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Foll i praksis

### **Theorising mathematics teaching:**

## pre-service teachers' perceptions before and during school placement

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Pre-service teachers frequently experience a tension between their research-informed university college training and their in-school practice. In mathematics teaching, this is a particularly sharp contrast, since personal experience of traditional transmissionist school mathematics and dominant discourses about the importance of 'right answers' and 'natural ability' can resurface and be reinforced by schools which are driven by accountability and measurement within the context of international performance comparisons such as TIMSS and PISA. Consequently pre-service teachers often tend to focus on teaching instrumental skills, abandoning the holistic approach to mathematical literacy promoted by many teacher educators. This paper reports on data collected as part of a project focusing on this tension, drawing primarily on an analysis of first-year students' theories about mathematics teaching on entry to a teacher education programme, and their reflections during their in-school practice.

#### Background

Perhaps more than many other school subjects, mathematics engenders strong opinions and beliefs about the nature of knowledge, how it is learned, and how it should be taught. For many pre-service teachers, a main source of perceptions of/beliefs about mathematics, and about how mathematics is learned and therefore taught is their own personal experience, based in a long history as pupil. Students' personal epistemologies of mathematics – what knowledge in mathematics is and how that knowledge is developed in teaching and learning – have been studied extensively by many researchers, for example de Corte, Op't Eynde & Verschaffel (2002) and Schoenfeld (1989). Common characteristics include an association with memorised facts and rules, and solution speed as an indicator of ability; the idea of a fixed ability to do mathematics which cannot be acquired/improved through effort; and the equation of mathematical truth with teacher approval. Smestad et al (2012) found similar beliefs among the pre-service teachers attending the same university college as those discussed in this paper. Such beliefs play a crucial role in the positioning of self both as learner and teacher (Solomon, 2009), and in modes of teaching which favour 'transmissionist' over 'connectionist' styles (Pampaka et al, 2012). Furthermore, Morselli (2005) notes that beliefs about mathematics have an effect on pre-service teachers' sense of self-efficacy as teachers.

The impact of these beliefs about mathematics together with their own personal histories of school learning is frequently exacerbated by pre-service teachers' experience of school placements. While university teacher education about mathematics frequently attempts to challenge their beliefs, the impact of school placement can often act in the opposite direction, forcing a return to earlier embedded ideas, particularly when assessment, testing and accountability are high on the agenda. Thus, Allen (2009)

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found that beginning teachers privileged what they had learned on placement rather than university theory, while Ng et al (2010) report that school placement strongly influences pre-service teachers' beliefs about what constitutes effective teaching.

Both students and teacher educators experience a number of tensions between school practice and university theory/practice. These are particularly noted by Nolan (2012) in her account of the conflict between support for inquiry based pedagogies at university level, and instrumentalism in practice schools (see also Nolan, 2008, Towers, 2010, and Van Zoest & Bohl, 2002). She points not just to the role of accountability and assessment in schools, but to the force of students' educational habitus which are firmly embedded from a very young age and highly resistant to change: the power of cultural routines associated with teaching are such that 'every adult knows what teaching and learning should look like because he or she has spent thousands of hours as a student in school' (Bullock & Russell, 2010, p. 93, cited in Nolan 2012). Reproduction of these routines is supported by dominant discourses in schools which regulate practices and stifle opportunities for pedagogical change.

These various issues are brought together by Goos (2009) in her discussion of the gap between what pre-service teachers are taught at university and what they actually do when they teach. She focuses on the need to understand how students *interpret* their teacher education programs, how (and why) they *appropriate* certain aspects of those programs, and the nature of the different *influences* on the execution of their teaching plans. So, for example, Arvold (2005), like Nolan, uses the idea of *habitus* as an explanatory device, but in this case to argue that pre-service teachers attend to different aspects of their teacher education programs and make sense of them differently – ie, they experience and interpret their teacher education through the lens of their prior experience – how they were taught mathematics, and how they experienced mathematics. Such research suggests that it makes sense to understand pre-service teachers as interacting with their teacher education programs through the lens of prior experience and the beliefs and values that go with that experience. Similarly, Bednarz and Proulx (2005) suggest that pre-service teachers appropriate different things from their teacher education programmes, resulting in crucially different views of what the program is about, which are in turn reflected in their teaching practice.

In this paper, we take these issues forward as part of a major project examining the interface of theory and practice, with a general focus on the perceptions of competencies, professional identities and the relationship between theory and practice held by the different partners involved in the practicum. We report here on the early stages of the project, which involves collecting baseline data in preparation for an action-research intervention, addressing the following research questions:

- What is the nature of pre-service teachers' theories about mathematics teaching and learning?
- What is the impact of in-school practice on their developing theories?
- How do pre-service teachers and their mentors experience the connection between what pre-service teachers are taught in University College and their practice within the school placement?

We will discuss trends in pre-service teachers' perceptions of mathematics, many of which appear to stem from traditional transmission teaching experiences. We will suggest, with Bednarz and Proulx (2005), that pre-service teachers do not all take the same messages from their university teaching, and that these are filtered through their prior experience. In addition, we will explore how school placement experience also plays a role in students' professional development as they reflect on the tensions between theory and practice. We discuss the implications for the action research component of our project and for teacher education more generally.

#### Method

We first gathered information on students' theories of mathematics teaching and learning by eliciting their views on what constitutes an ideal classroom situation (i.e., we were seeking normative statements). Two hundred and two students, who were training to teach grades 1–7, were asked to complete open-text answers to the question: «What makes a good mathematics class? Write a short list of keywords that deal with both teacher and student roles», at the beginning of the academic year. In order to assess the impact

of school placement on their developing theories, 31 of these students completed questionnaires after 6 days in their school placement (plus 2 weeks in the autumn semester) in 1st–4th grade, and a further 137 students completed the questionnaires after 4 weeks of school placement (plus 2 weeks in the autumn semester). The questionnaires gathered information on the influences of school and University College training on their teaching practice, and on their perceptions of mathematics and mathematics teaching and learning. In order to provide a point of comparison with the pre-service teachers' responses, 46 teacher mentors working with this group of students in their school placements were asked to complete questionnaires focusing on the students' performance as teachers, and their own experiences as mentors of this particular group. The questionnaires included 5-point Likert scale responses to a number of statements about mathematics teaching and learning. In addition, three free-text questions aimed to gather information on pre-service teachers' and mentors' experiences of the connection between University College teaching and school practice, as follows:

Questionnaire for pre-service teachers:

- 1. Describe a situation from your practice where you benefitted from something you learned in your mathematics course at HiOA.
- 2. Describe a situation from your practice where you benefitted from something you learned from your teacher mentor.
- 3. Are there any challenges that prevent you from using in practice what you learned in the mathematics course at HiOA?

Questionnaire for teacher mentors:

- 1. Describe a situation from practice where your pre-service teachers benefitted from something they learned in their mathematics course at HiOA
- 2. Describe a situation from practice where your pre-service teachers benefitted from something about mathematics teaching that they learned from you.
- 3. Are there any challenges that prevent the pre-service teachers from using in practice what they learned in the mathematics course at HiOA?

The Likert-scale data were coded on a 5-point scale, from 1 strongly disagree to 5 strongly agree. Comparisons between pre-service teacher and practice teacher responses were analysed using Mann-Whitney U tests. The free text data were analysed thematically, in order to identify discourses of mathematics learning and teaching which the pre-service teachers and teacher mentors drew on, and their role in the university and school communities of practice. In what follows, we first present an analysis of the pre-service teachers' 'baseline' perceptions of mathematics and mathematics teaching and learning at the beginning of their first year, followed by an analysis of the data gathered from this group and their teacher mentors six months later regarding the school placement itself. We blend the quantitative and qualitative data in our account.

A first sweep analysis of the free text responses to the question «What makes a good mathematics class?» identified a range of themes which were then used to systematically code the data and so enable us to quantify the response types. We concentrate here on those relating to teaching methods, on the classroom environment and teacher pupil relationships, and on pupil roles and experiences.

In terms of teaching and teaching methods, a large number of the students wrote about the need for variety in mathematics classes, but detailed inspection indicates that this encompasses some very different statements ranging from explicit reference to using a range of connectionist teaching methods such as:

Varied methods, for example group activities, puzzles with a class discussion at the end, real life related tasks.

to reference to rather more transmissionist teaching of rules or algorithms:

Explain how you arrive at the answer, then ask if they can figure it out and say the answer aloud. Then the teacher will know that all pupils have got it and can move on to something else..

A transmissionist bias is further suggested by the fact that just over one half of the students (107 out of 202) mentioned «doing exercises» in their descriptions of a good mathematics class, for example «Whiteboard teaching -> followed by exercises aimed at teaching that has just been completed, repeat». Only 54 mentioned understanding, often still in terms of knowledge acquisition rather than participative learning e.g «Give those who understand it a slightly more advanced exercise» *vs.* «The challenge is to speak a language that pupils understand, to reach each one».

A related theme underlined the role of emotions such as anxiety and the relationship between teacher and pupils. There were frequent references to questions, for example «Students should not be afraid to ask questions. It is important that they feel safe», and to the need for teachers to be enthusiastic, patient and "cheerful". In some cases, the surrounding text suggested that the writers may have experienced the opposite:

A lesson in which pupils do not suddenly have to find the solution in front of a whole class, where one is not forced to have to find the solution of a piece of math in front of 30 pupils.

Bearing in mind previous research on the effect of pre-service teachers' own school experiences, and the effect of transmissionist teaching, we pursued this issue by exploring the degree to which students identified with pupils. Taking the use of personal pronouns as a marker, we observed that some 7% of students identified with the pupils in their answers, as here:

For me, it is important that there is openness to so called dumb questions. It also helps that the teacher repeats the problem solution, [you are] not always able to understand the procedure. Also important to understand how math can be used and utilized in practice. It's easy to feel "stupid" when you do not get things. Perhaps important that the teacher emphasizes that we are all intelligent / have skills in different areas and that it is equally valued. That if you are struggling in math, you are often stronger in other subjects and that it is okay.

Focusing further on pupils' roles in the classroom, we found that although they were asked specifically to include the role of pupils in a good mathematics class, only 32% (65/202) of the students did so, often allocating pupils a passive role as in, for instance:

Raise their hands and not be afraid to ask questions if needed. Be quiet and pay attention.

Pupils do exercises about what the teacher has gone through on the board.

While some responses focused on more active roles for pupils, most involved asking questions of the teacher, with very few suggesting that pupils might fruitfully collaborate without the teacher: "Collaborative tasks, solve problems together and learn from each other".

Clearly, at this stage, the vast majority of pre-service teachers had only their own school experience to fall back on in answering the question. While they often talked about the need for variety and making mathematics «fun», they were vague as to how this could be done, focusing only on avoiding boredom: «Have fun with the tasks (so that pupils do not think lessons are too long and boring)». Although we recognized that lack of recent experience might mean that very few pre-service teachers would write about specific techniques in mathematics teaching, we noted that 7% mentioned the use of physical models and diagrams to support learning. We were interested to note whether this and other techniques might be more prominent six months later, when the pre-service teachers were in their spring school placement, and we report on this below.

Following on the suggestion made by Goos and others that pre-service teachers do not necessarily take the messages from their university training that are intended by teacher educators, we were particularly interested to understand whether pre-service teachers attributed what they learned and did during their placement to their university experience or to their workplace learning with their teacher mentor. Thus we analysed answers to the two free text questions «Describe a situation from your practice where

you benefitted from something you learned in your mathematics course at HiOA» and «Describe a situation from your practice where you benefitted from something you learned from your teacher mentor» together. We were similarly interested to explore the university-school partnership link by considering pre-service teachers' answers to these questions alongside responses given by the teacher mentors to the equivalent questions «Describe a situation from practice where your pre-service teachers benefitted from something they learned in their mathematics course at HiOA» and «Describe a situation from practice where your pre-service teachers benefitted from something about mathematics teaching that they learned from you». Analysis of these free text responses, together with comparisons from the Likert-scale responses to the questionnaire responses, identified particular issues which are illuminating in terms of providing an insight into how pre-service teachers may be connecting learning between university and the school.

The first of these involved mismatches in the commentary on the use of manipulatives (physical models) in teaching. As we note above, these were mentioned by only a small number of pre-service teachers in their baseline accounts of mathematics teaching. Six months later, 49% of them recorded this as a technique learned from their university course, while 15% said they had learned it from their teacher mentor. However, teacher mentors took a different view: only 15% reported use of manipulatives as something their pre-service teachers had learned at university, versus 39% who reported that this was something they had taught the pre-service teachers themselves.

The second issue concerned pupil reasoning. As a major focus of the university course, we had expected that pre-service teachers would be likely to cite this fact in their responses to the first free-text question. However, this issue was raised by only 13% of pre-service teachers (and 7% of teacher ment-ors) alongside a further 4% of pre-service teachers (and 22% of teacher mentors) who said this was something they had learned from the teacher mentor. Thus the following response was unusual:

When teaching first grade, I often felt I needed what I had learned at HiOA, and because of what we worked with in the fall, I was a little more aware of how children think when they encounter math (for the first time).

This pattern may be related to a series of findings from the Likert-scale data on students' perceptions of mathematics teaching, which indicated a conservatism about teaching and learning and pupils' roles which was not reflective of the programme. For example, 50% of pre-service teachers agreed that «Mathematics is a subject for rote learning», and in response to completions of the opening statement «When pupils are to learn mathematics, it is important that:», teacher mentors agreed significantly more strongly with the completion statements «— they use their own algorithms», «— they take what they know as a starting point», «— they have to explain what they think» and «— they can use fantasy and creativity in their work». Teacher mentors were less likely to agree that «To become good at mathematics, you need to do lots of exercises» and that «The solution of a mathematics exercise is either right or wrong». The strength of these results is illustrated in Table 1.

These results indicate not only a mismatch between school and university experience, but also between university input and pre-service teachers' attitudes. The third free-text question asked pre-service teachers directly about the practice-theory divide – «Are there any challenges that prevent you from using in practice what you learned in the mathematics course at HiOA?"»– with a parallel question to teacher mentors «Are there any challenges that prevent the pre-service teachers from using in practice what they learned in the mathematics course at HiOA?"»– with a parallel question, while twenty-four per cent of students responded that it was difficult to translate theory into practice, and 12% that it was difficult to find the right language. Responses regarding the difficulty of translating theory into practice were quite wide-ranging, and several themes emerged. One such theme was a perceived absence of University College teaching on a particular topic at school:

When one is in a teaching situation is not always easy to come up with something you have learned in HiOA

It can be difficult to draw connections and parallels between theory and practice. Especially considering that the topics we have used in school practice have not been particularly emphasized at HiOA. Table 1: Percentages of students and teachers who agree or strongly agree with statements. Results for agree, strongly agree are amalgamated. Comparison using Mann-Whitney U test. (\*\*: significant at 0.01 level. \*: significant at 0.05 level)

Statment	% of students agree	% of teachers agree	U	р
When pupils are to learn				
mathematics, it is important that:				
— they use their own algorithms	41.1	75.6	2152.5	.000**
— they take what they know as a				
starting point	88.6	97.8	2998.0	.011*
— they have to explain what they				
think	95.2	100.0	2744.0	.000**
— they can use fantasy and				
creativity in their work	84.2	95.5	2814.5	.012*
To become good at mathematics,				
you need to do lots of exercises	83.9	66.7	2789.0	.004**
The solution of a mathematics				
exercise is either right or wrong.	39.5	30.0	2628.0	.030*

Not many situations have come up that can be linked to the topics we have had. And if they have, I have not thought about those in the way that relates them to what I have learned at HiOA.

While this kind of reason illustrated a lack of grasp of HiOA's aim to teach pedagogic principles as opposed to 'recipe-following' teaching tips, other reasons were more reflective on method:

Yes, I think it was a bit difficult. Math teaching at HiOA focuses on our awareness of how we think when we do various calculations. I find that difficult, and have not come so far in the process yet that I feel I can take advantage of this when teaching.

Finding ideas for a lesson plan and collecting everything you've learned to channel it into simple language to the children so they understand

or on the tension between school and university:

 $(\dots)$  not so easy when you have to follow the plan set up for what the pupils should learn

or the difficulties of being a novice:

It's easy to forget to use one's knowledge in some situations. But in retrospect, one thinks of what was done and finds that there was a much better option.

Much of what I'm learning here is perceived as too intangible to use in real life [i.e. practice]. However, it may very well be that it settles into the subconscious and will show up when it's convenient.

Thirty-four per cent of students said that mathematics at HiOA was too difficult or irrelevant for their teaching. Some thought that the mathematical content was too difficult for them, others that it was too difficult/ irrelevant for the grade they were teaching. The range of responses here included some reflections on difference in pitch between university and school, such as:

I do not think it's clear when it comes to diagnostic teaching and how to find out what students are struggling with. I think the teaching of mathematics should have been clearly linked to the challenges we may face in practice.

but many were more clearly illustrative of the same problems of applying principles as noted above:

It is not easy to link the knowledge I have learned with [my practice] in the school placement because I feel that much of the curriculum isn't linked to the teaching of first grade, but to further grades.

which when contrasted with an almost opposite statement underlines that students appear not to be making the connections which the university intended:

Definitely! Maybe not for those who have had practice in the 1st grade, but I felt it was difficult at 4th grade. I think we've learned most about the number sense of children who start school.

The teacher mentors recorded fewer barriers, but also cited difficulty in translating theory into practice (20%), difficulty/irrelevance of mathematics at HiOA (13%) and insufficient mathematics at HiOA (9%). In free text responses, 13% said that they did not know what the pre-service teachers learned at HiOA, while 91% agreed or strongly agreed with the statement «I wish I had more information on what the students have learned in mathematics at HiOA». Their responses to the statement «Students refer to different theories they have learned about during their studies when we have guidance conversations» (23.9% agree) also indicated difficulties in translating theory into practice. For their part, students perhaps sum up the situation in that they agreed more strongly that «Experiences from practice have been important in the rest of the programme» (91.6% agree) than «Practice continued what I have learned in mathematics in the other parts of the programme» (34.4% agree).

#### Discussion

In response to our first research question, we can see patterns in pre-service teachers' theories of mathematics teaching and learning which indicate that traditionalist perceptions of mathematics and a largely transmissionist school experience have a complex role in their responses to their University College programme, their school placements, and their developing pedagogic models. One of the important conclusions in Arvold's (2005) research is that when we judge a teacher education programme and also the teachers it produces, it is a mistake to assume that teachers should emerge in accordance with some sort of 'best way' of teaching that is promoted by the programme. A corollary of this argument is that we need to recognise that pre-service teachers will inevitably draw selectively from university programmes, through the lens of their own experience and beliefs. It might be more appropriate, then, to acknowledge that new teachers need to develop their own approach to teaching. The aim of teacher education programmes then becomes one of enabling teachers to reflect critically on their own developing practice and its interface with the programme content.

In addressing our second and third research questions, we have found that many of our pre-service teachers were reflective on the difficulties of translating theory into practice, but, at least from the point of view of the teaching team, had badly missed the point of much of the University College's input. Their experience of the school placement is one of learning concrete practice from their mentors which they see as more informing than their university programme. While we need to bear in mind that in the early days of practice pre-service teachers are most concerned with the here and now in the classroom and simply 'getting through', we feel that this study has illustrated some ways forward in enabling them to make the most of their school placement and for the University College-school partnership to be strengthened. It is worth noting that teacher mentors felt that it was instructive to have pre-service teachers in their schools, and that they wanted to know more about HiOA input and to involve the University College in placement preparation. These findings suggest potential intervention strategies including better communication with mentors and understanding of what schools are doing generally and during placement; more discussion of the expectations of student teachers as becoming professionals and, perhaps most importantly, a closer understanding of what pre-service teachers draw from university teaching. There are multiple ways in which these aims can be realised; in the current project one strategy is to focus on the integration of university college-school communication into the first-year curriculum by means of student reflections on the programme input which become part of a newsfeed for schools. These same reflections will form a focus of class discussion and debate in which pre-service teachers are increasingly encouraged to voice their opinions on the relationship between theory and practice, through the lens of critical reflection on what they perceive to be the lecturers' and teacher mentors' views.

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# Foll i Praksis 2012

konferanse om praksisretta
FoU i lærerutdanning

Den tiande FoU i praksis-konferansen fann stad i Trondheim 23. og 24. april 2012 og vart arrangert av Dronning Mauds Minne Høgskole for førskulelærarutdanning.

Sidan den fyrste FoU i praksis i 2002 har konferansen blitt ein viktig møtestad for dei som arbeider i lærar-utdanning og dei som forskar på lærarutdanning og praksisfeltet.

l år er artiklane for fyrste gang publisert digitalt på nettet.

I tillegg utgis ei papirutgåve med samandrag av dei publiserte artiklane.











Kunnskapen du trenger