



Pre-service teachers' views about their mathematics teacher education modules

Author:Faaiz Gierdien¹**Affiliation:**¹Research Unit for Mathematics Education, University of Stellenbosch, South Africa**Correspondence to:**

Faaiz Gierdien

Email:

faaiz@sun.ac.za

Postal address:

Private Bag X1, Matieland 7602, South Africa

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This article reports on the views of intermediate and senior phase pre-service teachers (PSTs) enrolled in mathematics education modules that attempt to teach both content and pedagogy. The PSTs are students in a four-year Bachelor of Education (BEd) model located in a faculty of education. Findings were analysed by means of an analytic framework that takes into account the university–school divide. Findings indicate that the PSTs position themselves in different ways with regard to their preparation for school mathematics teaching. Implications are considered, especially the PSTs' affective views such as their anxiety and apprehension related to the discursive differences between the content in the university modules and school mathematics.

Introduction

In the faculties of education of South African universities there are mathematics teacher educators who teach pre-service mathematics education modules which attempt to include both content and pedagogy. For the purposes of this article these content–pedagogy mathematics education modules will be referred to as mathematics teacher education modules. For instance, we find pre-service teachers (PSTs) enrolled in a Bachelor of Education (BEd) degree who take mathematics teacher education modules aimed at teaching school mathematics at the intermediate and senior phases (i.e. Grades 4–9). This is the result of rapid institutional shifts in the provision of teacher education in South Africa such as mergers or the integration of teacher training colleges into universities because of a particular policy implementation. The PSTs enrolled in these modules hold different views on the value of the modules. For the purposes of this article PSTs' views are defined as their comments about different social practices they encounter in the modules. These practices are discussed in more detail below.

Further details on the context – such as the BEd degree programme of the PSTs concerned, the mathematics teacher education modules they take, and the activities, actions and tasks in the modules – are in order. The PSTs referred to in the article are students in some of the mathematics education modules that I teach in one of the four year BEd programmes of a faculty of education at a university. When they obtain their degrees, the PSTs will be certified to teach mathematics in the phases where mathematics is a compulsory subject, for example, Grades 4–9. I have been teaching these modules consecutively to a cohort of PSTs during their second, third and fourth (final) years of the BEd programme. A module in the sequence runs for one academic year. The content is presented and taught in ways that are informed by different strands of literature on what is called (social) practices found in mathematics teacher education and pre-service or initial teacher education. For example, what are important in the modules are insights that PSTs derive from connecting (school mathematics) content to pedagogy. In the second year there is a focus on various nuanced interpretations of fractions such as ratio, part-whole, operator, rate, decimal, percentage and measurement. Such interpretations span and conceptually connect the components of the school mathematics content. The PSTs are required to read and write reviews of practitioner-intended mathematics education literature on these different interpretations of fractions. In addition, they have to examine in what way these interpretations are important when they investigate methods for teaching concepts where there is a need to take into account children's existing knowledge. In the third year the content focuses on ways to foster algebraic reasoning, starting from arithmetic as prior knowledge. In both modules there are attempts to show conceptual connections within and between mathematical ideas that are not made explicit in school mathematics, according to the mathematics education literature. In the fourth year students continue to explore school mathematics from perspectives informed by the use of different information and communications technologies (e.g. Excel).

The problem statement and research question for this article are as follows. There are differences and similarities between teaching content–pedagogy mathematics education modules in pre-service teacher education (aimed at the intermediate and senior phases) in a university, and



teaching school mathematics in those phases. The fact that universities and schools are two different kinds of institutions means that there are different, though at times overlapping, ways of knowing and doing in the two contexts. The overarching differences and similarities can be stated in terms of the university–school divide. Taking this situation into account, I pose the following research question: What are PSTs' views about the mathematics teacher education modules that I teach?

The research question is important because it has the potential to illuminate ways of communicating the role of mathematics teacher education modules with respect to school mathematics teaching. Knowing the PSTs' views about the mathematics teacher education modules is useful in terms of my own practice as a reflective practitioner (Schön, 1983). The PSTs' views can also serve as an evaluation of the mathematics teacher education modules per se. In other words, their views should not be interpreted narrowly as being aimed at me on a personal level. The PSTs' views can contribute to perspectives on the practices of other mathematics teacher educators at faculties of education where they try to teach both content and pedagogy to PSTs. There are science teacher educators (e.g. Berry, 2004; Loughran, 2007) who engage in 'self-study,' that is they use their teaching as a site to reflect on their practice.

The remainder of the article is organised as follows: Firstly there is a literature review starting with mathematics teacher education (modules) in the pre-service preparation of primary school PSTs. Primary school PSTs were chosen because of the particular population of PSTs (intermediate and senior phases) used in the study. Secondly there is an elaboration of social practice theory (SPT) with special reference to practices specific to teaching mathematics teacher education modules in pre-service teacher education. A review of empirical literature on the views of primary (elementary) school PSTs in terms of practices follows. The different strands of literature will then be integrated to build a framework that can be used to analyse the empirical data, that is PSTs' views about the mathematics teacher education modules that I teach. A description of, and justification for, the methodology of the study will be provided. The findings reflecting the views of particular PSTs' will be presented. The article ends with a discussion and conclusion based on the findings.

Literature review

On (primary) mathematics teacher education modules

The 'central tasks' (Feiman-Nemser, 2001) in pre-service teacher education are activities that aim at preparing PSTs for school mathematics teaching. These tasks engage the PSTs in analysing and forming new visions, building an initial repertoire, developing subject matter knowledge for teaching, and developing an understanding of learners and learning. The tasks should not be viewed in isolation, meaning that the one relates to the other in terms of pre-service preparation. For example, if the PSTs are to form

new visions of school mathematics teaching it is necessary to have them read and review mathematics education articles aimed at a practitioner audience. My conjecture is that such actions should enable them to see school mathematics from perspectives that are informed by mathematics education literature. One example is the nuanced interpretations of fractions such as ratio, part-whole, operator, rate, decimal, percentage and measurement mentioned above. At the same time the goal is to have the PSTs build their initial repertoire in preparation for school mathematics teaching, and lastly, reading these articles should assist the PSTs in developing subject matter knowledge for teaching. The latter is a point that will be developed below as an instance of what is called 'mathematical knowledge for teaching' (MKT). Collectively, the central tasks in university modules should be aimed at assisting PSTs to develop insights into teaching mathematics in a school. Evident from the latter is the university–school divide.

The case for content–pedagogy mathematics education modules is taken from Askew (2008) who argues against the traditional distinction between content and pedagogy in primary school mathematics PST courses. His view coincides with Ball, Thames and Phelps (2008) and Hill, Ball and Schilling (2008) who argue that the knowledge required for teaching mathematics, *mathematical knowledge for teaching* (MKT), is multifaceted and consists of the following domains:

1. common content knowledge held by all mathematically sophisticated occupations such as accountants and engineers
2. content knowledge specific to the specialised practice of mathematics teaching
3. knowledge of student learning of the mathematical content
4. knowledge of the practices of teaching mathematics
5. knowledge of mathematics-related curricula.

Each of these domains has some effect on a practicing teacher's ability to select, organise and sequence tasks at an appropriate developmental level at the appropriate time in the mathematical sequence and student learning. These domains overlap in ways whereby the one supports and informs the other. PSTs have to encounter these domains in the university, because they potentially afford them with opportunities to see and experience mathematics in ways in which they can enable access to it (Morrow, 2007, p. 82) in the school.

Doing the central tasks implies having the PSTs do different activities, actions, and assignments in some organised and regular ways. We therefore look for a more comprehensive way to talk about activities, actions and tasks related to the social context of the mathematics teacher education modules. Various, related strands of literature on practices turn out to be useful.

On social practices in the mathematics teacher education modules

In the present study the PSTs encounter social practices which can be explained in terms of social practice theory



(SPT). According to Brodie (2012, p. 3) SPT begins with the notion of practices 'which are constituted in communities' and not as 'conceptual structures that are constructed in the mind'. In other words, from the perspective of SPT, practices have nothing to do with what are in people's minds, but much with what people do in communities in order to achieve specific goals. For example, drawing on Scribner and Cole (1981), Brodie and Shalem (2011, p. 421) offer what can be called a broad definition of 'practices as patterned, coordinated regularities of action directed towards particular goals'. Brodie and Shalem (2011, p. 421) also note that 'practice is always social practice' (Wenger 1998, p. 47). Stated differently, social practices involve people or communities who interact in coordinated and regular ways to get to specific goals.

Brodie and Shalem (2011) provide a definition of social practices that is applicable to the modules where there are attempts to teach both content and pedagogy. For example, they argue that 'both mathematics and mathematics teaching constitute practices' (p. 422) which I interpret as meaning social practices. These two social practices 'intersect through the use of the knowledge and technologies of mathematics, which include symbolising, generalising, solving problems, justifying, explaining, and communicating mathematical ideas and concepts' (Rand Mathematics Study Panel, 2003, p. 422). We find more applications of this definition in the way the Rand Mathematics Study Panel (2003, p. 32) defines mathematical practices in terms of activities such as mathematical representation, attentive use of mathematical language and definitions, articulated and reasoned claims, rationally negotiated disagreement, generalising ideas, and recognising patterns. Mathematical representation, for example, can include a focus on decompressing mathematical symbols with the aim of focusing on their meanings within school mathematics. Also, generalising ideas and recognising patterns would involve pointing out elementarised versions of (algebraic) symbols such as their connections to arithmetic. This panel notes that these practices are not explicitly addressed in schools and strongly recommend that they should be done as preparation for teaching school mathematics. These social practices should be interpreted as 'process' dimensions of mathematics and are therefore key features in terms of learning and doing mathematics.

To gain a clearer picture of the different actions, tasks and activities that constitute the two social practices (mathematics and mathematics teaching) in the modules, we compare them to Julie's (2002) 'school-teaching mathematics' and Watson's (2008) 'school mathematics'. Julie and Watson make the point respectively that school mathematics is a 'variety' and 'a special kind of' mathematics that is subject to the institutional constraints of the school. It has different warrants, authorities, forms of reasoning, core activities and purposes. In turn, these determine many of the 'content' features such as a strong focus on single answers (Julie, 2002), a high degree of fragmentation rather than structural insights and abstraction (Watson, 2008). The presence of these two social practices in the modules implies that there

are discursive differences between mathematics content in a school and the 'content' features in the modules in the university where there are attempts to teach both content and pedagogy.

On pre-service teachers' views in the present study

As mentioned earlier, PSTs' views are defined as their comments about the different social practices they encounter in the modules. It must also be noted that all views carry affect, some more than others. Pre-service teachers' views can be informed by affective issues such as their own schooling with respect to mathematics and mathematics teaching, differences between the mathematics in the modules and school mathematics in the intermediate and senior phases and teachers' lack of content knowledge.

Grootenboer (2005) and Peker (2009) found that PSTs have views on mathematics and mathematics teaching. Examples of their views are negative dispositions, fear, anxiety and apprehension. For instance, Alridge and Bobis (2001), and Szydulik, Szydulik and Benson (2003) found (primary school) PSTs not to be positively disposed towards mathematics. Brady and Bowd (2005, p. 43) report on mathematics anxiety, which may contribute to PSTs' concerns, especially the 'apprehension' they experience when faced with the prospect of teaching the subject during their initial teaching practice. Cassel and Vincent (2011) describe how (primary school) PSTs feel overwhelmed and scared about mathematics teaching. Another source of uncertainty or anxiety can arise when the PSTs experience differences between the mathematics in the university modules and the mathematics in the intermediate and senior school phases. In other words, they may not feel confident about teaching school mathematics. Science teacher educator Berry (2004, 2007) writes about similar challenges that her PSTs experience where they feel uncertainty as opposed to confidence about teaching school science in the middle grades. Stated differently, PSTs' lack of confidence or uncertainty can give rise to anxiety and apprehension, which may influence the PSTs' views.

There is also the possibility that the PSTs' views could have been influenced by perspectives such as talk about teachers' lack of (mathematics) content knowledge. The notion of the lack of content in South African teacher education programmes is thus a view that PSTs may have encountered before. Pre-service teachers' views about lack of (mathematics) content is an issue that Morrow (2007) raises. He criticises some South African teacher education programmes because they construe teaching and learning as generic activities, with scant reference to the content of what is being taught or learned (p. 82).

Towards an analytic framework

Constant comparison (Corbin & Strauss, 2008) will be used to develop an analytic framework to analyse PSTs' views. Constant comparison is suitable for the following two reasons. Firstly, it became evident from data excerpts that the PSTs were making comparisons between and commenting



on their experiences of social practices in the modules with what is or could be happening in actual school mathematics teaching.

Secondly, in terms of an analytic framework I have to keep a 'distance', that is, I have to take into account and compare instances where PSTs' views are in disagreement as well as in agreement with social practices in the modules. A reason for this has to do with my dual role as the teacher of the modules and the researcher. In addition, the analytic framework has to take into account that the social practices in the modules are framed in ways that aim at teaching both (mathematics) content and pedagogy applicable in the intermediate and senior phases (Askew, 2008). A particular consequence of adopting this viewpoint is the differences in the content features of the modules in the university in relation to descriptions of school mathematics teaching given by Julie (2002) and Watson (2008). The social practices should thus be seen in the light of attempts to bridge the university-school divide.

The various strands of literature will now be integrated through relational statements with the aim of providing details on the analytic framework. Firstly, a faculty of education in a university and a school are quite different but related institutions, because the former is the site for preparation for school mathematics teaching by means of the modules. Social practices in the modules are informed by overlapping strands of literature that come from pre-service preparation, SPT, mathematics and science teacher education and PSTs' views. Figure 1 is a diagrammatic representation that captures the various notions and ideas related to the research question.

The analytic framework represented in Figure 1 is skeletal. Because of constraints regarding space it does not include all the strands of the reviewed literature, but does show the overarching university-school divide *vis-à-vis* preparation for school mathematics teaching. We cannot lose sight of this divide because of the nature of the bridging, that is the details of the social practices that are present in the PSTs' views. The left column denotes the university and specifically a faculty of education where the modules are taught. This column contains skeletal references to MKT and mathematical practices that PSTs encounter in the modules. As stated earlier, the content of the modules is discursively different from school-teaching mathematics (Julie, 2002).

University	School
<p>The two social practices of mathematics and mathematics teaching in pre-service mathematics teacher education modules in a faculty of education:</p> <ul style="list-style-type: none"> Mathematics teacher education modules: coordinated tasks and actions aimed at developing <i>mathematical knowledge for teaching</i> (MKT). The two social practices impact on the content of the mathematics teacher education modules, making it discursively different from school mathematics. 	<p>School mathematics teaching.</p> <p>Mathematics as a school subject:</p> <ul style="list-style-type: none"> school-teaching mathematics school mathematics. <p>School places institutional and organisational constraints on mathematics.</p>

FIGURE 1: A diagrammatic representation of the analytic framework.

The right column denotes the school and specifically a mathematics classroom, with selected references to the literature on school mathematics teaching and its impact on mathematics content.

On methods

In the present study a distinction has to be made between the method of data collection and the method of analysis. A description and explanation for each of these will be given, because they relate to the way in which the research question is answered.

Method of data collection

During one of my classes with each of the second, third and fourth year modules I gave the PSTs a questionnaire to complete anonymously and on a voluntary basis. I wanted to know the PSTs' views about the mathematics teacher education modules I was teaching. In particular, the PSTs were asked questions on how they were experiencing the module at that time. What excited them, what inspired them, what frightened them, what did they find particularly difficult, and what challenges had they been able to overcome? They were told that their responses would not affect their marks for the modules. They self-administered the questionnaire, that is completed it in their own time. I left the room whilst they completed the questionnaire. The class representatives brought the completed questionnaires to my office the following day. According to the class representatives 28 PSTs agreed to answer the questionnaire on their views. Not all of them completed the whole questionnaire, however.

Validity

Ethical clearance and permission to conduct the study were obtained from the university's research ethics committee. The PSTs were informed of the purpose of the study, namely, that I wanted feedback in order to understand their views about the modules better. That, in its turn, would enable me to improve the modules and thus the PSTs' experiences of the modules. Participation in the study was voluntary. The procedure of volunteering was a way to ensure that the PSTs participated of their own free will. The PSTs completed a self-administered questionnaire on their views about preparation they were receiving for teaching school mathematics. It should be noted that the PSTs' written responses on their views amount to self-reports. There was no interference on my part as teacher of the modules. Comprehensive instructions and details about confidentiality and the purpose of the questionnaire were provided to all the PSTs in the study. Because of the possibly sensitive nature of the study, PSTs reported anonymously on their views, attitudes and feelings about the modules. As the teacher-researcher I was available to answer questions and address any concerns. I maintained the confidentiality of the PSTs and kept their completed written responses in a secure place. Those PSTs who wanted feedback provided their contact information and received feedback on the results of the study. All names of PSTs in the excerpts are pseudonyms.



Reliability

The claim is that the findings – the PSTs' views – are reliable, even though they are in the form of self-reports. If a different group of PSTs taking the same modules were to be asked their views about their preparation to teach school mathematics, it would be highly likely that there would be consistency in the variety of views ranging from anxiety and apprehension to confidence, with the exception of Liezel whose views are isomorphic with the epistemology of practice, although not the actual practice, and the discourse associated with the pre-service mathematics teacher education modules. One plausible explanation for the confident views is that the PSTs may have figured out what party line to take in terms of my expectations as the teacher of the modules. Another plausible explanation for views showing disagreement, anxiety or apprehension is the discursive differences between the variety of mathematics in the modules and the modal, highly fragmented content of school mathematics (in the intermediate and senior phases) as described in the reviewed literature.

Method of data analysis

A few important remarks have to be made about the method of data analysis. Firstly, the data analysis has to be seen in relation to bridging the university–school divide. Secondly, as a mathematics teacher educator and teacher of the modules I face 'personal trouble' around 'public issues' (Mills, 1959). In South Africa a current public issue is practicing teachers' lack of mathematics content knowledge. A deliberate and personal decision I make in my teaching is to conceptualise the content in the modules in ways which are discursively different from typical school mathematics content (in the intermediate and senior phases) such as a focus on single answers (Julie, 2002) and a high degree of fragmentation (Watson, 2008). My conviction is that (primary school) PSTs need opportunities where they can begin to see content that is informed by a multifaceted MKT, that is specific to school mathematics teaching. The fact that there may be disagreement with such a conceptualisation of content is a manifestation of personal trouble that I face as a mathematics teacher educator. Thirdly, in a methodological and theoretical sense all attempts to teach content and pedagogy in the modules are driven by literature on MKT and the views of Askew (2008). Therefore, teaching the modules provides me as a mathematics teacher educator with a space to study teaching (and learning) (Ball, 2000) and discover ways in which the university–school divide can be bridged. Self-study researchers or science teacher educators such as Berry (2004, 2007), Loughran and Berry (2005) and Loughran (2007) also study this divide. Conceptually and methodologically there is thus a need for 'distance' in terms of data analysis. In other words, the choice of data excerpts (PSTs' views) has to show disagreement as well as agreement.

The research question requires that the unit of analysis should be PSTs' views. In the modules the PSTs encounter social practices and in the questionnaires they express a variety of views with regards to the modules. As noted earlier, the PSTs' views are defined as their comments on the social

practices they encounter. In a general sense their views can reflect affect such as disagreement, anxiety, apprehension, uncertainty, confidence or agreement with respect to the modules. In a specific sense their comments can reveal their views on the social practice of mathematics and the social practice of mathematics teaching. The views of eight PSTs will be presented for analysis; they range from anxiety to confidence with respect to the social practice of mathematics (content) and the social practice of mathematics teaching. The rationale for choosing these eight PSTs has to do with space as well as the need to bring into view complexities surrounding a conceptualisation of bridging the university–school divide. The two social practices are specific to the university context but are aimed at the school context.

Pre-service teachers' views were coded as disagreement, anxiety, apprehension, uncertainty, confidence or agreement with respect to the social practice of mathematics and the social practice of mathematics teaching.

Findings

Disagreement, anxiety and apprehension

Anne's views indicate that she feels anxious and apprehensive and is in fact critical about the modules:

This course, with reference specifically to mathematics, has been an 'ok' module of the course. To be truly honest, I do not want to teach maths in schools as I do not feel properly trained/educated. These modules have not brought desire into my heart to teach maths. Merely trying to understand what is actually being asked is a challenge, and I am a very strong maths student. I would like this course/modules to be revised. I would like to suggest that our course, and specifically key major subjects, be content based. Too many teachers are lacking content. Now in our 3rd year, we know how to teach and now we need proper content – content that is addressed in schools. (Anne, 4th year student)

She starts by stating that mathematics' has been 'ok', but quickly expresses her anxiety and apprehension through phrases such as 'to be truly honest' and 'have not brought desire into my heart to teach maths'. She provides specifics by making a comparison between the content of the modules and school mathematics. According to her, the content in the teacher education modules is not the 'proper content – content that is addressed in schools'. Also, she experienced difficulty in following the pedagogy, specifically the questions that were posed in the modules. For instance, she states 'merely trying to understand what is actually being asked is a challenge, and I am a very strong maths student'. Being a 'very strong maths student' can refer to her school mathematics or other mathematics experiences outside of the BEd programme. There is no further evidence to pin down any specific references when she writes about being a 'very strong maths student'. What can be said is that she encountered a variety of mathematics in the modules that was quite different from her views of what the content of school mathematics should be like. It seems to be that Anne expected a one-to-one correspondence between the content in mathematics teacher education modules and her view of school mathematics content.



Anne views teaching as a generic activity separated from the mathematics content. For example, she writes ‘now in our 3rd year we know how to teach and now we need proper content – content that is addressed in schools’. She feels that she knows how to teach by the third year and wants the rest of the BEd programme years to be devoted to the ‘proper content that is addressed in schools’. Her view indicates a fundamental disagreement with attempts in the modules to teach both content and pedagogy. Her suggestion is that during the fourth year of the BEd programme there should be a teaching of the ‘proper content that is addressed in schools’. Teaching the ‘proper content’ of the maths taught in the intermediate and senior phases in the fourth year of the programme is impossible from many perspectives. For example, university conditions are quite different from those found in schools in terms of contact time, holidays and daily routines such as timetables. It is therefore not possible to teach the ‘proper content’ of the mathematics that PSTs like Anne will have to teach learners in the intermediate and senior school phases during the fourth or final year of the BEd programme, because a university and a school are simply different environments. Secondly, at a conceptual level the modules have goals such as privileging patterned, coordinated regularities of actions related to social practices of mathematics and mathematics teaching.

Anxiety and uncertainty

Candice’s views are similar to Anne’s in that we also notice evidence of anxiety and a quest for certainty in terms of school mathematics teaching. She writes about the need for ‘practical work’ and ‘lessons that we can use’ when it comes to school mathematics teaching:

We as students are never 100% sure of what to study or what we are being taught, for example in maths. I also find that we do not do enough practical work and we do not cover enough about ‘teaching’ and creating lessons and this is what teaching is about. Why don’t we get lessons that we can use? (Candice, 3rd year student)

Her anxiety is evident in words like ‘never 100% sure of what to study or what we are being taught in maths’. This anxiety may refer to the overall quality of the modules and the need for more detailed explanations of the activities, actions and tasks in the modules with respect to the social practices of mathematics and mathematics teaching. Her anxiety also points to the difficulty of trying to teach content as well as pedagogy in the modules. She provides details about her anxiety when she writes that ‘we do not cover enough about “teaching” and creating lessons and this is what teaching is about’. Her view is that time should be spent on ‘creating lessons’ which, according to her, ‘is what teaching is about’. Creating lessons about school mathematics ‘teaching’, to use her word, could reduce the anxiety and uncertainty she expressed in her comments. For example, she feels a need for ‘lessons that can we can use’.

Her comments about creating lessons and not covering enough about teaching in the modules deserve attention.

These comments have relevance for the university modules as well as the actual school mathematics classroom setting. Let us assume that she wants ‘creating lessons’ to happen as part of or within the modules. Designing lessons in the modules are about the social practice of mathematics teaching. They imply designing lessons where the many domains of content knowledge are taken into account, such as knowledge of learners and knowledge of teaching, which constitute the multifaceted MKT. From the perspective of the modules, creating lessons in an epistemic sense entails selecting, organising and sequencing the many nuanced interpretations that a mathematical concept can represent and how it is connected to or networked with other mathematical concepts. In the university modules creating lessons means taking into account what it takes to learn and to teach a particular mathematical concept by, for example, unpacking or decompressing it into its elementarised versions. Here creating lessons involves knowing how and when to compress a mathematical concept when teaching it and when to point out connections with other mathematical concepts, that is identifying ‘unifying concepts’.

Candice’s request for lessons that can be used is therefore understandable, because lessons will help her to reduce her anxiety and gain confidence in school mathematics teaching. One way of complying with her request would be to model lessons that can be used in real classrooms with the explicit understanding that such lessons must be adapted so that children’s responses, for example, can be anticipated and then taken into account as the lesson unfolds during its actual teaching in school mathematics. Now and then the PSTs should be provided with model lessons that are as far as possible situation-specific with respect to the school.

Verbal awareness of shift from mathematics to mathematics teaching

Some PSTs do not feel anxious about the social practices specific to the modules but do notice shifts towards the social practice of mathematics teaching in terms of particular school mathematics content. For example, Johan writes that he has been asked to direct his ‘strength’ in ‘solving equations’ to thinking about ‘various ways to teach equations’:

I feel that I’m quite strong in mathematics but have not been stimulated to use it but have instead been asked to develop that strength for teaching. This changes the challenges presented to me from solving equations to thinking of various ways to teach equations, etc. I tend to feel that I catch on quickly and feel bored waiting for other students to ‘click’. (Johan, 3rd year student)

Like Anne, who sees herself as a very strong mathematics student, Johan considers himself as ‘quite strong in mathematics’, referring to mathematics content. In his comments we notice particular (school) mathematics content – solving equations – being considered with an eye on ‘various ways to teach equations’. He feels confident about these shifts or changes in the challenges presented to him. He writes about an instance where the two social practices – mathematics and mathematics teaching – intersect in the modules. His use of ‘challenges’ is an indication that he has



somehow become aware of differences between mathematics content and instances of MKT, that is solving equations and thinking of various ways to teach equations. Here his views also reflect evidence of one of the central tasks in pre-service preparation, that is developing subject-matter knowledge for teaching.

There is more to learn from a comparison of the views of Anne, Candice and Johan. They articulate opposing views about their preparation to teach school mathematics. Johan's description of his challenge in having to shift from equations to *teaching* equations is different from Anne's suggestion of a need for 'proper content – content that is addressed in schools'. According to her, school mathematics content is something that exists ad hoc and can be addressed in the final year of the BEd programme in terms of preparation. Johan seems to have become aware of particular school mathematics content in relation to various ways of teaching equations. However, Anne does not see such a need in terms of teaching. Teaching or methods of teaching, according to her, are what she has come to know by the third year of the programme and are therefore separate from content. From Candice's perspective, there are not enough activities or tasks related to teaching such as methods of designing lessons that can be used in school teaching. What becomes clear is a complex picture of the PSTs' views about school mathematics teaching.

From apprehension to excitement

In the next section we turn to instances where the PSTs' views are in agreement with the social practices of mathematics and mathematics teaching that underpin the modules, but where concerns about school mathematics and its teaching as they know it are raised.

Tami's views indicate apprehension and anxiety at the beginning of the modules, which eased but then reappeared as she started thinking about school mathematics teaching in an actual classroom:

I found this course extremely challenging at first. Now I find it easier. What excites me is the way we approach maths and all the connections we are making. What I find difficult and frightening is I don't know how I am going to apply everything to the curriculum. I am also concerned about those other aspects of the maths curriculum that we are not going to cover because I don't know if I will be able to apply the same approach and methods by myself. (Tami, 4th year student)

Affective views are evident in words such as 'extremely challenging' and 'frightening'. These words show the anxiety and apprehension that she experienced in the beginning ('at first') of the modules. Over the duration of the modules she has come to notice a mathematics content that is different from school mathematics as described by Watson (2008). 'All the connections' is evidence of the mathematics content in the modules being illustrated through the social practice of mathematics such as mathematical representation where unifying concepts, that is 'connections', are pointed out. Also, her use of 'approach' is evidence of the actions illustrating the social practice of mathematics teaching which occurred in the

modules. She wishes for continuity in terms of the 'approach' in the modules with respect to the rest of the (school) 'maths curriculum' ('I don't know if I will be able to apply the same approach and methods by myself'), that is when it comes to the actual practice of school mathematics teaching. A reality is that the teaching arrangement and organisation within the modules is such that not every 'aspect of the (school) maths curriculum' can be 'covered' for reasons related to time and the fact that, as the teacher or researcher, I have yet to figure out all the myriad ways that mathematics concepts can unfold in actual teaching, whether in the university or in a school.

Reality of schools and mathematics as a school subject

Jana and Petro are in agreement with the social practice of mathematics teaching that underpins the modules, but they point out 'the reality of schools':

The module is very effective and helpful for me especially because I'm learning things that I did not know before and I believe this is the reason why I'm here, to acquire new knowledge and to expand my knowledge. On the other side there is the reality of schools. Mathematics gets taught in rote ways and children are forced to memorise formulas etc. (Jana, 3rd year student)

Jana has made a comparison between mathematics content and pedagogy that she had been exposed to in the past and what she claims to have learned in the modules. It is very likely that she is referring to her school mathematics experience, although there is no solid evidence for making this claim. We read further that she refers to the 'reality of schools' and ways in which mathematics is taught there. According to Jana, there is clearly a difference between the social practices of mathematics and mathematics teaching in school and in the modules. Petro's views are almost similar with regards to the 'curriculum laid out work that needs to be done', that is, school mathematics, as compared to the modules:

I feel that it will almost be impossible to implement half the things we've done. Effective as they may be, the time limit in schools and the curriculum laid out work that needs to be done doesn't allow it. (Petro, 3rd year student)

She writes how 'impossible' it will be 'to implement half the things' we have done in the modules (in the university).

Agreement and confidence

Asma and Liezel are confident about their preparation to teach school mathematics. Asma's confidence is reflected in a particular, coordinated task in the modules which requires the PSTs to read, discuss and summarise mathematics education journal articles aimed at a practitioner audience. The task is assigned in all modules and serves as a means to get the PSTs to develop their initial repertoire and their subject matter knowledge for teaching – specifically MKT. Reading journal articles connects to the central tasks of pre-service preparation. Asma wishes to apply 'everything' she has learnt and continues to learn to her teaching in a school:

In the future I want to be a maths teacher. I plan to apply everything I have learnt and am learning to my teaching. I also plan to stay current with maths education through the reading of journals. (Asma, 4th year student)



She intends to 'stay current' with 'maths education' by reading journals. Somehow she seems to have realised the value of reading journal articles as a possible, coordinated, regular action directed towards the practice of (school) mathematics teaching.

Liezel's expresses a view where we notice patterned, coordinated regularities of action directed towards the social practices of mathematics and mathematics teaching:

The course has enabled me to acquire a new perspective on mathematics and teaching approaches. We often underestimate learners and go with the assumption that we have to tell them what to do all the time. This programme has actually proved the opposite. In mathematics especially, children can be led by means of the correct facilitating strategies and probing questions, to use their own methods by means of inherent experimental processes to formulate and thereby solve the problems posed to them. The module has changed my approach to mathematics. By and large we are taught to follow a product-oriented mathematical approach. In this programme, however, there is emphasis on the opposite (process-oriented) approach as a way to highlight the necessity of the child's mathematical development. (Liezel, 4th year student) [Translated from Afrikaans]

She feels confident about her experience in the 'course', which may refer to the BEd programme as whole, including the modules I teach, and claims that it has enabled her to acquire 'a new perspective on mathematics and teaching approaches'. She claims that she now looks at school mathematics with an eye on teaching and on 'learners'. Furthermore, she cautions about 'underestimating' learners in terms of what they can do in relation to the mathematics content. It can be argued that her intended, not actual, patterned, coordinated regularities of action reflect the process dimensions of mathematical practices, that is of doing mathematics. This claim is supported by her references to actions such as 'facilitating strategies' and 'probing questions' where 'they (learners) use their own methods', and 'inherent experimental processes to formulate and thereby solve the problems posed'. Here she may be referring to the types of mathematics problems she has in mind, that is ones where the mathematics can emerge through a 'process-oriented approach' and possibly having her learners acquire structural insights with respect to school mathematics. She wishes to teach in ways where the 'the child's mathematical development' is taken into account, that is she has knowledge of student learning of the mathematical content. This is an instance of the multifaceted MKT such as knowledge of content and learners, as well as knowledge of content and teaching.

What Liezel espouses is different from the mathematics found in school, according to Watson (2008) and according to Petro ('curriculum laid out work'). Also, her views are different from Anne's, that is the 'proper content – content that is addressed in schools'. Liezel articulates the social practices of mathematics and mathematics teaching, such as solving problems and communicating mathematical ideas and concepts, according to the Rand Mathematics Study Panel (2003). She positions herself in ways that differ from those of the other PSTs. It is important to note that her positioning is

not relative to actual school mathematics teaching but rather to what she has probably encountered in the university.

Discussion

The discussion focuses on the university–school divide because the PSTs' views about the modules are about social practices related to bridging this divide. Firstly, there will be comments on views that reveal anxiety and apprehension, followed by those that reveal instances of confidence related to social practices in the modules. The discussion ends by mentioning implications for the university–school divide. In an overall sense the discussion aims at highlighting personal troubles that I have as mathematics teacher educator around public issues with regard to the preparation of primary school PSTs.

Mathematics teacher educators who teach modules aimed at mathematics teaching at the intermediate and senior phase must be aware of, and take into account, PSTs' feelings of anxiety and apprehension. Empirically we see the examples of Anne and Tami. These examples are confirmed by the literature, which also states that PSTs feel scared and are overwhelmed by mathematics and mathematics teaching. Tami had considered the modules 'extremely challenging' in the beginning, whilst Anne had feelings of anxiety almost right up to the end of the modules. On the one hand there is Liezel, whose views can be described as confident with regard to the intended and not the actual social practices related to (school) mathematics and mathematics teaching. More activities and tasks are needed to provide situation-specific instances of mathematics teaching, such as creating lessons within the university modules. Ideally the university environment, that is the modules, provides an intellectual space for creating lessons. Here a school timetable is absent and there are possibilities for mathematical practices such as the thoughtful use of representation to show how, why and where school mathematics ideas (in the intermediate and senior phases) can be connected through teaching. Certainly what is proposed can be criticised as coming from an ivory tower. On the other hand, reflection on such teaching and the availability of sufficient time will probably not be possible in a school situation, where there are limited time slots (Watson, 2008), which can influence school mathematics teaching.

At a structural level the different views of the different PSTs on their preparation to teach school mathematics speak to the university–school divide. The university is a place that valorises theoretical insights and questions such as 'What could or should school mathematics teaching be like?' For a PST like Anne, the kind of mathematics that focuses on connections and considerations for teaching (eloquently articulated by Liezel) and counts in the university, is not the 'proper content' that is 'addressed in school' or that counts in the school. If the school mathematics content that Anne refers to is interpreted as school-teaching mathematics (Julie, 2002) or simply as school mathematics (Watson, 2008), she does not take into account MKT, for example. Examples of mathematics teaching in the modules are situation-specific



to the university, that is they count within the confines of the university. Jana and Petro see value in such examples of mathematics teaching but express reservations when it comes to the school situation. On the other hand, Anne has experienced a rupture in terms of her prior mathematics experiences. Candice, however, wishes to bridge the university–school divide; hence she is interested in creating lessons that can be used in school (the mathematics classroom). In practical terms PSTs such as Anne and Candice should be helped to notice the larger picture of MKT. They and other PSTs also need knowledge that is situation-specific and related to a context such as a school classroom in which they meet a problem. In practical terms, Liezel's formulations of the social practices of mathematics and mathematics teaching and Asma's views about wanting to remain up to date with mathematics education are necessary in terms of transitioning, albeit verbally, from their earlier mathematics experiences. When they enter the school, they will have to wrestle with the overlay of a school classroom on the mathematics content. They will have to contend with textbook writers, test developers, education bureaucrats and parents. It makes sense to ask what support they will receive in their transitioning from the university to the school. It can also be said that Liezel and Asma may have figured out what the idealised PST should say or how they should behave.

Concluding remarks

This article reports on the views of a selected number of intermediate and senior phase PSTs about mathematics teacher education modules that aim at teaching both content and pedagogy. It is evident from the findings that the PSTs position themselves differently in relation to the social practices that are privileged in the modules. Their positioning should be interpreted in relation to the social practices of mathematics and mathematics teaching exemplified in a university context and not in a school context. Making the PSTs' views public is a means to show what it means to be at the coalface of offering the PSTs a particular vision of school mathematics teaching as I come to understand it based on my on-going reading and understanding of mathematics teaching enacted in and confined to the university. The PSTs' views can only tell us the extent to which the PSTs are able to verbalize the social practices of mathematics and mathematics teaching that are privileged in the modules. Their views reported here cannot tell us what they will or might do in a school context.

The social practices of mathematics and mathematics teaching in the modules are ultimately about conceptualising the nature of bridging of the university–school divide. In many ways these practices are informed by strands of literature specific to pre-service teacher education and mathematics teacher education. For the purposes of learning, the university–school divide cannot be collapsed. The university context can never become the school context. Also, the vision of (school) mathematics teaching in the university context that is offered to the PSTs is far from complete and perfect. Such a vision is necessary and so is the university as

a place for the education of the PST. There is an important lesson to be learned, at least for me, in the complaint of one of the PSTs that 'we do not cover enough about "teaching" and creating lessons'. It is in 'creating lessons' that we can all stand to learn.

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References

- Aldridge, S., & Bobis, J. (2001). Multiple learning contexts: A vehicle for changing pre-service primary teachers' mathematical beliefs, knowledge and practices. In J. Bobis, B. Perry, & M. Mitchelmore (Eds.), *Proceedings of the 24th Annual Conference of the Mathematics Education Research Group of Australasia*, Vol. 1 (pp. 43–49). Sydney: MERGA.
- Askew, M. (2008). Mathematical discipline knowledge requirements for prospective primary mathematics teachers, and the structure and teaching approaches of programs designed to develop that knowledge. In P. Sullivan, & T. Wood (Eds.), *International handbook of mathematics teacher education: Vol. 1: Knowledge and beliefs in mathematics teaching and teaching development* (pp. 13–35). Rotterdam: Sense Publishers.
- Ball, D.L. (2000). Working on the inside: Using one's own practice as a site for studying teaching and learning. In A. Kelly, & R. Lesh (Eds.), *Handbook of research design in mathematics and science education* (pp. 365–402). Mahwah, NJ: Lawrence Erlbaum Associates.
- Ball, D.L., Thames, H.M., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389–407. <http://dx.doi.org/10.1177/0022487108324554>
- Berry, A. (2004). Confidence and uncertainty in teaching about teaching. *Australian Journal of Education*, 48(2), 149–165.
- Berry, A. (2007). Reconceptualising teacher educator knowledge as tensions: Exploring the tension between valuing and reconstructing experience. *Studying Teacher Education*, 3(2), 117–134. <http://dx.doi.org/10.1080/17425960701656510>
- Brady, P., & Bowd, A. (2005). Mathematics anxiety, prior experience and confidence to teach mathematics among pre-service education students. *Teachers and Teaching: Theory and Practice*, 11(1), 37–46. <http://dx.doi.org/10.1080/1354060042000337084>
- Brodie, K. (2012). Learning about learner errors in professional learning communities. In D. Nampota, & M. Kazima (Eds.), *Proceedings of the 20th Annual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE)* (pp. 1–19). Lilongwe, Malawi: SAARMSTE.
- Brodie, K., & Shalem, Y. (2011). Accountability conversations: Mathematics teachers' learning through challenge and solidarity. *Journal of Mathematics Teacher Education*, 14(6), 419–439. <http://dx.doi.org/10.1007/s10857-011-9178-8>
- Brodie, K., Slonimsky, L., & Shalem, Y. (2010). Called to account: Criteria in mathematics teacher education. In U. Gellert, E. Jablonka, & C. Morgan (Eds.), *Proceedings of the Sixth International Mathematics Education and Society Conference*. Berlin: Freie Universität Berlin. Available from http://www.ewi-psy.fu-berlin.de/en/w/mes6/documents/proceedings/Band_1_Finale.pdf
- Cassel, D., & Vincent, D. (2011). Metaphors reveal pre-service elementary teachers' views of mathematics and science teaching. *School Science and Mathematics*, 111, 319–324. <http://dx.doi.org/10.1111/j.1949-8594.2011.00094.x>
- Corbin, J., & A. Strauss. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd edn.). Thousand Oaks, CA: Sage.
- Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record*, 103(6), 1013–1055. <http://dx.doi.org/10.1111/0161-4681.00141>
- Grootenboer, P.J. (2003). Facilitating affective change with pre-service primary teachers. In L. Bragg, C. Campbell, G. Herbert, & J. Mousley (Eds.), *Proceedings of the 26th Annual Conference of Mathematics Education Research Group of Australasia*, Vol. 2 (pp. 413–420). Sydney: MERGA.
- Hill, H., Ball, D., & Schilling, S. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education*, 39(4), 372–400. Available from <http://www.jstor.org/stable/40539304>
- Julie, C. (2002). The activity system of school-teaching mathematics and mathematical modelling. *For the Learning of Mathematics*, 22(3), 29–37. Available from <http://www.jstor.org/stable/40248400>
- Loughran, J. (2007). Researching teacher education practices: Responding to the challenges, demands and expectations of self-study. *Journal of Teacher Education*, 58(1), 12–20. <http://dx.doi.org/10.1177/0022487106296217>
- Loughran, J., & Berry, A. (2005). Modelling by teacher educators. *Teaching and Teacher Education*, 21(2), 193–203. <http://dx.doi.org/10.1016/j.tate.2004.12.005>



- Mills, C.W. (1959). *The sociological imagination*. New York, NY: Oxford University Press.
- Morrow, W. (2007). *Learning to teach in South Africa*. Cape Town: HSRC Press.
- Peker, M. (2009). Pre-service teachers' teaching anxiety about mathematics and their learning styles. *Eurasia Journal of Mathematics, Science & Technology Education*, 5(4), 335–345.
- RAND Mathematics Study Panel (2003). *Mathematical proficiency for all students: Towards a strategic research and development program in mathematics education*. (Deborah Loewenberg Ball, Chairperson). (DRU-2773-OERI). Santa Monica, CA: RAND Corporation. Available from http://www.rand.org/pubs/monograph_reports/MR1643.html
- Schön, D.A. (1983) *The reflective practitioner: How professionals think in action*. London: Basic Books.
- Scribner, S., & Cole, M. (1981). *The psychology of literacy*. Cambridge, MA: Harvard University Press.
- Simon, M.A. (2000). Research on mathematics teacher development: The teacher development experiment. In A. Kelly, & R. Lesh (Eds.), *Handbook of research design in mathematics and science education* (pp. 335–359). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Szydlik, J.E., Szydlik, S.D., & Benson, S.R. (2003). Exploring changes in pre-service elementary teachers' mathematical beliefs. *Journal of Mathematics Teacher Education*, 6, 253–279. <http://dx.doi.org/10.1023/A:1025155328511>
- Watson, A. (2008). School mathematics as a special kind of mathematics. *For the Learning of Mathematics*, 38(3), 3–7. Available from <http://www.jstor.org/stable/40248612>