display the academic quality required for international publication part or summary. The doctoral dissertation is expected to meet requirements for publication in reputable, refereed science journals. The student’s own contribution must be clearly distinguishable.

6.3 Supervision

Doctoral students are entitled to advisors in accordance with the principles stated in the current policy document at Karlstad University.

6.4 Individual Study Plan

Each doctoral student must draw up an individual study plan in conjunction with the advisors. The plan should include a realistic estimate of time for course work, thesis work and supervision as well as an introduction to the proposed research field, problem, aim, methodological and theoretical frames, and relevant ethical considerations.

The individual study plan is subject to continual revision (at least once a year).

6.5 Examination

Doctoral students are examined in accordance with the requirements of each individual course syllabus. Doctoral or licentiate dissertations are examined in accordance with the *Higher Education Ordinance* (Ch.6, §§ 40-47) and Karlstad University’s current policy document.