

## PREFACE

### Preface to special issue

In this special issue of NorDiNa we introduce the *Finnish Graduate School of Mathematics, Physics and Chemistry Education* and the *Swedish National Graduate School in Science and Technology Education Research* (FontD) through articles of the graduate school students and recently completed doctorates. These articles give one view of current research projects at the graduate schools. Moreover, a brief overview of doctoral studies in Finland and Sweden is made and the graduate schools' structures and activities are described.

#### **AN OVERVIEW OF DOCTORAL STUDIES IN FINLAND AND IN SWEDEN**

The general aim of the doctoral studies in both countries is to provide students with an in-depth knowledge of the field of research and the capability to produce novel scientific knowledge independently. A doctoral degree can be completed within the faculties of Finnish and Swedish universities, respectively. Students can apply for doctoral studies after the relevant second-cycle degree by writing a research and a study plan. The application is accepted by the faculty council based on the evaluation of the application. However, the evaluation varies and typically at least a recommendation of the main supervisor is needed. In Sweden full funding is required to be appointed as a doctoral student. In Finland funding for studies is not required: some students are working in doctoral student positions, some in research projects, some in graduate school and some have a scholarship. However, most of the students are part-time students. In Sweden a doctoral student has one head supervisor (a professor or a "docent") and one or more co-supervisors. In Finland a doctoral student has one main supervisor (a professor of a faculty) and typically another supervisor: The main supervisor is responsible for "organising" the doctoral studies.

Doctorates in both countries should take approximately 4 years of full-time study to complete. However, normally studies in Sweden are combined with 20% assistant work at the university department, so the total study time is 5 years. In Finland the studies consist of one year (60 credit points) of "formal" studies and writing of the thesis which demonstrates independent and critical thinking. The formal studies consist of studies in research methodology, philosophy and language studies. In addition, students participate in a research seminar and conferences abroad. The doctoral studies in Sweden are comprised typically of 90 credits of courses and 150 credits of doctoral thesis work. In both countries the thesis can be a monograph or it can be a combination of 3 – 5 research articles in refereed journals and a summary which combines these articles and gives relevant background and research methodology information in the field of study. A pre-doctoral degree of Licentiate may be taken in both countries before the Doctor's degree and it is equal to 2 years of full-time study.

Before the public examination of the doctoral thesis in Finland the faculty nominates two pre-evaluators who evaluate the doctoral thesis manuscript. In their evaluation, the pre-evaluators write a recommendation to the faculty. Based on the recommendation the faculty can give printing permission for the doctoral thesis manuscript. For the public examination the faculty nominates

a custos, typically the main supervisor, and an opponent or in some cases two opponents. The public examination is similar in both countries, but there are differences. In Finland it starts with an introductory lecture (*lectio praecursoria*) of at most 20 minutes given by the candidate. In the lecture, the candidate will introduce his or her dissertation and the research methods used. After the introductory lecture, the opponent will make a short statement about the scientific status and significance of the dissertation and about other general issues. In the actual examination, the opponent will discuss the dissertation, commencing from its title and proceeding to the methods, sources and conclusions. The candidate will respond to the comments made, defending his or her choices, conclusions and results. Finally, the opponent makes a statement and announces that he or she will propose to the Faculty that the dissertation can be accepted. Based on the recommendation of the opponent, the faculty accepts the thesis.

The role of the opponent at the public defence of a thesis at Swedish universities is to make an oral review of the thesis and pose questions to the respondent to bring out merits and shortcomings of the work. When the opponent has finished his/her questioning, a closed session is followed where the thesis is evaluated, accepted or refuted by an examination board consisting of three or five professors or “docents”. The result of the evaluation process is publicly announced immediately after the decision of the board.

### **THE GRADUATE SCHOOL SYSTEM IN FINLAND AND IN SWEDEN**

The first graduate schools were established in Finland in 1995 by Finnish universities and they were financed by the Ministry of Education. The money was allocated for salaries and for activities, like common courses, and for conference travelling. The graduate school system was established in order to shorten study time, and to increase international cooperation. In addition to full-time students, there are typically also part-time students, financed by other scholarships or by students' personal money, participating in the research training offered by the particular graduate school. In 2007 there were altogether 119 graduate schools with 1,500 postgraduate positions.

The *Finnish Graduate School of Mathematics, Physics and Chemistry Education* was established in 1995. The school was established by 5 universities and their 18 departments. The partner departments included both subject departments, like the physics departments and teacher education departments/educational departments and, therefore, the students could obtain their degree either in the mathematics and science faculties or in the faculty of education. One of the supervisors has been typically specialised in mathematics, physics or chemistry and the other in education. Consequently, the school is interdisciplinary. In the beginning, the goal set by the school was to deal with the development of mathematics, physics and chemistry teaching in schools and the competence of mathematics and science teachers to teach mathematics and science. In 1995 there were 4 full-time students and the number was increased to 10 at the beginning of 1998. At the same time the number of member universities was increased to seven and the number of member departments to 23. Physics professor Kaarle Kurki-Suonio was the first director of the school. The second director was Professor Maija Ahtee (in mathematics and science education) between 1998 – 2002. In 2003 professor (in mathematics and science education) Erkki Pehkonen was nominated as the director of the school and funding was given for four full-time doctoral student positions. At the beginning of 2007 professor (in physics and chemistry education) Jari Lavonen was nominated as a director of the school and five permanent doctoral student positions were given. The number of part-time students studying in the graduate school has varied from 55 to 75 students (see in detail <http://www.edu.helsinki.fi/malu/tutkijakoulu/opiskelijat.htm>).

The *Finnish Graduate School of Mathematics, Physics and Chemistry Education* aims now to bring together the Researches of mathematics, physics and chemistry education in Finland to form a pool of supervisors for training experts in the field of the graduate school. In addition, the

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Graduate School aims at providing a broad scientific education. The educational environment comprises of research groups with international profiles and international research contacts. In practice two times a year the graduate school organises one-week common courses. The topics of the courses are, for example, writing scientific text, research methodology, and philosophical basis of educational research. The supervision is challenging because the students' projects are interdisciplinary and focusing on problems where both deep subject and pedagogical knowledge are needed. Supervision is provided on a local basis as well as within the network of supervisors working in the partner institutes. In Finland since the existence of the graduate school system (1995 – 2007) altogether 55 doctoral theses in mathematics, physics and chemistry education research have been published. Altogether 27 of them have been completed within the graduate school by full-time or part-time students.

The Swedish national graduate school system, inaugurated in 2001/02, intends to stimulate recruitment for postgraduate studies, develop postgraduate programs, shorten study time, and improve cooperation between universities and university colleges. In all 16 national graduate schools in different disciplinary areas got started in 2001/02. Among them was a graduate school in science and technology education.

After a general application session among Swedish universities, Linköping University became the host university for this school, and together with seven partner universities and university colleges it was named *The national Graduate School in Science and Technology Research (Forskarskolan i naturvetenskapernas och teknikens didaktik, with the Swedish acronym FontD)*. Financial support, around 12 million SEK per year, was guaranteed by the Swedish Government. The school's center is geographically located at the Norrköping campus of Linköping University. The graduate school is organised under the Faculty of education. Professor (in Science Education) Helge Ström-dahl has been the director of the graduate school since 2001.

FontD is a joint collaboration network between Mälardalen University College, Malmö University College, Stockholm University, University of Karlstad, Kalmar University College, Kristianstad University College and Umeå University. Two other university colleges in Halmstad and Gävle together with Midsweden University are associated with the network.

Doctoral students are employed at each participating university/university college and each student should carry out his/her duties at one of the participating institutions. At the same time the graduate school has a solid common kernel developing a knowledge base of national and international interest. The aim thus is that the graduate school should both contribute to the formation of research environments at the various universities/university colleges and also function as a national and international arena for research as well as training doctoral students in the field of science and technology education.

Three main perspectives describe the content of the graduate school research:

- Learning and communicating science and technology
- Scientific and technological knowledge cultures in school and society
- Scientific and technological knowledge – general education, democracy, gender and ethnicity

The three perspectives do not mark clear-cut boundaries. It is easy to see that individual research projects can, and in many cases should, address issues which are approached from and inspired by all perspectives.

According to a governmental commission the graduate school is assigned to make research with relevance to teacher training and examine at least 25 doctoral students during a period of 5-6 years. In February 2008 FontD comprises 34 doctoral students. Of those who entered their studies

in 2002 (two other cohorts of doctoral students were employed in 2003 and 2005) nine (9) have graduated as doctors (PhD) and 2 as licentiates. The latter are continuing their studies in order to receive a PhD. During 2008 another ten doctoral students are expected to graduate with PhDs. Abstracts of all doctoral students' work can be found at [www.isv.liu.se/fontd](http://www.isv.liu.se/fontd).

Before the establishment of FontD there were few research groups in science and technology, the main one being at Gothenburg University, with others at the University College of Kristianstad, Uppsala University and the Teacher Training Institute in Stockholm (since 2008 integrated in to Stockholm University). Otherwise R&D- work was performed by single individuals at teacher training departments. The creation of FontD has strengthened the area of research to become comparable in the research field to other countries in Europe.

## **EXAMPLES OF DOCTORAL THESES IN FINLAND AND SWEDEN**

Here we introduce seven articles by graduate school students or recently graduated PhD students.

Anu Hartikainen's article focuses on seventh-graders' talk in inquiry-oriented instruction, aiming to describe it and assess its meaning. The article is based on her doctoral thesis monograph. The study was carried out in the framework of the sociocultural theory, where learning is seen as a social activity and talk is therefore assigned an important role in any analysis learning. The data were collected in situations where the pupils were studying biology in inquiry-oriented instruction.

Niina Nurkka was a part-time student in the Finnish graduate school and had a scholarship. She participated very actively in the graduate school courses. She used in her research project two transfer teachers who implemented a teaching-learning sequence designed and developed according to the model of educational reconstruction. Her article presents a part of a wider study with the aim of determining how the understanding of moment of force and its applications can be improved by developing and evaluating a teaching-learning sequence on the moment of force in physiotherapy training.

Kaija Salmio presents a part of her doctoral thesis in her article. Her thesis deals with the national tests (years 1993–1995, 1998) and the evaluation of the learning results. She analysed the goals in the national core curricula and tasks in the national science tests from the point of view of sustainable development. Moreover, she analysed quantity and quality of student learning in the field of sustainable development based on the students' responses to the tasks in the national science tests.

Kari Sormunen was a part time graduate-school student and he actively participated in the courses. His article here is based on his doctoral thesis monograph. He presents in his article two different models related to the levels of epistemological beliefs and the epistemological resources. The empirical data of the thesis was collected during 12 hours of science lessons. During the lessons eighteen 7th-grade pupils were taught the modelling idea connected to the topic 'structure of matter'. Sormunen was collecting the data together with the full-time graduate school students Heikki Saari and Pirjo-Liisa Lehtelä. Saari's thesis was about pupils' conceptions of models and modelling, and Lehtelä's dissertation concerned the metacognitive aspects related to model-based learning and instruction.

Susanne Engström has a background as a civil engineer and teacher in technology. She is now a full-time doctoral student in FontD at Mälardalen University College, Sweden. Her research interest is pupils' capacity to relate physics knowledge to sustainable development with a focus on sustainable energy systems. She takes her point of departure as the national curriculum for physics

and investigates teachers' and students' ideas about the development of education on sustainable energy systems. The present article describes a pilot study, an introduction to a series of investigations of upper secondary school pupils' explanations of sustainable energy.

Mari Stadig Degerman and Karin Stolpe are full-time doctoral students at FontD Mälardalen University College and Linköping University, Sweden. Mari is mainly educated in chemistry and Karin in biology. Both are upper secondary teachers in biology/chemistry. Mari and Karin have elaborated a "tool of association" to analyse students' discussion around science concepts. In the present paper they advocate that the tool yields rich data in the discussions of some concepts, and allows an opportunity to study interactions in both group-work and in interviews.

Pernilla Nilsson is a teacher educator and a researcher in primary science education at Halmstad University College, Sweden. In 2003 she became a doctoral student in FontD at Linköping University. Her research concerns primary science student teachers' learning to teach and the complex processes that underpin that learning. The present paper is based on an exploration of the ways in which primary science student teachers recognise and learn about issues that shape their own professional learning.

### **SUCCESS AND CHALLENGES FOR DOCTORAL EDUCATION IN FINLAND AND SWEDEN**

Both graduate schools have a special national goal to support the strengthening of teacher education. Through educating doctoral students, there will be more doctors teaching in primary and secondary school teacher education in the future. Therefore, the quality of teacher education will supposedly be improved. Second, both graduate schools are interdisciplinary. This interdisciplinarity has increased collaboration between subject departments (physics, chemistry and biology) and pedagogical departments. Furthermore, this collaboration has been a fruitful starting point for the discussion, development and even research of the teaching and learning at the subject departments.

International collaboration has been fruitful in both graduate schools. Graduate school students and senior researchers have actively participated in international conferences like EARLI, NARST, AERA, GIREP and ESERA. ESERA summer school has also been an important resource for doctoral students and offered possibilities for students to become familiar with doctoral students from all parts of Europe.

Several foreign experts have participated in the training courses of the graduate schools as lecturers and supervisors. Moreover, in Sweden, there have been several visiting professors.

However, there are challenges for increasing collaboration between graduate schools in the Nordic countries and Europe. For example FontD have had a beneficial meeting with doctoral students and supervisors from a graduate school at the Essen-Duisburg University, Germany. The Finnish graduate school and the graduate school at the University of Duisburg receive a scholarship from their national science foundations to start official collaboration. In summer 2008 altogether 28 graduate school students and their supervisors from Germany will participate in a summer school in Finland. A corresponding seminar will take place at Christmas time in Essen. An extension of such meetings and also more collaborative attempts need to be developed.

The number of doctors in science education has been and will be increased. Some of them will get a position in teacher education institutes. However, there are several other possibilities. Both schools have challenges in development of guidance in employability and career planning. There is also need for postdoc positions for newly graduated PhDs.

In Finland one out of five students who start as a full-time student in the graduate school does not complete their studies during the agreed time. The corresponding number with part-time students is much higher. Therefore, there is a challenge to find solutions to the delay or drop out. This problem can not be solved only through development of teaching and supervision. The problem is also a financial problem. A working teacher in a school gets a better salary than a doctoral student in a graduate school. Moreover, a PhD holder gets the same salary as a teacher with a master level degree. Consequently, some development is needed also in the labour market.

In FontD only one student drop out has been noted thus far from a total of 44 doctoral students. Since every doctoral student in Sweden is guaranteed full-time employment with full finance for 5 years they enjoy a certain security whilst studying. Additionally, an individual working plan for every doctoral student, evaluated and revised annually is compulsory according to the University bill. Thus, the students' doctoral studies can be effectively followed and supported. However, FontD is a phase where the admission of new doctoral students will decrease and instead postdoctoral positions (postdoc and research assistant) will be created in order to consolidate the research groups at the different universities.

The articles presented in this special issue of NorDiNa are some examples of what is focused on by doctoral students in the Finnish and Swedish graduate schools. We hope that the reader will find them so inspiring that they will want to read part of or the full theses published or appearing in the future. Moreover, we hope our review increases collaboration and discussion about doctoral education in Nordic countries and will help our colleagues to analyse their own doctoral education practices. Finally, we hope that the articles create curiosity to read also the papers and theses of other doctoral students of our graduate schools.

Guest editors,



Jari Lavonen



Helge Strömdahl