

Mathematics Teachers: Negotiating Professional and Discipline Identities

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The professional practice of teachers is shaped and directed by their sense of identity (Beijaard, Verloop, & Vermunt, 2000). All teachers have some conception of themselves as pedagogues, but they also have identities which relate to the disciplines that they are required to teach. Here we report on a project that explored the nexus of these identities with specialist mathematics teachers in secondary schools and generalist teachers who teach mathematics in primary/middle schools. The preliminary findings presented here suggest that when teaching mathematics, teachers often enact a pedagogy that unconsciously reflects their identities as somewhere on the continuum from mathematician to teacher. It appears that 'excellence' as teachers may be associated with teachers viewing themselves as educators first and foremostly, but who have a positive perception of the discipline area, and who are confident in the related Pedagogical Content Knowledge.

Central to all students' school education is the teacher (Boaler & Greeno, 2001; Hayes, Mills, Christie & Lingard, 2006; Zammit, et al., 2007). There are a multitude of research studies that document and support successful teaching practice, but rarely have these studies investigated teacher qualities that go beyond the question of technique (incorporating strategies and approaches used in the classroom). Yet, good teaching goes beyond 'good technique' (Palmer, 1993) – if it were mere technique then it should be well understood by now. Palmer argues that teachers teach from their sense of self – their identity. In the classroom, that identity primarily consists of the way they see themselves as a pedagogue and how they see themselves in relation to their discipline – in this case, as a mathematician. This study focused on the teacher themselves – their identity – and in particular how their teaching practice is conceptualised through their discipline-based, and professionally-based identities (Ballantyne, 2005). The findings here are somewhat preliminary and require further investigation and theorising. To this end we offer some of the initial findings and our early thoughts about the data, but these are tentatively held and hopefully they will promote discussion and debate.

Teacher Identity

There have been many studies that have looked somewhat independently at teachers' knowledge, beliefs and practices, but the concept of 'identity' is a more encompassing conceptual framework. Teacher identity incorporates their personal knowledge, beliefs, values, emotions and practices about teaching, about the disciplines they are teaching, and about themselves as educators (Grootenboer, Smith & Lowrie, 2006). It includes what teachers think and do, but it also encompasses their sense of who they are.

The term identity has been variously defined and there is continuing debate about whether an individual has one identity with many aspects, or if they have multiple identities (Grootenboer, et al., 2006). While finding clarity and theoretical rigour concerning the phenomenon of identity is important, it is not the focus of this paper. Here we take the term as being unproblematic and we do not take a stance on the singularity or plurality of personal identity, although we do acknowledge that this is a simplification of a



complex term. We as authors are far more interested in how teachers see and define their own identities, and implications of such identities to their practice.

Disciplinarity and Identity

Teachers are required to teach within and through particular disciplines (e.g., mathematics and music), and the nature of their teaching practice has been shown to vary according to the discipline being taught and the ages of the students (Martinez, 1994). When teachers teach particular subjects, they teach more than just knowledge and skills – they also convey aspects like beliefs, values and emotional responses about the field (Grootenboer, 2006). These discipline-based ‘teachings’ are grounded in the teacher’s disciplined-based identity – i.e., what they know, think, value and do as a mathematician, and they also have a significant impact on their students’ developing discipline-based identities (Eder & McCabe, 2004; Zevenbergen & Grootenboer, 2009). As argued by Ramsey (2000), “it is impossible in any discipline to separate the content from the pedagogy” (p. 37), with the implication being that “teachers never teach something in general – they always teach particular things to particular groups of [students] in particular settings ... most human learning and teaching is highly specific and situated” (Shulman & Sparks, 1992, p. 14). If this is true, then teachers’ professional identities are likely to also be situated within discipline or age level specialisation.

However, teacher identities also include how they see themselves as educators and their professional practice is significantly constituted by their pedagogical identity **and** their discipline-based identity (Ballantyne, 2006). Mathematics teachers’ identities in relation to their mathematical sense of self and their professional sense of self will be foundational to their teaching practice. It is important to note that this is significantly more complicated for primary school teachers who are required to teach across several discipline areas, and may identify primarily as teachers of particular aged students rather than as teachers of disciplines.

Teacher Identity and Teacher Knowledge

Shulman (1987), in his seminal work, theorised the knowledge bases of teaching (content knowledge, pedagogical knowledge and pedagogical content knowledge). Ballantyne’s (2007) study revealed that (in the case of music teachers) pedagogical content knowledge and skills was of most importance to those teachers in the early stages of their careers, and that professional identity appeared to be associated with perceived aptitude in relation to the discipline (and pedagogical content knowledge and skills). In this study we hope to be able to offer a more comprehensive understanding by broadening the focus to identity. This sort of theory would be significant in underpinning practices in teacher education and development, and indeed, to better understand the pivotal work of teachers.

The Study

The data reported on here is part of a larger study conducted in 2009 and 2010 that focussed on mathematics and music teachers. The project was conceptualised as a series of related case studies (Stake, 1995) and employed qualitative methods to explore the professional and disciplined-based aspects of the school teachers’ identities, and the relationship between these aspects of their identities and their teaching practice.

Data Collection

Data were gathered through in-depth interviews, classroom observations and document analysis with both primary generalist teachers and secondary specialist mathematics teachers. The participant group was made up of four secondary school mathematics teachers and four primary/middle school general teachers from schools in South-East Queensland. There was an equal balance of male and female participants and all were experienced teachers (10 to 35 years experience). Participants were selected and invited to participate because they were acknowledged as being good teachers of mathematics by the educational community (for example, one of the participating teachers has received a national teaching award, another was recommended by mathematics teachers from four other schools). A program of data collection was negotiated with each participant, and each included an initial in-depth interview and a classroom observation and follow-up interview. In most cases, a small group of students from the teachers' class were also briefly interviewed.

Semi-structured interviews were the primary mode of data collection, and all the interviews were audio-taped and transcribed. The interviews lasted between 45 and 90 minutes. An initial semi-structured interview was undertaken with each participant and focused on aspects of their professional identity including their personal philosophies, beliefs, values and knowledge about teaching and mathematics, and how these are enacted in their classrooms. These conversational interviews were designed so that participants could experience them as professional discussions about the nature and meaning of teachers' work and their convictions about the pedagogy of mathematics (Kvale, 1996). Follow-up interviews were undertaken to explore aspects of the participant's practice after a lesson had been observed and photographed, and through examining artefacts such as student work samples and programs. To gain a student perspective of the teachers' actions and philosophies, in most cases additional informal interviews were undertaken with students who had been in the class of the participating teacher.

Following the classroom observation a stimulated recall interview was conducted. During the observed lesson detailed field notes were taken and these notes were the basis for a semi-structured follow-up interview where the observations made by the researcher were explored with the participant (Lyle, 2003). The observations were enhanced by photographs of the participant as he/she was engaged in the teaching process. The photographs were used to stimulate recall to prompt discussion about the practices captured, but they were then deleted and not retained as part of the data set. During the reflective discussions/semi-structured interviews, the researcher(s) and the participant viewed and examined the photographs together, stopping as required to discuss and question aspects of the teacher's practice as they emerged. The use of photographs was seen as preferable to video-taping because the still pictures require the participating teacher to discuss and 'fill-in the gaps', whereas a video can be seen as somewhat 'self-explanatory' (Zevenbergen, 2005).

Data Analysis

The data collection process yielded a large data set that included 16 interview transcripts with the participating teachers and 8 group interview transcripts with students. Grounded theory analysis techniques were utilised (Strauss & Corbin, 1998) using the NVivo8 software. The data was initially divided into conceptual units and coded both inductively and deductively (Schwandt, 1997). Once this initial coding was complete, the

researchers began to impose some structure upon the data by developing themes and sub-themes. The structured data set was then used to theorise the central topics of the study, while always returning to the empirical data for verification and exemplification.

Findings and Discussion

Before briefly outlining a few of the key findings, it is important to note one striking feature of the data collection process. Having visited, observed and talked with each of these eight teachers and some of their students, it was clear that they all had different styles and approaches to teaching. They ranged from strict, highly structured classes to quite informal and open lessons, and some teachers used a largely investigative approach while others were more textbook and exercise based. Despite the great diversity in the teachers and the lessons, all the participating teachers have been acknowledged as effective teachers of mathematics by their peers. This indicated to us that there is indeed more to effective mathematics teaching practice than the pedagogical approach and the classroom management style.

The data set generated is large and a wide range of themes have emerged from the data analysis process. Here we will only report on the findings that specifically relate to the teachers' identity as 'mathematics teachers'. In particular, we will focus on their professional identity as an educator, their discipline identity as a mathematician, and the way these two realms interact and are negotiated in their role as mathematics teachers.

Mathematics Teachers as Educators

Without exception, all of the participants identified themselves first and foremost as teachers. While there were many dimensions to the pedagogical aspect of their identity, the two most prominent aspects were relationships and the classroom environment, and clearly these are not distinct elements. The relational basis for their classroom practice was seen as critical to all the participants, although they may have enacted it in different ways. For example, Geoff¹¹ (Middle School, Initial interview) said:

I think so very much so and you've got to connect. That means you've got to be a real person to them, you can have the greatest knowledge in the world but if you can't connect and you can't communicate you're stuffed.

There was a sense throughout all the data collection events that the participating teachers cared deeply about their students, that they knew their pupils well, and they had mutual respect for one another. Similarly, all the participating teachers and their students noted the importance of an engaging and inviting classroom environment. In particular, they noted the importance of "fun" and "humour", and these also helped establish and maintain good pedagogical relationships. The notion of having a teaching identity that is fun and humorous was not meant in a frivolous sense, but rather a notion of being engaging, warm and 'human'.

Mathematics Teachers as Mathematicians

It was prominent that all the participating teachers did not see themselves as mathematicians. Each teacher was specifically asked whether they thought of themselves as a mathematician and without exception they all said "no". A typical response was;

¹¹ Pseudonyms are used throughout this report

No, not really. I'm more of a teacher than a mathematician I think. I love my maths, don't get me wrong but I don't think I'm a mathematician, otherwise I'd be out doing that instead. I kind of think of mathematicians as insular sorts of people and I'm nothing like that, so no I'm not a mathematician, I'm just a teacher who loves maths. (Cathy, Secondary Mathematics, Initial interview)

Cathy's response is indicative of the views of all the participants in that, while she did not accept the label of mathematician, she did acknowledge of love for the subject, but as one who is primarily a teacher. The common belief was that a mathematician is one who only does mathematics, and associated with that view were certain pervasive common beliefs about what a mathematician is like and what they do. These included beliefs about mathematicians being "insular", "geeky", "dry" and "detached from the real world", and their work being "isolated", "disconnected", formulaic and unemotional. Perhaps then it is not surprising that the participants did not want to align themselves with the title 'mathematician'. However, these views do not resonate with the findings of Burton (1999) who found that mathematicians are collaborative and emotive, and in their practice they sought connections and insight. Also, it was interesting to note that the participating teachers wanted their students to see themselves and/or to behave as mathematicians:

However, I like my kids to think of themselves as mathematicians and we explore things so I set up activities that allow the kids to build their understanding and feeding new information as we go along and that sort of stuff. But I want the kids to act as mathematicians. (Tanya, Secondary Mathematics, Second Interview)

Indeed, during the interviews when this point was discussed vis-à-vis their view of themselves as mathematicians, it prompted some reflective consideration.

That said, there was other data that indicated that the participating teachers did espouse and enact mathematical beliefs, values and behaviours, even if they did not feel they were 'mathematicians'. As noted above, all had a passion for mathematics and they enjoyed working on mathematical problems to a greater or lesser degree. One participant discussed the challenge and the joy of finding problems or contexts in the popular media that could be modelled mathematically, and then engaging with this task to see if it was an appropriate activity for his senior mathematics classes.

I think you've got to have the passion about what you do. I think you've got to have that interest - it would have taken me a couple of weeks to actually unpack the Tacoma Narrows Bridge problem, to get it to a point where I knew the kids had a chance of being able to work it through so you've actually got to really understand what's happening. Like the assumptions and stuff like that - assumptions to be able to then allow the kids to have access so I mean it's really fun to do and I think we can actually do a lot more with it, and play around with it. ... If I don't get enjoyment out of it I don't do it really. I mean to say it's got to be fun! (Glen, Secondary Mathematics, Second interview)

Here it is clear that Glen actually enjoyed doing the mathematics himself, but this only occurred in the context of preparing something for the students. As such, this is a point where he is drawing on the mathematical and pedagogical aspects of his identity.

Mathematics Teacher Identity

While the teachers saw themselves primarily as teachers, it was clear that they all had a strong mathematical sense of self, and their professional practice as mathematics teachers developed from both their pedagogical and discipline-based identities. One such example was noted above, where Glen was planning learning experiences for his class, but perhaps where this was most prominent was in the teachers' classroom practice.

During the lesson observations it was clear that the teachers were making many decisions about what to do and say in the classroom. These decisions didn't appear to require a great deal of thought or reflection because the ensuing actions were almost immediate. The decisions were complex as they often involved appraising the mathematics presented and considering the personalities and identities of the particular student(s) concerned. Therefore, a good deal of time was spent in the post-observation interviews discussing the decision-making process as they engaged in the business and complexity of the classroom. It should be noted that the participants found these parts of the interviews quite difficult because they had not overtly considered this aspect of their mathematics teaching before. The photographs and fieldnotes were valuable in recreating particular classroom events for the participating teachers to consider and reflect upon.

Routinely throughout the lessons the teachers were confronted with situations where they had to decide whether to support and protect the students' mathematical identity and when to promote challenge and uncertainty for mathematical growth. Unfortunately, learning mathematics can cause anxiety and stress for many students, and so the participating teachers commented on the importance of being attentive to the students' emotions and their developing mathematical identities. However, students' mathematical development requires times of uncertainty and disequilibrium as they face new material or ideas (Carter, 2008). This means that in mathematical learning situations there is an inherent tension between protecting students' (often fragile) mathematical identities and facilitating unease and discomfort so growth can occur. Furthermore, the teachers regularly responded to different students in different ways. When seeking assistance from the teachers while working on the same problem, some students were offered specific advice and encouragement about what to do next while others were given a probing question. Similarly, on some occasions the teachers gave quite direct instruction or teaching, whereas on other occasions they would allow the students to explore a problem and/or continue with their ideas. When asked whether the decision to do this was based on educational grounds or mathematical grounds, David (Secondary Mathematics, Second interview) said;

Both - it's what I see the kids doing. It's about, like for instance when we were talking about the logarithms and about the language that we use, it's very explicit, this is what I want you to use and there's no negotiation in that sense but other times I'm happy for kids to use communication and justification in a way that they want to use it. So it's based on what I see the kids doing and how their thinking is going and also the fact that I want them to have that mathematical rigor, for want of a better word, that we are using the right language and we are using it in an appropriate context.

Thus, this teacher and his students were engaged in a sort of "dance of agency" (Zevenbergen & Grootenboer, 2009) negotiating the requirements of the discipline and their own agency as doers and makers of mathematics.

In order to decide whether to challenge and let the uncertainty remain, or to alleviate the pressure the teachers needed to have a sound mathematical perspective and a good knowledge and understanding of their students – thus drawing on their mathematical and pedagogical identities (Grootenboer & Zevenbergen, 2008). Furthermore, as noted previously, these decisions are made very quickly as is demanded by the hectic nature of the classroom, and so there is limited capacity for deep thought, and careful and evaluative consideration. Thus, it appeared to us that the decisions were made from their identity as mathematics teachers – from a sense of who they are in that classroom. These mathematical and pedagogical perspectives may well have been developed through a range of factors including thoughtful, reflective and analytical consideration and personal mathematical

experiences, but in the classroom it is the person of the mathematics teacher who must respond and act.

Conclusions and Implications

As was mentioned at the outset, the findings and discussion of this paper are interim in nature, and so we do not claim any firm implications for practice at this stage. That said, we do feel that the data has given rise to some issues that are worthy of further consideration.

Firstly, despite all the participants for this study being selected because they were acknowledged by their peers as good mathematics teachers, their pedagogical approaches and their classroom practices varied greatly. Thus, it appeared to us that effective mathematics teaching cannot be defined in terms of a technique and teaching style, or at least not in terms of these alone. However, what was clear was that each of the teachers had coherent views about how children learn mathematics, and their classroom practice was developed from these beliefs. Therefore, in this study it seemed that a consistent and coherently articulated identity as a mathematics teacher was foundational to effective practice, rather than holding to any particular fashionable or required pedagogical approach – a professional sense of identity.

Secondly, even amongst this community of mathematics teachers, there appears to be some inconsistency about mathematicians and mathematical practice. Perhaps for some of the participants this was related to a sense of modesty and not wanting to over-state their mathematical capabilities. Nevertheless, it is desirable that mathematics teachers have robust mathematical identities, including some pride in owning the label of ‘mathematician’.

Finally, the teachers’ classroom practice was characterised by a stream of quick decisions and actions that seemed to be undertaken with limited consideration. However, these teaching actions can have significant consequences, particularly because what is done cannot be undone (Kemmis, 2008). The sense of immediacy about these decisions and actions – decisions and actions that are the fabric of classroom teaching, indicated to us that they were made from the teachers identity or sense of self. While this idea is difficult to capture and articulate, this notion of ‘who they are’ it appears to be important. This would mean that good mathematics teachers not only have sound mathematical knowledge, pedagogical knowledge, and mathematical pedagogical knowledge, but they are mathematical educators whose identity is imbued with discipline and professional qualities. If this is the case, then teacher development will be about developing the all-round person who teaches mathematics – an identity as a mathematics educator.

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