SMDF

Svensk Förening för **M**atematik**D**idaktisk **F**orskning

MEDLEMSBLAD

Nr 16

Juni 2010

INNEHÅLL

Medlemsblad nr 16

I detta nummer av SMDFs medlemsblad presenterar vi fyra nya doktors-avhandlingar i matematikdidaktik skrivna av Jonas Bergman Ärlebäck, Marcel Gahamanyi, Per-Eskil Persson och Erika Stadler. Vi gratulerar dem alla och önskar dem lycka till i sina fortsatta karriärer.

I artikeln ”Lektorer i skolan – Vad ska det vara bra för?” för Niklas Bremler en diskussion kring lektorstjänster i gymnasieskolan som en följd av införande av lärarlegitimationer. Han ger en nyanserad blid av hur läget ser ut i dag med arbetssituationer och krav och hur trenden varit för att sedan blicka framåt.

Barbro Grevholm beskriver utvecklingen av nordiska forskarutbildningsprogram i matematikdidaktik och beskriver strukturer i de olika länderna och samarbeten dem emellan i till exempel forskarskolor. Aktiviteter som sommarskolor, kurser, handledarseminarier och workshops presenteras.

I januari var det dags för den sjunde konferensen som SMDF anordnar, MADIF7. Den gick av stapeln i Stockholm i anslutning till Matematikbiennalen. Erika Stadler var på plats och har skrivit om sina upplevelser.

Jag vill som ny redaktör för bladet uppmana er, som har något ni känner att SMDFs medlemmar skulle vara intresserade av, att skicka in era texter till mig (adress finns sist i bladet).

Trevlig sommar!

/ ***Kristina Juter***

Några rader från …

I förra numret av medlemsbladet skrev jag att det "har varit och är ett händelserikt år inom det matematikdidaktiska området" och man kan bara konstatera att det fortfarande är en händelserik tid inom SMDF:s intresseområde och att det finns mycket att se fram emot. I ett nordiskt perspektiv har MADIF7 genomförts i Stockholm (en personlig rapportering från seminariet ges i detta nummer av medlemsbladet av Erika Stadler) och NORMA11 väntar nästa år i Island. Flera nya doktorsavhandlingar har presenterats (se rapporter i detta nummer av medlemsbladet). I Sverige har flera nya professurer och tjänster som universitetslektor annonserats, liksom ett antal doktorandanställningar. Licentiandforskarskolan, som jag berättade om i förra medlemsbladet, har kommit mer än halvvägs och nästa vår förväntas ett antal licentiatavhandlingar presenteras. På bokfronten kommer en "sourceboook" om nordisk matematikdidaktisk forskning att ges ut under sommaren 2010, som förhoppningsvis kommer att ha högt informationsvärde inte bara för den internationella publiken utan även här "hemma". Se preliminär information på förlagets hemsida: <www.infoagepub.com/products/First-Sourcebook-Nordic-Research-Mathematics-Education>.

I ett internationellt perspektiv hade CERME-konferensen i Lyon 2009 ett större svenskt deltagande än tidigare (16 personer) och man kan nu ladda ner proceedings från internet på adressen: <www.inrp.fr/editions/editions-electroniques/cerme6>. Hemsidan till ERME, den europeiska förening som arrangerar CERME-konferenserna, har nu adress <www.erme.unito.it> och kommer att successivt uppdateras. Nästa konferens, CERME7, äger rum i Rzeszow i Polen 9-13 februari 2011. Senaste datum för bidrag är den 15 september 2010 (se vidare hemsidan < www.cerme7.univ.rzeszow.pl>).

I samband med ICME11 hade ICMI sin *General Assembly* so var historisk genom att det var första gången som valet av dess nya *Executive Committee* (för perioden 2010-2012) genomfördes av den egna organisationen och inte ”utifrån” av IMU (*International Mathematical Union*). ICMI:s nya styrelse under president Bill Bartons ledning har alltså inlett sin mandatperiod. För att vara uppdaterad om verksamheten inom ICMI rekommenderar jag att lista sig för att få e-postutskicken av det elektroniska nyhetsbrevet, vilket enkelt görs på hemsidan <www.mathunion.org/ICMI/Mailinglist>. Jag rekommenderar också att följa ICMI:s verksamhet på via hemsidan.

Den nordiska forskarskolan NoGSME har nu avslutats och har haft stor betydelse för utvecklingen av vårt område i Norden. Delar av verksamheten har tagits över av NORME, där SMDF är en av medlemsföreningarna. Finansiering måste nu sökas speciellt för de aktiviteter man vill genomföra. Information om NORME och dess verksamhet finns på hemsidan <www.norme.me>.

På skolfronten, inklusive lärarutbildningen, är som bekant mycket på gång. Förslaget till nya ämnesplaner i matematik för GY2011 finns nu tillgängligt på Skolverkets hemsida under en remisstid fram till den 16 augusti 2010 på adressen <www.skolverket.se/sb/d/3398>. Välkomna med synpunkter till SMDF:s styrelse så att vi får underlag för att kunna reagera på förslagen, som vi gjort på tidigare versioner av förslagen. Skolverket har också till regeringen överlämnat nya förlag till kursplaner för grundskolan (se information på hemsidan <www.skolverket.se/sb/d/3719/a/19774>). Även lärarutbildningen är inne i ett reformskede och ansökningar om nya examensrätter ska lämnas av högskolorna senast den 28 juni 2010. Regeringens beslut om examensförordning m.m. kan ses på hemsidan <ncm.gu.se/node/4502>.

Den debatt om skolan och inte minst matematikutbildning som pågår i landet vittnar om att föreningens verksamhetsområde är viktigt och att därmed vårt arbete inom föreningen kan påverka utvecklingen om vi vill. På föreningens hemsida <matematikdidaktik.org> är alla välkomna att lägga in debattinlägg. Här bör också nämnas att alla förslag är välkomna för att göra hemsidan så rik och användbar som möjligt för våra medlemmar – kontakta SMDF:s webbmaster Anette Jahnke eller undertecknad. I medlemsblad nr 15 efterlyste jag idéer och förslag från SMDFs medlemmar om aktiviteter och verksamheter i SMDFs regi som känns angelägna. Jag upprepar här denna uppmaning då medlemmars engagemang är en vital ingrediens för att utveckla en kraftfull förening. Jag skrev om detta i medlemsblad nr 14 och vill gärna uppdatera den texten här.

Vad finns det inom föreningen som det är angeläget att utveckla? Inom den engelska motsvarigheten till SMDF, dvs. BSRLM, finns t.ex. olika arbetsgrupper (working groups; se <www.bsrlm.org.uk>). Nu är BSRLM en mycket större förening i medlemmar räknat, men SMDF borde ha en potential att växa om kännedom om vår verksamhet sprids och upplevs som intressant och attraktiv. Det är medlemmarnas egna intresseområden som kan ha en kraft att utveckla föreningens verksamhet men då måste dessa lyftas fram och synliggöras. Här finns medlemsbladet, årsmöten och andra typer av medlemsmöten som möjliga tillfällen för sådana diskussioner. Då MADIF är en tidsmässigt kort konferens (begränsning ges genom den anslutande biennalen, där många deltagare också

medverkar) är det svårt att få utrymme för ett medlemsmöte inom dess ramar, men efter det stora intresset med många papers vid MADI7 bör vi fundera på att förlänga den en dag, vilket skulle göra det möjligt att lägga in en programpunkt med års- och medlemsmöte, då även med diskussion kring frågor som de ovan nämnda. Vi diskuterar också möjligheten är arrangera ett SMDF-seminarium de år MADIF inte äger rum (alltså udda årtal). Välkomna med idéer och tankar om detta och om andra aktiviteter/initiativ för att stärka och utveckla vår förening!

/ …. Christer Bergsten, ordförande i SMDF

Jonas Bergman Ärlebäck

disputerade 2010-03-12
vid Linköpings universitet med avhandlingen

Mathematical modelling in upper secondary mathematics education in Sweden

I avhandlingen tas olika aspekter av begreppen *matematisk modell* och *matematisk modellering* upp i samband med ämnet matematik i den svenska gymnasieskolan. Avhandlingen är en sammanläggningsavhandling och består av fem artiklar och rapporter som sammanfattas i en kappa. Begreppen studeras från ett kursplaneperspektiv, ett lärarperspektiv och ett elevperspektiv. I studien ingår ett samarbete mellan två lärare och en didaktiker där modelleringsmoduler för introduktion och exponering av matematisk modellering för gymnasieelever utvecklas, provas och utvärderas.

Resultat ur ett kursplaneperspektiv är bland annat att fokus på begreppen matematisk modell och matematisk modellering har ökat i kursplanerna i matematik sedan 1965, men det saknas tydliga definitioner av begreppen. Lärarna i undersökningen kunde inte formulera och förklara innebörden av de undersökta begreppen, men fann arbetet med modelleringsmodulerna givande. Resultatet visade också på olika faktorer, beroende av bland annat rutiner och lärarnas attityder, som inverkade på effektivitet och kommunikation. Väldigt få elever, 25% av 381 elever, hade hört talas om matematisk modellering under sin gymnasietid. Efter att ha arbetat med 7 problem om modeller visade eleverna en negativ attityd till arbete med modellering. De elever som arbetat med modulerna från studien var å andra sidan positiva. Resultaten bidrar till en ökad förståelse av hur de undersökta begreppen kan användas i gymnasieskolan.

Fakultetsopponent var professor Bharath Sriraman, University of Montana.

Kristina Juter

Marcel Gahamanyi

disputerade den 19 februari 2010
vid Linköpings universitet med avhandlingen

Mathematics at work – A study of mathematical organisations in Rwandan workplaces and educational settings

Utgångspunkten för arbetet var en önskan att bättre förankra skolmatematiken i Rwanda i den lokala kontexten för att göra den mer meningsfull för eleverna än dagens mer formella matematikundervisning. Genom att i ett första steg studera hur matematik används på några lokala arbetsplatser (taxi, restaurang och byggplats i Rwanda) och sedan utifrån denna kunskap utarbeta kontextualiserade uppgifter som ges till lärarstuderande i matematik får de en insikt i arbetsplatsmatematik som de sedan själva kan anknyta till i sin undervisning i skolan. De lärarstuderande konstruerade i detta syfte egna uppgifter avsedda för skolelever (på gymnasienivå) som, efter forskarens bearbetning, gavs till en grupp gymnasieelever. I avhandlingen studerades med teoretiska verktyg från verksamhetsteori (Engeström) och antropologisk didaktikteori (Chevallard) hur den matematik som användes var strukturerad och uppfattades, samt hur den lokala kontexten och typen av matematik bevarades eller förvandlades mellan de tre kontexterna/institutionerna, dvs. arbetsplats, lärarutbildning och skola. Denna didaktiska transposition var starkt beroende av de institutionella villkoren och begränsningarna, och det matematiska arbetet inom respektive institution tolkades och styrdes utifrån de mål och de kunskapskriterier som präglade institutionen.

Fakultetsopponent var professor Eva Jablonka, Luleå tekniska universitet.

Christer Bergsten

Per-Eskil Persson

disputerade 2010-03-12
vid Luleå tekniska universitet med avhandlingen

Räkna med bokstäver! En longitudinell studie av vägar till en förbättrad algebraundervisning på gymnasienivå

Avhandlingen beskriver en fyrdelad studie av gymnasieelevers algebrakunskaper och villkor för lärande i algebra. Studien är genomförd under lång tid och bygger på ett forsknings- och utvecklingsprojekt. Två årskullar följdes i den inledande fasen där orsaker till elevers framgångsrika algebrastudier identifierades. I den andra fasen studeras utvecklingen från att vara lärare till att vara forskare och vad denna utveckling har för effekter på förståelse av lärprocesser. Sedan återkommer Persson till eleverna och går vidare med analysen för att studera deras förklaringar av funktionssamband. Avhandlingen avslutas med en litteraturöversikt kring nyare forskning rörande teknologiska hjälpmedels effekter på elevers lärande och kunskaper i algebra.

De fyra delstudierna sätts samman i ett större sammanhang som beskrivs av den didaktiska triangeln (den lärande, läraren och resultatet av undervisningen). Implikationer för undervisningen inom bland annat kunskapsutveckling, algebrans roll genom matematikutvecklingen och teknologi diskuteras. I utifrån sina resultat föreslår Persson möjliga vägar för att förbättra algebraundervisningen på gymnasieskolor i Sverige.

Kristina Juter

Erika Stadler

disputerade 2009-12-18
vid Växjö universitet med avhandlingen

Stadieövergången mellan gymnasiet och universitetet – matematik och lärande ur ett studerandeperspektiv

Avhandlingen är en monografi om nybörjarstudenters upplevda övergång från gymnasiematematik till universitetsmatematik. Fem studenter som ska bli lärare ingår i en kvalitativ studie där intervjuer och observationer använts för att samla in data. Med en analysmetod inspirerad av Grounded theory har Stadler fått fram tre kategorier som beskriver hur studenter lär sig matematik. Kategorierna kallas *matematikens lärandeobjekt*, *matematiska resurser* och *studenten som lärande aktör*. De tre kategorierna bildar grunden för ett teoretiskt ramverk som utarbetats och används för att beskriva stadieövergången. Studenterna anser att stadieövergången innebär en minskad samstämmighet mellan matematikens lärandeobjekt och matematiska resurser. Studenterna är vidare medvetna om att de bör ha sammanhangsbunden förståelse, men de har inte alltid lätt för att uppnå detta visar resultaten.

Studien är ett exempel på en, i någon mening, omvänd metodologisk ansats med en definition av ett fenomen grundad i forskarens vardagserfarenheter som utgångspunkt. Via empiriska undersökningar av fenomenet kommer forskaren fram till ett teoretiskt resultat.

Fakultetsopponent var professor Carl Winsløw, Köpenhamns universitet.

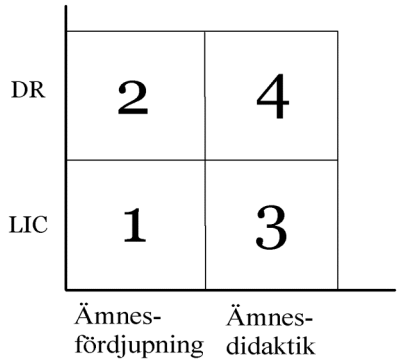
Kristina Juter

Lektorer i skolan – vad ska det vara bra för?

Den nya skollagen och beslutet om lärarlegitimation kommer att innebära att lektorstjänster ska inrättas i skolan på ett mer systematiskt sätt än vad som är fallet idag. Det finns skäl att noga fundera igenom situationen, föra fram viktiga frågeställningar samt att erbjuda genomtänkta förslag inför implementeringen av lektorstjänsterna i skolan.

Gymnasielektorer är ett utdöende släkte eftersom i stort sett inga nya tjänster inrättats på senare år. Det finns endast cirka 200 gymnasielektorer idag. Sedan 2003 har antalet halverats och så sent som på 80-talet fanns det tusentals lektorer i gymnasieskolan (Jällhage & Bondesson, 2010, s. 11).

De lektorer som finns idag kan indelas i fyra kategorier enligt följande schema:



Historiskt sett har det i regel krävts att man doktorerat för att kunna bli lektor i gymnasieskolan. På senare tid har dock kraven mildrats och det har räckt med licentiatexamen. Detta fastslås även i de formuleringar som publicerats inför den nya skollagen som träder ikraft 2011. Kraven anges där som ”doktorsexamen, eller minst licentiatexamen” (Regeringsskansliet, 2010), vilket skulle kunna läsas som att det är önskvärt med doktorsexamen men att man även kan acceptera lic:ar.

En annan skillnad jämfört med förr är att det nu är mycket vanligare med ämnesdidaktiska lektorer. Ämnesdidaktiken har tidigare inte haft ett allmänt erkännande som vetenskapsområde och ända in på 2000-talet förkommer starka ifrågasättanden (se exempelvis inlägg i Svenska Matematikersamfundets medlemsutskick samt matematikprofessor Ulf Perssons ifrågasättande i *Dagens forskning* 23:2002). Mitt bestämda intryck är dock att politiker och kommunala tjänstemän i växande grad ser ett värde med ämnesdidaktisk forskning. Även om Utbild-

ningsdepartementet inte uttalar sig om framtida inriktningar så är det rimligt att anta att de nya lektorat som inrättas till största delen kommer att vara ämnesdidaktiska. En viktig faktor som pekar åt detta håll är det faktum att framtidens lektorer ska kunna finnas på alla skolstadier, från förskola och grundskola upp till gymnasieskola. På de tidiga stadierna är det svårt, för att inte säga omöjligt, att tänka sig ämneslektorer istället för didaktiklektorer.

Utöver kravet på licentiat- eller doktorsexamen finns ytterligare ett krav på dem som ska få lektorstjänster, nämligen att endast de som ”under minst fyra års tjänstgöring har visat pedagogisk skicklighet ska benämnas lektor” (Regeringskansliet, 2010). Formuleringen som används i samband med lanseringen av lärarlegitimation lyder att lärarna ska ha ”visat minst fyra års yrkesskicklighet” (Reinfeldt et al., 2010). Här infinner sig frågan vem som ska intyga detta. Närmast till hands ligger aktuell lärares rektor. Med tanke på att Skolverket, och inte som hittills kommunerna, kommer att utnämna framtidens lektorer, kan man här ana risken för konfliktsituationer. Vad händer om en disputerad lärare söker en lektorstitel hos Skolverket men lärarens rektor inte vill tillstyrka att ”yrkesskicklighet” föreligger?

En intressant frågeställning är varför antalet lektorer minskat så drastiskt. Det krävs ingen ny skollag för att lektorstjänster ska kunna inrättas. Det har stått varje arbetsgivare fritt att genomföra detta. För att finna svaret på denna fråga har jag valt att studera situationen i min kommun, Stockholm. Här finns ett tydligt uttalat politiskt stöd för karriärtjänster för lärare, exempelvis i form av lektorstjänster. Trots detta har vi i realiteten bevittnat försämringar inom detta område. Inga riktiga lektorstjänster har tillsatts i Stockholmsskolorna de senaste åren. Faktum är att antalet lektorat i Stockholm har minskat från 39 till 29 under mandatperioden, dvs. en minskning med 25 %. Sorgligt nog visar de flesta rektorer ringa intresse för att inrätta lektorstjänster. Man ser de ökade lönekostnader som lektorer skulle innebära men inte några mätbara fördelar. Ansvariga skolpolitiker har hittills inte velat gå in och detaljstyra vilka tjänster som inrättas ute på skolorna. Därmed uppstår en klyfta mellan den fina politiska retoriken och den krassa verkligheten ute i verksamheten. Här krävs tydligare styrning och bättre resursstöd om man menar allvar med att karriärtjänster för lärare behövs. Stockholm har här en hel del att lära av andra kommuner. Ett exempel på en förebildskommun är Uppsala, där man från politiskt håll satt upp ett tydligt mål och avsatt ekonomiska resurser för att inrätta 30 lektorat i gymnasieskolorna under mandatperioden 2006-2010.

I slutet av 2009 utannonserades tre lektorstjänster av Utbildningsförvaltningen i Stockholm. Dessa skulle inte vara förlagda till skolor, utan till själva förvaltningen. Ansvarsområdet sträckte sig från förskola upp till gymnasienivå. Tjänsterna innebar semestertjänst istället för ferietjänst. Dessutom var de tidsbegränsade till några år. Föga överraskande sökte bara några få dessa tjänster och man beslöt sig för att avbryta rekryteringsprocessen, så inga lektorstjänster inrättades. Min tolkning av situationen var att tjänsterna ställde orimliga krav på kompetensbredd, befann sig för långt från skolornas verksamhet samt inte hade tillräckligt bra arbetsvillkor.

I denna diskussion kan det vara värt att fundera på hur man definierar begreppet *karriärtjänst*. Den gängse bilden är att det handlar om möjligheten att successivt befordras och kunna klättra uppåt på en arbetsplats, där varje ny position medför ökat ansvar, viktigare arbetsuppgifter och högre lön. Att utföra tillfälliga uppdrag och sedan återgå till sin vanliga lärartjänst, vilket de just beskrivna utannonserade tjänsterna innebar, kan inte med den bästa vilja i världen sägas vara karriärtjänster. Tidsbegränsade karriärtjänster i skolan rimmar illa med behovet av långsiktighet och kontinuitet. Bevakning av och kontakt med forskningsvärlden är inte något som kan kopplas på och av med kort varsel beroende på om man har en tidsbegränsad s.k. ”karriärtjänst” eller inte.

Ett problem med de lektorstjänster som finns idag är att ingen tid i tjänsten för särskilda arbetsuppgifter garanteras. Därmed bakbinds dagens lektorer eftersom de har svårt att hinna med utvecklingsinsatserna inom ramen för sina tjänster. Dessutom finns ingen genomtänkt strategi för var och hur lektorerna ska verka. De finns lite här och var och i varierande ämnen. En bättre väg att gå vore att ge varje skola stöd så att de kan ha en lektor per större ämnesgrupp. Då skulle utvecklingen kunna ske nära verksamheten i samråd med lärarna.

Såsom tidigare konstaterats i denna text tycks det finnas en outtalad (men ändå verklig) skepsis mot lektorer i skolan från skolornas chefer, rektorerna. Finns det då i samhällsdebatten någon uttalad kritik mot att ha fler lektorer i skolan? Ja, ett sådant exempel är professor Tomas Kroksmark, verksam vid Högskolan i Jönköping. Han menar att det faktum att grundskolans och gymnasieskolans lärare arbetar mer kollektivt än tidigare kan försvåra, ja, till och med omöjliggöra, att lektorat skulle kunna fungera i skolan:

> Men den mest påtagliga skolkulturen är kollektiv. Lärare vill ha samma lön, trots att lönesättningen är individuell; samma arbetsvillkor, lika stora grupper/klasser, likvärdiga resurser för kompetensutveckling, samma anställningsvillkor etc. Det tyder på just att yrkesgruppen har fler kollektiva förtecken än individuella. Om

> det är en riktig iakttagelse ställer jag mig tvivlande till att skolan tål lektorer – om de ska ha andra villkor än alla andra och om de ska ta ansvaret för att vetenskapligt utveckla kollegorna. Det har fungerat dåligt tidigare och jag tror inte att det blir bättre nu… Jag tror alltså inte längre på individuella lösningar i en kollektiv yrkeskultur. Några lektorer i skolan, här eller där, räcker alltså inte – det kan till och med motverka sitt eget syfte. (Kroksmark, 2010)

Kroksmark sätter här fingret på ett mycket viktigt problem. Skolans platta organisation har vant lärarna vid att inga lärare får sticka ut, vare sig vad gäller lön, ansvar eller inflytande. Detta kan självklart försvåra möjligheterna för lektorer att få gehör för förändringsförslag som har sin utgångspunkt i ämnesdidaktisk forskning. Krokmarks lösning på behovet att överbrygga den klyfta som finns mellan skola och forskarvärld är att ”ALLA pedagoger och lärare … ska utveckla praktiskt klokskap i kritdammsnära skolforskning” (ibid.). Detta låter bra men är orealistiskt. Dels har inte alla lärare ett intresse att personligen forskarstudera och dels skulle kostnaden för kommunerna bli oerhört stora. Det vore bättre att på ett uthålligt och genomtänkt sätt förankra en ny organisation i skolan, där lektorer blir ett naturligt inslag, inte som ”upphöjda” figurer, utan som *bevakare* av forskningsområden och *förmedlare* av ny kunskap.

Nämnas bör även att de två stora fackliga organisationerna är starka anhängare av lektorer i skolan. *Lärarnas Riksförbund* vill öka antalet lektorer i Sverige och anser att lektorer måste ges "möjlighet att kombinera forskning med undervisning" och "som en del av sin tjänst, ha som uppdrag att bidra till spridning och tillämpning av aktuell forskning" (Lärarnas Riksförbund, 2009). *Lärarförbundet* välkomnar det faktum att lektorstjänster nu skrivs in i skollagen. Deras ordförande, Eva-Lis Sirén, anser att det ”kommer att stärka resultaten i den svenska skolan, i språkutveckling, i läsning och skrivning, i matematikförståelse. Det kommer också att betyda mycket för integrationen” (TT, 2009). Även Skolledarförbundet är positivt (ibid).

För att lektorerna ska kunna spela en viktig roll i skolornas kvalitetshöjning, behövs resurser så att de i sina tjänster får möjlighet att ägna sig åt skolutvecklande verksamhet. Åtminstone en dag i veckan, dvs. minst 20 % av heltid, behövs för att denna verksamhet ska kunna få ett märkbart genomslag i skolorna. De särskilda arbetsuppgifter som lektorerna ska ägna sig åt bör utgå från skolornas behov och fastställas gemensamt av skolledning och den enskilde lektorn. Det kan exempelvis handla om kontakt med högskolevärlden, forskningsbevakning, utvecklings- och forskningsprojekt, utprovning av nya arbetsmetoder samt anordnande av seminarier och föreläsningar. Stimulerande arbets-

uppgifter och goda lönevillkor kan göra det eftersträvansvärt att vilja bli lektor. Dessutom ökar det chanserna för att lektorerna stannar i skolan istället för att gå vidare till högskolan.

/ ***Niklas Bremler***

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Nordic doctoral programmes in mathematics education[1]

Introduction

A short historical background of doctoral programmes in didactics of mathematics

In Sweden the academic subject pedagogy (or general education) developed in the beginning of the 20th century and inside this field it was possible to carry out doctoral studies concerning mathematics education. One of the first doctoral dissertations about mathematics learning was the one by K. G. Jonsson in 1919, which is an interview study with pupils: Investigations concerning the conditions and course of problem calculations (Undersökningar rörande problemräkningens förutsättningar och förlopp, my translation) (Bergsten, 2002). According to Bergsten (2002) 23 Swedish Ph D works during the period 1919-1999 could be classified as belonging to the field of mathematics education. It was not until the mid 1990 that separate doctoral programmes in mathematics education were constructed.[2] This happened around the same time in the universities in Luleå, Umeå and Gothenburg. The first dissertation was presented in Luleå University of Technology by Andrejs Dunkels (1996), and it was followed by Tomas Bergqvist in Umeå University (2001). In 2000 the Swedish Bank Centennial Foundation decided to offer 45 million Swedish crowns for a National Graduate School in mathematics with didactical direction. This led to the development of new doctoral programmes in seven more departments (Leder, Brandell & Grevholm, 2004). More about the graduate school will be presented below. The development in the other Nordic countries was similar to this example from Sweden, which will be visible from later sections in the paper.

[1] En förkortad version av denna text finns publicerad i R. E. Reys & J. A. Dosey (Eds.) (2008). *U.S. Doctorates in mathematics education: Developing stewards of the discipline, Issues in Mathematics Education, Vol. 15 (pp. 189-194). CBMS.* Providence, R.I.: American Mathematical Society, in cooperation with Mathematical Association of America.

[2] A combined programme in pedagogy with an emphasis on mathematics education, with a cooperation of departments of pedagogy and mathematics also including shared supervision and course work, existed earlier for example at Linköping University, where two dissertations appeared in 1990.

About terminology

In Sweden and the Nordic countries mathematics education is called 'matematikdidaktik' (or similar words in the different languages), didactics of mathematics, thereby following the German and French tradition rather than the Anglo-Saxon, when it comes to the notion. In Sweden mathematics education is translated to 'matematikutbildning', which means education in mathematics, including school level and other levels. Thus there is a risk of misinterpretations when using the word mathematics education as a name for the research field. Here I will use both these notions interchangeably.

My background and experiences of doctoral programmes in mathematics education

Since 2004 I am the director of the Nordic Graduate School in Mathematics Education, situated at the University of Agder (UiA). During 2000-2006 I was the vice chair of the Swedish Graduate School in Mathematics with Didactical Direction, which included 10 institutions in Sweden and had 21 doctoral students. I will say more about that later. I was appointed full professor in didactics of mathematics at the University of Agder in 2002 and before that I worked as professor of mathematics and learning at Luleå University of Technology during 2001-2002. Still earlier I have worked at the mathematics department at Lund University for 10 years, as mathematics teacher (lector) and head of department in upper secondary schools for many years and as mathematics teacher educator (associate professor) for about fifteen years, first at Lund University and then at Kristianstad University. My own education is a master of philosophy in mathematics (also with physics, theoretical physics, astronomy and pedagogy), a research degree in pure mathematics and an examination from upper secondary mathematics teacher education. As teacher educator since 1985 I have gradually grown into the field of didactics of mathematics, which did not exist in Sweden, when I took my early postgraduate education. The first courses in didactics of mathematics organised at Lund University took place in 1988 and I was part of the course team. My teaching has gradually moved from mathematics to mathematics education over the years and my research and supervision over the years have been in mathematics education.

The structure of doctoral programmes in the different countries

In this section I want to offer short descriptions of some characteristic features of the doctoral programmes in didactics of mathematics in those Nordic

countries where it exists. This includes some parts of the recent developments in each of the countries also.

Denmark

In Denmark the doctoral education lasts for three years and there is no compulsory course part. The doctoral student can have one or several supervisors. The research education leads to a thesis that will be examined by three examiners, and two of them are external. The examiners read the thesis and produce a written document, where they classify the work as acceptable or not. After the acceptance the doctoral student is allowed to defend the thesis in a public viva (disputation), where also external persons can criticise and discuss the content. The thesis is normally not published. At least five universities offer programmes which can include didactics of mathematics (at least as part of a broader subject description). They are Ålborg University, University of Southern Denmark, Roskilde University Center, Copenhagen University and Denmark Pedagogical University. Since 2004 Denmark has a National Graduate School in Science and Mathematics Education. The graduate school can offer financing for seven doctoral students and organises courses, seminars and workshops. The first professor of didactics of mathematics in Denmark was Mogens Niss and he has been followed by others recently.

Finland

Following some national and rather general guidelines, the doctoral education in Finland is designed in ways decided at each university. Models exist where different disciplines are integrated into the same programme as for example the sub-disciplines of pedagogy at Åbo Academy. There are also more separated models. The doctoral education is normally four years of full time studies and builds on a masters' degree. Most teacher educations in Finland are currently qualifying for doctoral education (Westbury, Hansén, Kansanen & Björkqvist, 2005). Teachers qualified to teach mathematics have either a master's degree in pedagogy (class teachers, years 1-6) or with the main area among mathematical subjects (subject teacher). No university offers a separate doctoral programme in didactics of mathematics, but such studies can be carried out under different examination rubrics.

The following is an example from Åbo Academy, where courses and seminars take up about one year of full time studies in the doctoral education. Among them are common philosophical, theoretical and research methodological courses (about one semester). Normally the doctoral student has one supervisor,

but a co-supervisor can be appointed if needed. The content of the doctoral education is decided in an individual study plan, which is created by the student and the supervisor and accepted by the faculty board. Teaching experience is not a prerequisite for research studies in didactics of mathematics. The studies result in a thesis on licentiate or doctoral level (60 or 180 study points). Fewer students are now choosing to take the licentiate degree.

The dissertation is examined by at least two external experts, preferably with 'docent'-competency (see below). The examiners send their decisions to the faculty board, where they express suggestions for improvements and where they give a judgement of the acceptability of the work. The faculty board can ask for changes in the manuscript as conditions for a new examination. After the permission for defence of the thesis is given by the faculty board, a public disputas (viva) is carried out where the doctoral student presents the work and defends it. The official examiners, opponents and the public are given opportunities to discuss and criticize the work. The opponent has to hand in his written criticism to the thesis and the defence no later than a month after the disputas. Based on that, the faculty board decides about the judgement in an eight graded scale. Examiners can function as opponent at the disputas. All dissertations are printed (in paper or digital form).

National graduate schools for teachers in mathematics, physics and chemistry in Finland were organised first during 1995 to 2001 and then again from 2003. It started with four doctoral students in 1995, then grew to 10 in 1998 and since 2007 it has five doctoral students. The responsibility for the graduate school lies at the University of Helsinki. The doctoral students must have a masters' degree in pedagogy or in any of the subjects involved. The main focus can be either pedagogy or any of the mathematical sciences. In both cases studies in subjects, in didactics of the subjects and methodology are included. The aspiration is to offer two supervisors for each student, one from pedagogy and one from mathematical sciences. Each year two five-day seminars for doctoral students are organised, with emphasis on research methodological themes. No doctoral courses are given. The graduate school has a close cooperation with The Finnish Mathematics and Science Education Research Association (Malinen & Kupari, 2003). Doctoral students are encouraged to present at its yearly symposia.

A distinct growth in number of dissertations in didactics of mathematics can be noted since 1995. During 1984 to 1996 6 dissertations were defended and during 1997 to 2006 it increased to 23 (Pehkonen, 2007).

In Finland there is a clear wish to develop further the cooperation between institutions in national and international graduate schools. A recent development plan for 2007 to 2012 is voicing such views (Undervisningsministeriet, 2007)

Iceland

There is no special doctoral programme in mathematics education in Iceland. One student is at the moment doing her study in this field, but it is formally taken in a programme for Educational Studies – Philosophy of Education. Iceland has had a professor in mathematics education since 1992, but no research education has been created during that time. In general doctoral studies are based on a master's degree. The Study time is at least 3 years and at most 8. The course part can be of one year duration. A study plan is set up every year in collaboration between the student and the supervisors. The examination is done by two external examiners, who read the thesis in advance and write their comments. The student is allowed to make changes based on the comments within one month. The doctoral candidate is then defending her thesis in a public meeting. It has been common for Icelandic students to go abroad to carry out their doctoral studies.

Norway

In Norway the doctoral education is a three year study with course work and research leading to a written thesis. The course work in general is one semester but in the biggest programme (in University of Agder) the course work covers one year of study. The prerequisites for study are a master's degree in mathematics or mathematics education and teaching experiences. The examination is similar to the one in Denmark, with two external opponents and one local producing a written judgement in advance and then acting as opponents during a public defence (disputas). The dissertations can be published. There is no national Graduate School in Mathematics Education in Norway yet, but plans to start one. On the other hand, the Nordic Graduate School in Mathematics Education (see more below) is situated in University of Agder. University of Agder is at the moment the only university that offers doctoral courses in mathematics education at a regular basis in the Nordic countries.

Exemplifying with the programme of University of Agder, it can be noticed that each doctoral student will get at least two supervisors (a main supervisor and a co-supervisor) and an individual study plan is made up each year, followed by a yearly report to the board about the outcome of each study year. Also supervisors' reports to the board are handed in and carefully followed up. Two

courses are compulsory, Theory of science from a didactics of mathematics perspective (5 study points) and Research methodology in Mathematics Education course (15 study points). One or two courses are running each semester and they normally attract doctoral students from the whole of Scandinavia.

Sweden

The doctoral education in Sweden is a four year full time education building on a bachelor or masters' degree. The programme consists of courses and research resulting in thesis-writing. Normally the courses take up half of the time. It is possible to take a licentiate degree half-ways in the programme. This is an independent degree and the student can stop there. The normal case is to continue with the second part and that the two parts are closely linked to each other.

Programmes in mathematics education did not exist until fairly recently. The first ones were, as mentioned above, in Gothenburg, Luleå and Umeå. In Luleå one student graduated in 1996. The first one in Umeå graduated in 2001. In 2000 a national graduate school in didactics of mathematics was created, with ten participating universities. In addition to the mentioned ones they were: Kristianstad, Linköping, Mälardalen, Stockholm, Uppsala, Växjö and Royal Technological University (KTH). The graduate school was funded from Riksbankens Jubileumsfond (Swedish Bank Centennial foundation) and Vetenskapsrådet (VR, The Swedish Research Council). In 2001 21 doctoral students were taken up at the ten different institutions and were intended to finish in 2006 (studying on 80 %-basis for five years with a 20 % teaching duty). In 2006 eight of them defended their theses, one finished in 2007 and the rest of them were still carrying on with their studies (delayed by pregnancies or sick leaves).[3] The graduate school finished to exist in 2006 (a one time funding) and an application for a continuation has been sent to VR but has not yet succeeded.

The special programmes for mathematics education in Sweden are situated at mathematics departments and doctoral courses in mathematics are part of the course work. The prerequisites were three semesters of fulltime mathematics studies and mathematics teacher education or equivalent experiences. In the national Graduate School it was supposed that students take 50 % courses in mathematic but most them actually did less than that. Courses in general

[3] This text was written by the end of 2007, since then several of these students have completed their degrees.

pedagogy or mathematics education dominated. One or two supervisors work with the student and individual study plans are created each year. In the national graduate school there was a close follow up of the students and they were given a special mentor (from the board of the school) in addition to the supervisors. The graduate school offered common courses in mathematics education, and seminars and workshops. The courses in mathematics were supposed to be the normal ones given at the department for doctoral students in mathematics. The graduate school also tried to offer competence development for the supervisors, but these arrangements were not used much by the possible participants (Leder, Brandell & Grevholm, 2004).

The Baltic countries, Estonia, Latvia and Lithuania

At the moment there is not a separate doctoral programme in mathematics education in Estonia. Mathematics education is considered as one specialisation in the doctoral programme in general pedagogy. Such programmes are offered in Tallinn University and University of Tartu in cooperation with faculties of education and mathematics.

In general, the doctoral education is a four-year study with course work and research. The course work (courses in general pedagogy and didactics of mathematics) covers one year of study and is compulsory. The research leads to a thesis that will be defended during a public defence and judged by two opponents (at least one external). The dissertations are published. The prerequisites for study are a bachelor degree in mathematics (3 years of studies) and a master's degree in mathematics education (2 years of studies).
The situation in other Baltic states, in Latvia and Lithuania, is similar.

Collaboration in Graduate Schools

National graduate schools

Research areas that are small with only one or two students and one or two faculty are vulnerable and it is tempting to create cooperation between institutions. As can be seen from above the idea to build National Graduate Schools has developed in Finland, Sweden, and Denmark. Finland was first in 1995, followed by Sweden in 2000 and Denmark in 2005. Finland has repeated the initiative once, in Sweden it is so far a one time activity between 2000 and 2006. Many reasons have been presented for having national graduate schools. There is a wish to increase the number of students finishing in time, a wish to shorten the actual study time (which normally can be longer than the formally

expected time), to offer a richer study environment for the students and to offer competence development for the supervisors. In Sweden an evaluation of 16 national graduate schools was published in 2006 (Persson, 2006). The report points out that there have been some problems, such as lack of knowledge about and experiences in didactical research, inadequate planning and organisation of the activities, in some cases insufficient supervisor competence, difficulties to cooperate and antagonism between different fractions in the subject fields, financing problems and so on. The evaluation of the outcomes is more positive. Most doctoral students have finished in reasonable time and supervisors' competence has developed well. National and international networks have been established and are strengthening the opportunities for further development and improvement of research in subject didactics. The relations to the core subjects have been highly improved. There seems to be a promising labour market for the new doctors. Person points out that when establishing new graduate schools these experiences must be taken into account. There must be adequate supervisor's competence from the beginning and resources for competence development of supervisors must be set aside. Not too many institutions should be involved and very good preparations are necessary for a graduate school to function well from the beginning. All participating institutions must agree about the aim and goals of the activities. Common guidelines for students' conditions and financing must be agreed upon.

The Nordic Graduate School in Mathematics Education

In 2004, the Nordic Graduate School in Mathematics Education started, based on funding from the Nordic Research Academy (NordForsk). It is a five year activity with the idea that after five years the cooperation built is strong enough to survive by support only from the involved institutions.

I will present the Nordic Graduate School in Mathematics Education, its aims and some of its activities. The Graduate School is a network of about 40 Nordic and Baltic research environments with graduate education in mathematics didactics. Around 115 supervisors and 86 doctoral students are part of the network. An account will be given of doctoral courses so far, of seminars for supervisors and of workshops and summer schools that have taken place.

The aim of a Nordic Graduate School in mathematics education

The aim of the Nordic Graduate School as it was decided by the application to NordForsk in 2003 (The Nordic Research Academy) is to

- support and develop the education of researchers in mathematics education in the Nordic and Baltic countries,
- create constructive cooperation in order to raise the scientific quality of research in mathematics education,
- give all doctoral students in mathematics education access to the activities of the Graduate School
- create cooperation among a greater group of doctoral students and supervisors in order to share experiences and opportunities to improve the education of researchers.

The utmost aim is to create a network of cooperating partners, who can continue to collaborate after the five years of the Graduate School (Grevholm, 2004a).

Activities in the Nordic Graduate School in Mathematics Education

The activities in the Graduate School can be summarised in the following points (Grevholm, 2004b, 2005a):

- Common courses are created with the added competence from all researchers in the Nordic countries and international partners (Grevholm, 2004c)
- Seminar-series in specific research areas are offered as a complement to local series and workshops on subjects or issues of main importance (Grevholm, 2005b)
- Competence development for supervisors and exchange of experience is offered
- Partnerships and collaboration with distinguished international scholars are built
- Creating a database for ongoing work, theses and greater development work in mathematics education
- Mobility stipends and special financial support for doctoral students are given.

Courses that have been offered since 2004

The courses offered are of two kinds. Courses that are given on a regular basis at some of the participating universities are open to all doctoral students in the network. They are advertised each semester. Other courses are initiated by the

board of NoGSME. The board collaborates with some interested colleagues in one of the participating universities and the course is constructed and given at that place, with financial support from NoGSME (Grevholm, 2004d, 2005c). The regular courses so far have been given at University of Agder in Norway. The courses that have been initiated by NoGSME have taken place in Copenhagen University (Winsløw, 2006), Denmark Pedagogical University, and Norwegian University of Technology. Ongoing courses are planned together with Roskilde University and Umeå University. Here are the courses given so far or ongoing:

- Theory of science from a mathematics education perspective
- Meta-perspectives on mathematics and the learning of mathematics in a technological environment
- History of mathematics with emphasis on modern mathematics
- Theoretical aspects of mathematics education with emphasis on the French School
- Problem solving in mathematics education
- Theories of learning and teaching mathematics
- Research design and research methods in mathematics education
- Views of knowing and learning: Constructivism and socio-cultural theory
- Gender and mathematics education
- Justification of research in mathematics and science education with special emphasis on the role of theory in such justification
- Research on assessment in mathematics education

Students get travel support to come to the courses and they can also apply for mobility stipends if they want to spend one or two months at another Nordic university. The mobility stipend covers real costs for travels and accommodation.

Summer schools

In 2004 four students and the director of NoGSME took part in the ERME summer school in Podebrady in order to get inspiration for creating the coming summer schools of NoGSME (ERME is the European Society for Research in Mathematics Education). These four students were then part of the planning group for the summer school in 2005. That year 30 students took part in the NoGSME summer school in Finland in Jyväskylä University, which according to the evaluations of the participants was a great success. In 2006 20 students took part in the NoGSME summer school in Dømmesmoen at the University of

Agder campus in Grimstad in Norway (Grevholm, 2005ab, 2006b). Again two doctoral students were part of the planning group and helped to make it fruitful to their colleagues. The main part of the programme is taken up by work in groups, where each student can get her research project discussed and commented on. The groups are lead by international experts in the field, which is highly appreciated by the participants. Among these experts we have had Gilah Leder, Kath Hart, Tommy Dreyfuss, Marcelo Borba, Abraham Arcavi, Eva Jablonka, and Marianna Bosch. In 2007 NoGSME offered a summer school in Laugarvatn in Iceland, which had 42 participants and in 2008 NoGSME the summer school will take place in Sweden. The friendship and mutual understanding that is built in these summer schools are expected to be the foundation of longstanding cooperation of the students in their coming careers (Grevholm, 2004b, 2006b).

Seminars for supervisors

A crucial component of doctoral education is access to good and experienced supervisors. In order to assist the environments in strengthening the competence of supervisors NoGSME is organising seminars and competence development programmes for supervisors. They have focussed much on quality issues in research education and publications (both papers and theses) (Grevholm, 2006c). NoGSME has built a close cooperation with the journal Nordic Studies in Mathematics Education (Nomad) in order to enrich these programmes. Here is a list of the seminars given so far:

- September 2004 in Vasa, Quality in research in mathematics education
- April 2005 in Korsør, Quality of theses in mathematics education
- September 2005 in Trondheim, Supervision of doctoral students
- November 2005 in Lund, Reviewing of papers in mathematics education
- May 2006 in Vasa, Research programmes in mathematics education
- October 2006 in Magleås, Critical situations in supervision of doctoral students in mathematics education
- February 2007, Trondheim, Review process of papers for scientific journals
- October 2007, Lund, Outcomes of research in mathematics education.

The seminars most often have between 20 and 30 participants and quite an important network of researchers is growing from the meetings that take place

there. International scholars have been invited and generously offered from their expertise. Some of the invited researchers so far have been Frank Lester, Diana Lambdin, Uri Leron, Erkki Pehkonen, Gunnar Gjone, Carl Winsløw, Morten Blomhøj, Paola Valero, and Barbara Jaworski.

Workshops

NoGSME organises workshops on central research issues of interest for the participants in the Graduate School (Grevholm, 2007a). The activity involves both doctoral students and supervisors. The first took place in September 2005 in Trondheim and the workshop dealt with classroom research and was led by Simon Goodchild. The second workshop focussed on research on mathematics textbooks and was in May 2006 in Kristiansand. The experts here were Birgit Pepin and Linda Haggarty. Here a Nordic network for research on mathematics textbooks was created. In November 2006 in Kristiansand a third workshop on research on use of ICT in mathematics education took place with 25 participants and two invited experts, Luc Trouche and John Monaghan. The fifth workshop was on mathematics and language and it took place in Uppsala in Sweden in April 2007 with Heinz Steinbring and Candia Morgan as invited guests. In November 2007 a workshop on Justification of research in mathematics and science education with special emphasis on the role of theory in such justification, lead by Mogens Niss will take place and it is closely linked to the corresponding doctoral course. Patricio Herbst will be one of the invited lecturers.

The board of the Nordic Graduate School in Mathematics Education

The board consists of the director, one member from each of the five Nordic countries and a representative for the Baltic countries. Board members currently are Barbro Grevholm, director, Christer Bergsten, Sweden, Trygve Breiteig, Norway, Ole Björkqvist, Finland, Gudny Gunnarsdottir, Iceland, Madis Lepik, Estonia, and Mogens Niss, Denmark.

The members of the board are not paid for their work, but contribute for idealistic reasons and as part of their positions at the home university. The board meets about three times a year in connection to other NoGSME- activities. The board is responsible for the initiatives and work and has to report to The Nordic Research Academy once a year. Most of the board members are also active in their national society for research in mathematics education and in national graduate schools.

Cooperation with Nomad

NoGSME has close cooperation with the journal Nomad, Nordic Studies in Mathematics Education. Doctoral students and supervisors are invited to publish in Nomad and in each issue of Nomad a few pages are devoted to the NoGSME programme and activities (Grevholm, 2006a). Here they can publish in their Scandinavian mother tongue or in English.

International centres of excellence are working partners

To get support for the application to NordForsk in order to get financing for NoGSME we turned to a number of important international centres of excellence and asked them to write letters of support for us. Leaders from these centres have then been involved in our plans and activities in different ways. The centres we collaborate with are Institute of Advanced Study, La Trobe University, Gilah Leder, Concordia University, Anna Sierpinska, University of Michigan, Hyman Bass and Deborah Ball, University 7, Paris, Michele Artigue, and University of Klagenfurt, Didaktik der Mathematik, Willibald Dörfler.

Another important discussion partner has been Jeremy Kilpatrick, who is well informed about Nordic conditions relating to mathematic education. He has among other things been a guest professor at Gothenburg University and the supervisor of some Swedish doctoral students.

Results and outcomes of the Nordic Graduate School

The activities of the Nordic Graduate School are building strength in Nordic research for the future (Grevholm, 2006e). The knowledge and contacts that doctoral students and supervisors are getting from the events together offer insights that can not be achieved from reading books or by other means. In the future these links will be important and valuable for the field of mathematics education. Models of organising research education and supervision can be compared and developed and fruitful ideas from one university can be spread to other places (Grevholm, Persson & Wall, 2005). It is especially important for the Nordic Graduate School to build the contacts with colleagues in the Baltic countries.

Some features in order to strengthen the quality of researcher education

Ninety percent seminars

Mathematics education as a field of research is developing in the Nordic countries but it is still a young area and there is a need to assure the quality of

the work and to live up to international expectations and standards. A number of initiatives have been taken in order to raise quality. For example, both in the Swedish Graduate School and at UiA in Norway we have introduced what is called ninety percent seminars. This means that when the student and supervisors agree that there is a manuscript of about 90 % of the final thesis a seminar is organised. To this seminar an international scholar, who is expert in the area of study, is invited. He or she reads in advance the 90 % finished manuscript and gives constructive and creative feedback during the seminar, which is organised as a dissertation. The intention of the seminar is to inspire the doctoral student to raise quality in the final phase of writing and to get fresh ideas how to improve the dissertation and to be aware of possible criticism before it is too late. The seminars have proven to be of utmost value to both the doctoral students and the supervisors. International scholars have generously given from their expertise in these discussions.

International studies

Another feature of importance for quality is international collaboration and studies abroad. There is an expectation for the students to spend one semester at another university, thus learning about a different academic institution and meeting other mentors and supervisors. This has functioned in Sweden, where the programme is often taken over five years but has been difficult to realise in Norway within a three year programme. The students feel the time pressure too hard for going away for such a long period of time. As compensation we have invited many international scholars to give seminars at UiA, but this is of course not the same as spending time abroad. We are working on how to improve this feature of the education. Internationalisation is also a concern of the Norwegian and Swedish educational authorities (SOU 2004:27).

Models for supervision

Supervision is a crucial part of the doctoral education. In order to ensure good and continuous quality in supervision we have at UiA decided to have at least two supervisors. Supervisors move, get sick or retire and it is important that the students are not left in an unstable situation. Joint supervision and other forms for organising supervision must be considered. At Luleå University of Technology a dynamic model of supervision with many levels have been used and proven successful (Grevholm, Persson & Wall, 2005). The model mirrors an apprenticeship theory for the doctoral education, which seems to be embrace by many of the supervisors.

Public defence of the dissertation

A public defence of the dissertation and invited international opponents is typical of the Nordic doctoral educations. It seems very important to have open discussions, where anyone can question and criticise the dissertations. Also the publication of theses, which makes them accessible in libraries to everyone, is valued in the democratic Nordic societies. The publishing of thesis is the normal situation in Finland and Sweden and often is the case also in Denmark and Norway. Nowadays in addition to the printed books with theses there is often also an electronic version on the internet.

A Nordic Journal for Mathematics Education

The close collaboration with the journal Nordic Studies in Mathematics Education, Nomad, is of great value to supervisors and doctoral students in the Nordic countries. This journal is the natural choice for the fist publications of the students. But many of them prefer other international journals as ESM, JMTE, IJSME or FLM.

Crucial or critical issues for mathematics education doctoral programmes in the Nordic countries

Supervision in a new research field

Trying to build up and expand a new research field is not an easy task. The most problematic issue has been that here have not been many experienced researchers, who can function as supervisors. In Sweden, for example, many mathematicians accepted to be supervisors when the national graduate school started. Some of them realised that they could only be of help for general matters in the education and someone else had to do the actual mathematics education supervision. But others actually thought that they had the expertise (being expert mathematicians but amateurs interested in teaching and learning of mathematics). Thus over the years there has been a number of situations, where the board of the graduate school had to assist in finding new supervisors, often by using an international scholar as additional supervisor. Also it happens that the student and supervisors are not getting along in a good way and a shift of supervisor has to be made. This is difficult when not many choices are available. Thus some supervisors have been used to an extreme extent over some years. As the access to experienced supervisors was limited there was a need to build competence. This has been tried both in the Swedish Graduate School and in the Nordic Graduate School. The success was limited in the first case because of

lacking interest among the group of supervisors. In the Nordic Graduate School it seems to work well. The education of new supervisors is crucial for future survival of the area and we are focussing on getting all the new doctors to participate, thus fostering the future generation of supervisors. The quality of supervision is critical for the outcomes and here international contacts and links are of extreme value.

A first national conference on supervision of doctoral students was held in Sweden in 2003 and some research has been carried out in this area (Strömberg, 1979; Strömberg Sölveborn, 1983; Lindén, 1998). The international community in mathematics education has also cared for the issue of supervision (Hart & Hitt, 1999; Leder, 1995).

Interdisciplinary collaboration

Collaboration between researchers in mathematics, mathematics education and general education has been tried in all the Nordic countries with varied success. In the beginning of the Swedish Graduate School there seemed to be a mini Math War going on. Later this faded away, probably because the mathematicians realised that what was going on is not dangerous for them, on the contrary. This development is even visible in the evaluation of the graduate schools in Sweden (Persson, 2006).

Issues of format and language in theses

The format of the thesis – monograph or selection of papers with preamble ("kappa") has been much discussed in the graduate schools. The tradition from pedagogy is to write monograph and from mathematics it is a selection of published papers with a preamble. As most of the students have been situated in mathematics departments they have been strongly influenced to write a selection of papers. From the 9 in Sweden finished so far there is only a few strict monographs. One wrote the licentiate thesis as a monograph and the second part of the thesis as a selection of papers. Another discussion is how many of the papers must be published in journals before the dissertation. In mathematics there has been a development towards accepting theses where none of the papers are published. So there has also been shifting traditions in mathematics education. One of the Swedish students had 6 published papers in the thesis and others had only two or three non published papers.

Another critical issue is the question of language for the dissertation - mother tongue or English? In Sweden there has been a public debate about scientific

papers written by Swedes in bad English. They are claimed to make fools of themselves internationally. It is obvious that almost every non-native English speaking writer is much better in expressing fine nuances in the mother tongue than in English. But it is also clear that writing in English opens for international readers. And later on researchers must write papers in English anyway. Not using mother tongue leads to a poor scientific language in the local languages and publications that will not be read by teachers in school. There are many pros and cons to consider before the decision on language is taken. In the end it is up to the student and the supervisor and must be taken in each specific case taking care of the circumstances for each student. A student who has writing difficulties anyway will have still worse problems if the writing is in English.

Financing during and after the dissertation

The sources for financing doctoral studies differ from one place to another. In Sweden and Norway the student must have guaranteed financing for the studies before he or she can be taken up in a doctoral programme. The state offers a number of doctoral positions and there can be positions inside specific research projects. The student is employed by the university for 3-4 years and has legal rights as employee. The salary can be compared with that of a beginning teacher. After the dissertation the position is finished. There is a lack of post doctoral positions in didactics of mathematics and this creates problems for those who want to go on at once after the dissertation and qualify themselves to become a docent. In Sweden and Finland this is an academic title for which one must qualify through research and publications after the doctoral degree (the same as Habilitation in Germany). The normal rule of thumb is to publish as much as a second thesis. An application must be made to the faculty and the scientific work is evaluated by external international experts and a public popular scientific lecture is given and evaluated by a scholar in another research field. Based on these activities the decision is taken about becoming the docent title. In Sweden the main supervisor of a doctoral student must be at least on the level of docent.

In the Nordic countries academic studies are free, no costs are paid by students but all is paid by tax-money. Thus the salary of a doctoral student can be used entirely for the private consumption.

Vulnerability of small research environments

Another critical issue is the fact that many research environments in mathematics education in the Nordic countries are small with only one or two faculty

and one or two students. It is difficult to solve the supervisor problem and to create a vivid and inspiring work situation in a community of researchers. One solution for this situation is collaboration between two or more institutions or to be part of a graduate school. The evaluations indicate that graduate schools are efficient in offering what the student needs as a complement to a small environment (Persson, 2006).

Opportunities to finance collaboration in graduate schools or Nordic networks

Collaboration in networks of graduate schools is rewarding and helps to assure quality. But there must be financial resources for such work. In Finland the graduate school succeeded in getting a continuation but in Sweden so far this has been unsuccessful. It is critical to find opportunities to solve this problem. The research environments that have been built up during the time of the graduate schools can very easily be torn down again if there is no continuation of collaboration.

Some questions raised in relation to the conference on doctoral programs

What variations are there in the program beyond the master's degree, and how are those variations taken into account?

In the Nordic countries it is not possible to take a Ph D only by course work. The research part is the essential part, and must take up at least 2 years of the time spent in the program. As mentioned above in Finland and Sweden it is possible to take a licentiate degree half way through the program. In Finland and Sweden an academic career expects the doctor to qualify for docent through published research.

What is your experience with cross-institutional, as opposed to single-institutional, programs?

In collaboration with departments abroad we have very good experiences from student exchange. The evaluations show that students' experiences gained during a stay at another university improves the quality of the education. It has been easy to find colleagues abroad willing to take a guest student and provide support and access to courses, seminars and communities for cooperation.
No problems have been experienced, when different departments have give courses to students from several Nordic universities. Colleagues with expert knowledge in a specific area have been willing to create courses in collaboration with the Nordic Graduate School with just a little extra financial support. Thus the best from many institutions have been made available for all doctoral

students in mathematics education. Evaluations indicate that this is highly important for the students.

In some cases students have realised that the supervision they get at home is not as good as what other students get. Such cases have initiated actions and initiatives for improvement.

How is the program evaluated?

Any university can create their own doctoral programs, but university colleges in Sweden are not allowed to have own programs. In Norway they can if they get them accepted by the National Committee for Evaluation of and Quality in Education (NOKUT).

In Sweden academic subjects are evaluated regularly both at basic level and higher levels. This is done by external international experts and published reports are produced.

In the UiA program we are discussing changes as our dean wants us to have one semester of course work and the teachers want two. They argue that the interdisciplinary character of didactics of mathematics demands some common knowledge in the area. An external evaluator will soon be appointed for the program at UiA after its first five years.

The most influential evaluation is probably the one which is made by students taking the program. If students are satisfied with the program this is made known widely by themselves.

Quality assurance systems have been implemented in the Nordic countries. The process includes among other things regular evaluations made by participating students. Courses are evaluated in mid-term and at the end of the course. Each student has an individual study plan to follow, agreed between the student and the supervisors. The plans are followed up carefully by the board of the program. Students hand in yearly reports on their progress to the faculty board. Supervisors hand in yearly reports on students' progress and supervision.

A lesson learnt so far at UiA is that students consider 3 years to be too short and that one year of courses is too much in addition to participation in research projects.

The Nordic communities in didactics of mathematics seem to be equal proportions of female and male students. Among supervisors there is an

overweight of male academic teachers. The Nordic professors in didactics of mathematics were male dominated until 2003 when suddenly four female professors were appointed. Another additional female professor in 2007 almost creates gender balance in this small Nordic group.

What is the importance of knowledge of mathematics by doctoral students in your program?

The fact that the program is situated in a mathematics department indicates that mathematics plays an important role. A solid foundation of mathematics must be part of the bachelor and masters education that forego the doctoral education. In the Swedish Graduate School the emphasis on mathematics was still greater as doctoral courses in mathematics were a substantial part of the coursework.

What is the importance of knowledge of technology by doctoral students in your program?

In the methodology course students become familiar with software for both quantitative and qualitative data analysis (for example SPSS, NVivo, Atlas, digital video recoding and tape recording) and they are using many different programs in the writing of the thesis (for word processing, drawing, diagrams, reference management, layout). Most students have a very good background in technology when they start in the program, where they get access to all software they need and can get special courses for it. In their data collection in schools they meet most of the programs that are used in mathematics teaching and learning (Excel, Derive, Mathgraph, Cabri and so on) and have often used them themselves as teachers of student teachers.

What have I learnt during the conference?

Some issues and questions discussed during the conference are also crucial in the Nordic countries, such as the structure and content of a program and challenges and opportunities of the delivery of the program, prerequisites, recruitment and progress of students. The role of mathematics in a didactics of mathematics program is important also to us. The eternal question of what is a god enough thesis is common. The question of accreditation is not one we have discussed, probably because of different academic traditions and culture. The issue of how a program can supply teaching experience is not one we would raise. The doctoral education in the Nordic countries is seen as an education to become a researcher. The education to become a teacher must be given as a separate option (and is normally of equal length as the doctoral education). All academic teachers must take a course in university didactics or pedagogy.

Some of the issues that have taken up our considerations in the Nordic countries are how to create and supply excellent supervisors and the questions about quality in research, publications and theses. In the conference I did not notice much concern about supervision? Is that because mathematics education has been established so long in the US that it is evident that there must be access to good and experienced supervisors? In the Principles to guide the design and implementation of doctoral programs in mathematics education there is nothing about the relation between the doctoral student and the supervisors (AMTE, 2003).

Another aspect that became more transparent to me during the conference is how unique and valuable the cooperation between programs in the Nordic countries is. That is one feature the US-programs could learn from. This was noticed by Alan Bishop already in the first conference on doctoral programs. He wrote: "To me this situation cries out for inter-institutional collaboration, making the best of each university's faculty and programmatic resources available beyond its usual enrolment boundaries." (Bishop, 2000, p 59)

Aspects of quality have obviously been of interest also to the community in US (see for example Lester & Lambdin, 2003; Schoenfeld, 2003) and in the Nordic community we have profited from earlier discussions and experiences that were built up by the US-colleagues in the field.

The future of doctoral programmes in mathematics education in the Nordic countries

Do we have a critical mass of researchers in order to keep the activities alive? How do we ensure quality and endurance of programs? What opportunities are there to improve the programs and in what ways?

Is there a need for more persons in the labour market with a doctoral degree in mathematics education? Do we need research on doctoral education in mathematics education? Will society continue to ask for research in mathematics education?

There are many questions to inquire into and try to answer about postgraduate education in the Nordic countries (Grevholm, 2007b). The cultural and social conditions are similar in the five countries and problems are often the same. Also solutions seem to be similar and the public debates have parallels.

The government in Sweden has shown great concern about the research education. It was restructured in 1998 and a first evaluation of the results was published in 2007 (Högskoleverket, 2007). One outcome is that the students that graduate within a period of five years have increase from 16 to 28 % of the population. The number of degrees has increased with 50 % after the reform and stays at that level. In 1990 0.6 % of the working population (between 25 and 64 years of age) had a doctoral degree and that increased to 1.0 % in 2005. An investigation in 2002 took care of specific questions about the doctoral time and the time after graduation (SOU 2004:27). Doctoral education has expanded with 100 % between 1990 and 2000. In Sweden the number of doctoral students is about 13000 (fulltime equivalents). It would be astonishing if there were no problems in such a strongly expanding activity. A large generation of persons born in the 40ties are in the process of retiring and the new academics with a doctoral degree seem to have a prosperous labour market to enter into. As mathematics knowledge is seen as one of the tools a citizen in a modern society will need it seem probable that questions about teaching and learning mathematics to still larger groups of the population will be in focus. Most governments realise that we are moving into an international society, where the human capital resources in the form of education and competence are the means to survive and compete internationally through excellence and growth.

Acknowledgements: Thanks to Kirsti Kislenko, Madis Lepik, Jonina Vala Kristinsdottir and Ann Sofi Röj-Lindberg for assistance with information about the Baltic, Icelandic and Finnish situations for doctoral students.

The work presented here is partly financed from NordForsk (project number 90969 at University of Agder) for which we are grateful.

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/ *Barbro Grevholm*

MADIF 7

Det sjunde svenska matematikdidaktiska forskningsseminariet ägde rum onsdagen den 27 januari i Lärarhögskolans lokaler vid Konradsberg i Stockholm. En bred anslutning av forskningsintresserade personer hade samlats för att lyssna och delta i det varierande utbudet av forskningspresentationer av både mer väletablerade och yngre forskare. Efter konferensens öppnande och inledning med en gemensam middag på Myntkrogen vid Slottsbacken i Gamla stan på tisdagkvällen erbjöds ett rikt vetenskapligt program under nästa dag. Årets tema för konferensen var ”Matematik och matematikutbildning: kulturella och sociala dimensioner”. Det avspeglades bland annat i plenarföreläsningarnas innehåll. Professor Paul Dowling från Londons universitet valde att belysa matematikundervisning ur ett socioekonomiskt perspektiv. Dowling menar att beslutsfattares höga ambitioner av att utforma en inkluderande matematikundervisning snarare har fått motsatt effekt. Socioekonomiska skillnader etiketteras som förmåga och försök att sätta matematiken i ett sammanhang skapar en skolmatematisk kontext som har tendenser att reproducera sig själv. Istället borde en ny sociologi om kunskap införas som går ut på att tillägna sig en uppsättning redskap för att kunna använda matematik i praktiken och i handlingar. Professor Tine Wedege vid Malmö högskola riktade i sin föreläsning fokus mot spänningsfältet mellan sociala och kulturella aspekter av matematikutbildning. Medan *etnomatematik* främst syftar på den informella matematik som individer kan lära sig utanför skolan, kan begreppet *matematiskt litterat* (mathematical literacy) kopplas till de kunskapsmässiga krav som samhället och skolmatematiken ställer. Wedege presenterar därför *sociomatematik*, som kan användas som ett analytiskt begrepp som tar båda dessa aspekter i beaktande. De kulturella och sociala dimensionerna av matematikundervisningen debatterades även i paneldiskussionen där Jo Boaler, Paul Dowling, Stephen Lerman och Christer Bergsten deltog. Samtalet kom bland annat att handla om nationella skillnader mellan det svenska och brittiska skolsystemet men även inomnationella skillnader och likheter.

En viktig del av det vetenskapliga programmet utgjordes av deltagarnas forskningsrapporter och korta presentationer. På seminariet presenterades 20 papers och 19 korta presentationer under parallella sessioner. Varje forskningsrapport var läst av en diskutant som deltog under presentationen, ledde seminariet och bidrog med frågor och kommentarer till författaren. Utbudet av forsknings-

rapporter och korta kommunikationer spände över hela det matematikdidaktiska forskningsfältet. Här kan bara ges några exempel.

Med en tydlig koppling till seminariets tema behandlade forskningsrapporten av Eva Jablonka, Maria Johansson och Mikaela Rhodin hur elever ges tillgång till vilka kriterier som gäller i klassrummet för legitim matematisk kunskap medan rapporten från Eva Norén tog upp problematiken med elevers identitet i multikulturella klassrum. Alexandre José Santos Pais, Diana Stentoft och Paola Valero redogjorde för hur teorier med fokus på individens lärande har getts en dominerande roll i matematikdidaktisk forskning och argumenterade för hur teori som tar hänsyn till sociala och kulturella faktorer måste användas för att kunna beskriva och belysa många viktiga matematikdidaktiska fenomen.

Några forskningsrapporter hade ett tydligt intresse för IKT och teknik som hjälpmedel, stöd och inspiration för lärande av matematik. Per Nilsson och Håkan Sollervalls forskningsrapport om ”Augmented reality” visar hur man med hjälp av datorn kan visualisera olika tredimensionella objekt som elever och studenter sedan kan utföra olika beräkningar på. Två korta presentationer, Patrik Erixon och Gunnar Gjone, handlade om symbolhanterande räknare. Thomas Lingefjärd berättade under sin presentation hur Geocaching, att söka skatter med hjälp av GPS, stimulerar människans naturliga drivkrafter att söka skatter och hur detta sedan kan användas för att gynna lärande av matematik. Kartor kan också användas för att orientera sig inom det matematiska landskapet, något som Håkan Lennerstad behandlade i sin presentation.

Under seminariet presenterades också mer teoretiskt orienterade forskningsrapporter som till exempel den ovan nämnda rapporten av Pais, Stentoft och Valero. Ewa Bergqvist och Magnus Österholm presenterade en teoretisk modell om relationen mellan att läsa och lösa matematiska uppgifter som tillsammans med flera andra forskningsrapporter och korta presentationer, bland annat om lärandet och förståelsen av specifika matematiska begrepp samt om olika aspekter av lärande och undervisning i skolans alla årskurser, kom seminariets vetenskapliga innehåll att spänna över nästan hela det matematikdidaktiska forskningsfältet.

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