News from Nordic mathematics education

In this issue of Nomad, the NoRME column reports on past, present and future activities within the field of mathematics education research in the Nordic region. Included is also a summary of recent doctoral dissertations with a focus on mathematics education presented in Nordic/Baltic countries. Readers having information relevant for this column, and for the NoRME web page (www.norme.me), are encouraged to contact Christer Bergsten, the chair of NoRME, by e-mail: christer.bergsten@liu.se.

MatRIC: Centre of excellence in higher education

Agder university in Norway, had a successful application for a *Centre of excellence in higher education* (Senter for fremragende utdanning), awarded by NOKUT (Nasjonalt organ for kvalitet i utdanningen). The funding will run for five years (with a possible additional five years). The centre, MatRIC, will have a focus on mathematics and mathematics education at university level and will be directed by Simon Goodchild, professor of mathematics education at Agder university. The centre is run by Agder university in collaboration with Norwegian University of Science and Technology, Norwegian University of Life Sciences and the Norwegian Centre for Mathematics Education.

The following description is found in the application:

> The centre will lead innovation and research in university mathematics teaching and learning within the programmes of other subjects e.g. engineering, natural sciences, economics and teacher education (user programmes - UPs). The centre will engage in networking university mathematics teachers with teachers in the UPs and employers of graduates from the UPs. The centre will coordinate and sponsor research activity that enables sharing, dissemination and knowledge growth of good and innovative practice. [...]

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MatRIC will:

Create, lead and support networks that enable sharing and development of effective use of video, digital and web-based technologies in teaching, learning and assessing mathematics.

Initiate, support and disseminate research into teaching, learning and assessing mathematics to identify, understand and evaluate effective innovation in practice.

Bring together mathematics educators, scientists, engineers, computer scientists and economists in cross-disciplinary teams to produce workplace simulations and realistic tasks for mathematical modeling.

The centre will be launched at a conference on March 12, 2014 in Oslo. For further information, see web page at http://www.matric.no (with a link to more about MatRIC).

MADIF9

The biannual research seminar MADIF was arranged by SMDF (the Swedish Association of Mathematics Education Research), a member society of NoRME, on February 4–5, 2014 in Umeå, Sweden: MADIF9 (the ninth Swedish Mathematics Education Research Seminar). The seminar, which had as its main theme *Development of mathematics teaching: design, scale, effects* (see ncm.gu.se/media/smdf/madif9.html) attracted around 110 participants. Invited speakers were Koeno Gravemeijer (Eindhoven University of Technology), who discussed principles of design research and local instruction theories, and Beth Herbel-Eisenmann (Michigan State University), focusing on critical issues in the context of teacher-researcher collaborations. A total of 15 research papers and 24 short communications were presented, and the seminar was concluded by a plenary panel with Lisa Björklund Boistrup (Sweden), Jeremy Hodgen (UK), Darina Jirotkova (Czeck Republic), and John Mason (UK), with Ola Helenius (Sweden) as moderator, discussing responsibilities of researchers related to the usefulness of research for educational practices. Post-proceedings from the seminar will be published.

NOMAD workshop, April 2, 2014

The third workshop for doctoral students led by the editors of Nomad will be held in Gothenburg on April 2, 2014. PhD students in mathematics education from the Nordic and Baltic countries are invited to submit

a draft of a paper for Nomad, which they will have the opportunity to present and discuss during the workshop. The deadline for submission of a draft paper is set to March 13, 2014. The paper should be sent to johan.haggstrom@ncm.gu.se. The submitted papers will be distributed among the participants shortly after submission, and each participant will be asked to make a brief review of one other paper before the workshop, according to certain guidelines. Each paper will also be read by one or more of the editors of Nomad, who during group discussions will give feedback on the paper considering a possible publication in Nomad. Updates of the information will be given on the web page http://ncm.gu.se/node/6962.

Conference on textbook research, May 7–8, 2014

The network for research on mathematics textbooks in the Nordic countries will arrange a conference at the University of Reykjavik, Iceland, May 7–8, 2014. This network, funded by NordForsk, has existed since 2011 and the members are Nordic and Baltic researchers working with studies on textbooks and curricular resources. The deadline for submitting a paper for the conference is April 15, 2014. For further information, contact Barbro Grevholm (email: barbro.grevholm@uia.no).

NORMA14, June 3–6, 2014

The seventh Nordic Conference on Mathematics Education, NORMA14, will take place in Turku (Åbo), Finland (www.turku.fi) on June 3–6, 2014. The conference is hosted by the Department of Teacher Education at the University of Turku and organised in collaboration with NoRME – the Nordic Society for Research in Mathematics Education, and will give researchers in mathematics education opportunities to present their research by regular and short papers. It is also a forum for discussions and constructive meetings of researchers, teachers, teacher educators, graduate students and others interested in research on mathematics education in the Nordic context. Invited speakers are Helen Doerr (Syracuse University, USA), Erno Lehtinen (University of Turku, Finland), Morten Misfeldt (Aalborg University, Denmark), and Heidi Strømskag Måsøval (Sør-Trøndelag University College, Norway). The proceedings of the conference will be published electronically. For further information see the conference webpage at www.utu.fi/norma14.

At the NORMA14 conference the general assembly of NoRME will take place on June 5. Information about the GA will be updated on the NoRME web page at www.norme.me.

New doctoral dissertations

Since the last issue of the NoRME news column in Nomad 18(2), new doctoral dissertations in mathematics education in the Nordic area have, to the editor's knowledge, been presented only in Sweden. Of these, two have their disciplinary base in psychology, one in philosophy, while four are situated more in traditional mathematics education research. Two of these employ cultural-historical theory and two are of a more explorative character presenting papers using different approaches. The theses are presented in chronological order.

At Stockholm University, on March 22, 2013, *Karin Dahlin* defended her thesis *Does it pay to practice? A quasi-experimental study on working memory training and its effects on reading and basic number skills*. Considering that long-term studies have indicated that intelligence, working memory, visuo-spatial short term memory and processing speed are important for the development of mathematical performance, the aim of the thesis was to examine the effect of working memory training in students with attention deficits. Working memory is used for example when instructions or chunks of information need to be kept in mind for completing a task, and normally fully organised at 4–6 years of age. According to research, weak working memory capacity generally leads to a lower performance on reading, mathematics and attention tests but an intervention involving training of the working memory capacity could have a positive effect on reading comprehension and basic number skills. For this purpose, at special education units at regular schools, a treatment group of 42 students of 10–11 years age had about half an hour training every day for five weeks in school with an interactive computer program (Cogmed working memory training). The performances of the treatment group on reading related measures (study I) and basic number skills (study II) were compared to those of 15 students attending similar units but having only ordinary special educational instruction. In a third study, the aim was to investigate the students' reading and mathematics development three years after the completion of working memory training. It was found that reading comprehension and working memory measures correlated and improved at post-tests for the treatment group to a larger extent than for the comparison group, and that working memory measures and basic number skills were highly related. On basic number tests, the performance of the boys in the treatment group improved more than that of the boys in the comparison group. On visuo-spatial working memory measure, reading comprehension and basic number skills in boys, the treatment group seems to have gained from the cognitive training of working memory with the computer

assisted program directly after training and at the three year follow-up. In the thesis, some possible explanation of these improvements are discussed in terms of mechanisms such as executive function, attention, memory, motivation, and emotion. Some implications for education are also put forward.

Liu Yang defended his thesis entitled *Syllogistic analysis and cunning of reason in mathematics education* at Karlstad University on September 12, 2013. Here the abstract from the dissertation will be presented: This essay explores the issue of organizing mathematics education by means of syllogism. Two aspects turn out to be particularly significant. One is the syllogistic analysis while the other is the cunning of reason. Thus the exploration is directed towards gathering evidence of their existence and showing by examples their usefulness within mathematics education. The syllogistic analysis and the cunning of reason shed also new light on Chevallard's theory of didactic transposition. According to the latter, each piece of mathematical knowledge used inside school is a didactic transposition of some other knowledge produced outside school, but the theory itself does not indicate any way of transposing, and this empty space can be filled with the former. A weak prototype of syllogism considered here is Freudenthal's change of perspective. Some of the major difficulties in mathematics learning are connected with the inability of performing change of perspective. Consequently, to ease the difficulties becomes a significant issue in mathematics teaching. The syllogistic analysis and the cunning of reason developed in this essay are the contributions to the said issue.

At Linköping University, *Rickard Östergren* defended his thesis *Mathematical learning disability: cognitive conditions, development and predictions* on September 13, 2013. Of many different conditions that can result in low mathematical performance in school children, such as poor schooling, home environment and cognitive disposition, the focus in this thesis is on "Mathematical learning disability" (MLD) which is described as the cognitive aspects that lead to low numeracy. The thesis is thus located within the discipline of psychology. The research rests on the assumption that humans are born with a nonverbal number representation system providing the base for the development of number abilities such as number knowledge. General abilities, such as working memory, are also important due to their supportive function during development. Three empirical studies aimed to test and contrast five existing hypotheses about the foundation of MLD (including domain-general cognitive deficits and domain-specific number deficits): a domain general deficit,

primarily located in the domain general systems such as working memory; a number sense deficit located in the innate approximate number system (ANS); a numerosity coding deficit located to an exact number representation system; an access deficit, which is in the mapping between symbols and the innate number representational system (e.g. ANS); and a multiple deficit hypothesis stating that MLD may be related to more than one deficit. Number knowledge is described as an ability that develops through an interplay between primary and secondary (biological) abilities, where the first (e.g. ANS) develop without deliberate practice while the latter (e.g. comprehension of counting words, symbolic numerical comparison and arithmetic operations) do not.

In three studies the connection between cognitive abilities and arithmetic were examined. Studies I and III compared different groups of children with or without MLD (or risk of MLD), while study II investigated the connection between early number knowledge, verbal working memory and the development of arithmetic ability. In study I, 63 children of 11–13 years of age were tested for mathematical competence, cognitive function and number processing. For study II, 315 children in preschool were tested over two consecutive years. In study III, which was similar to study I, also the development of MLD in the same sample of children as in study II were investigated.

The results supported the multiple deficit hypothesis, as they indicate that number sense deficit together with working memory functions constitutes risk-factors to the development of MLD. Some of the deficits were domain general, such as in visuo-spatial working memory and retrieval from long term memory, while others were domain specific, such as deficits in the ANS. A developmental model based on previous research and the results of the studies is suggested, in order to understand the development of MLD in children. Care in relation to using labels such as MLD in educational contexts, especially for younger children, is suggested, as it first needs to be proven that they are beneficial.

On September 27, 2013, at Mittuniversitetet (Mid Sweden University, Sundsvall), O*duor* O*lande* defended his thesis *Students' narratives from graphical artefacts: exploring the use of mathematics tools and forms of expression in students' graphicacy*. The aim of the thesis is to identify and characterise students' interactions with graphical artefacts. Based on a cultural-historical perspective to cognition, with an emphasis on semiotic aspects including key notions from Peirce, the thesis builds on four studies. In the first of these, scores from students' responses to selected items from PISA surveys for items containing graphical elements are analysed using statistical cluster analysis. The outcome suggested two

clusters of items and approaches to work on graphical issues, where the Identification approach involves a focus on perceptual elements with a use of less demanding tools, and the Critical-Analytical approach involves evaluation of the graphical system, an active engagement with subject specific objects and forms of expression. This characterization of graphicacy, the I/CA framework, is used as an analytical too in the subsequent studies. Two studies, taking on the sociocultural perspective to learning, examine students' collaborative interaction around tasks containing graphical elements, using video observation and online discussions for the empirical data collection. The final study investigates aspects of students' written solutions from the Swedish national tests in mathematics, based on the I/CA framework, with a focus on tools and forms of expression used. Overall research questions are *What strategies do students use when faced with items containing graphical artefacts*? and *How are subject specific tools and forms of expression manifested in students' interaction with selected graphical artefacts*?

In the qualitative studies, most students seemed to be aware of how graphs are produced and presented. Different forms of expression used were mathematical, everyday, graphical, or only a short answer, along with different mathematical tools. There was overall a dominant use of everyday forms of the Identification type, while the performance indicated that a Critical-Analytical approach seemed more reliable and produced a higher proportion of correct solutions. As implications of the study it is pointed to how the type of tasks used in relation to graphicacy can be used to foster a Critical-Analytical approach in students. From a methodological point of view, the I/CA framework is suggested to help the identification of strengths and weaknesses in students' work with graphs, and has the potential of supporting the development of classroom practice.

At University of Gothenburg, *Linda Mattsson* defended her thesis *Tracking mathematical giftedness in an egalitarian context* on November 22, 2013. In this dissertation, the situation for mathematically gifted students in mathematics education in Sweden is examined in five articles with a focus on the history, state and potential development of education for mathematically gifted students (Paper I), teachers' conceptions of gifted students in mathematics at upper secondary school (Paper II, Paper III), requirements for creative reasoning in mathematical tasks used in admission tests to programs (Paper IV), and gender, origin, and socio-economic background of students selecting special mathematical tracks programs (Paper V). Key issues in the analyses are definitions of what constitutes mathematical giftedness in students and how such

students are selected for specialised programs or interventions. Here different theoretical descriptions of general giftedness are discussed, along with specific models for the subject mathematics (in particular the seminal study by Krutetskii), taking into account both innate and socially acquired abilities. It is concluded, from the background of the traditional Swedish policy of an integrated education for all, that some important steps have recently been taken that could further the development of a gifted education. The conceptions about giftedness reported by 34 upper secondary head teachers of mathematics are in line with models found in international literature, emphasising creativity, logical thinking and strong motivation as characteristic for mathematically gifted students, recognized by the teachers however through the students' own initiative for engaging and reasoning in mathematics, along with success on tests. Interviews with three mathematics teachers with long experience of working with mathematically gifted students point to signs of "mathematical promise" such as interest and pleasure in engaging with mathematics along with a strong fluency and skill in basic mathematics. Problem solving ability, creativity, and swiftness of thought were linked to being gifted in mathematics. The diversity observed of students' personal and social traits, however, suggests that their personal motives need to be considered when identifying mathematical giftedness. The analysis of task characteristics in admission tests to special programs, using the framework by Lithner and colleagues on imitative and creative reasoning, showed that the schools investigated differed on their requirements for creative reasoning and that generally, it was required but at the same level as for the national tests in mathematics. According to the study involving 147 students enrolled in gifted educational practices, females are underrepresented in such programs and parents of such students have a stronger educational background than the comparison group used. Students with a foreign background are not underrepresented. The results point to special educational needs of mathematically gifted students and educational activities to reach a greater number of those students.

At Linköping University, on November 29, 2013, *Margareta Engvall* presented her thesis *Handlingar i matematikklassrummet: en studie av undervisningsverksamheter på lågstadiet då räknemetoder för addition och subtraktion är i focus* [Eng. *Actions in the mathematics classroom: a study of teaching activities in primary school when calculation methods for addition and subtraction are in focus*]. The study aims to describe, analyse and understand primary mathematics teaching, more specifically what opportunities to learn teaching provides concerning written calculation methods in addition and subtraction: what characterises teachers' and

students' actions in the classroom, and what conditions for the learning of mathematical competencies are provided? The study of these questions is framed by activity theory (Engeström), acknowledging the key role of artefacts and social norms in mathematics teaching. It is pointed out how actions performed during mathematics lessons regulate how teaching activities with a focus on mathematics are constituted in different classrooms. These actions reflexively influence the teacher and the students, and shape both how the teacher is teaching and the students' mathematical knowledge. As activity theory pays attention to the relationship between goals, actions and outcome, it could in this thesis also serve as an analytic tool in the study of what type of mathematical knowledge is supported in the various teaching activities. The empirical base of the investigation is a field study of four primary mathematics classrooms in Sweden, followed during parts of school year two and three (in total 28 lessons), including participatory observations, video and audio recordings, and field notes. The data from each classroom is analysed from the point of view of the teacher and the student in terms of factors in the activity scheme such as primary and secondary artefacts, rules, community and division of labour. From this analysis, focussing on both general and specific mathematics teaching processes, conclusions are drawn about what is possible to learn in the classroom. As an outcome of the analysis, the activities in the different classrooms are categorized as procedural, procedural and conceptual, conceptual and argumentative, and procedural and communicational, respectively. As the methods used by teachers and students in the different classrooms focus on different aspects of mathematical knowledge or ability, it is concluded that the different classrooms provide different opportunities to learn mathematics. In common for all four classrooms is a focus on mathematical methods and calculations as well as trust in own ability, while conceptual ability is focussed in only two classrooms as well as communicational ability, and reasoning ability is emphasised in only one of these classrooms. From the results it is clear that classroom culture, including rules and language use, is crucial for what opportunities to learn different mathematics classrooms offer.

Peter Frejd defended his thesis *Modes of mathematical modelling: an analysis of how modelling is used and interpreted in and out of school settings* on February 14, 2014 at Linköping University. The dissertation, which reports on students', teachers' and modelling experts' experiences of learning, teaching and working with mathematical modelling in and out of school settings in Sweden and their interpretations of the notion of mathematical modelling, consists of a preamble and five articles that focus on different

levels of the didactic transposition of mathematical modelling: scholarly knowledge (an interview study with nine participants whose work with mathematical modelling is a main part of their profession), knowledge to be taught (an analysis of upper secondary mathematics textbooks with a focus on the presentation of mathematical modelling), taught knowledge (an interview study with 18 upper secondary mathematics teachers), knowledge to be learned (a literature review on modes of assessment of students' mathematical modelling competencies), and knowledge actually learned (a video based observation of students collaborating on a mathematical modelling task). Research approaches used include grounded theory (Strauss and Corbin) and commognition theory (Sfard).

The results presented provide a fragmented picture of the didactic transposition of mathematical modelling in school mathematics in Sweden. The variety of descriptions of what mathematical modelling involves emerging from the workplace makes the notion difficult to "transpose" into the teaching of school mathematics. There are also substantial differences in how professional modellers, teachers and students work with modelling in terms of the goals with the modelling activities, the risks involved in using the models, the use of technology, division of labour and the construction of mathematical models. Similarities identified described as important aspects of modelling work in the different practices are communication, collaboration, projects, and the use of applying and adapting pre-defined models.

Educational implications of the study include a need for teachers to clarify the meaning of modelling competency to be able to make the meaning explicit to students, a difficult task as there was no consensus on this issue among the different actors investigated. The choice of interpretation entails consequences for teaching. An atomistic interpretation of different aspects of modelling competency suggests that the teacher may use textbooks and written tests to justify their teaching, since these tend to focus on sub-processes. With a holistic view, taking the whole modelling process into account, the textbooks need to be complemented with other teaching material and alternative assessment modes, such as projects. Here, being explicit regarding the meaning and the goal of modelling and its relation to assessment criteria is emphasised. Project work with collaboration (also across school subjects), communication and division of labour, as well as the use of technology and application of already defined models should be emphasized. The latter also includes critical evaluations of mathematical models.