
5. Cross-case Analysis

This chapter is structured around the conceptual framework, as was the previous chapter. However, in this chapter, all six cases are discussed in terms of each of the twelve elements of the framework: the four influencers (personal history or biography; tertiary training, teaching practica and view of mathematics); the students' perceptions of the three aspects of their own PMTI (Mathematics Specialist, Teaching-and-learning Specialist and Carer) and the actualisation of their PMTI's (examined as mathematical expertise, evidence of understanding, teacher/learner-centeredness, flexibility, and purpose and evidence of care).

The six students who formed the sub-sample were selected to be as individually diverse as possible. However, as a group, many commonalities could be observed. For this reason, the insights they came to as fledgling teachers spending a prolonged time in the classroom for the first time, are the subject of the group interview that was held in the middle of the long teaching practicum. These insights are discussed in conjunction with the data pertaining to the six participants as individuals. The extended practicum, consisting of two whole school terms (approximately six months) as opposed to the three week practica of their second and third year's training, gave them the opportunity to "experience all the challenges in the school" (Group interview, Thandi, 1:9) and "you got to be in every aspect of the school - the culture, the sports and you got to interact with the kids more and for a longer period of time" (Group interview, John, 1:13). Some experiences were unexpected: Thabo, for example, was able to observe some of the logistics of being a teacher: "Now we had more time to experience and to know what are we really going to expect in the teaching profession. From the practices in the classroom I had to...the sports that we've been involved, like some were activities and then the management of the school as a whole" (Group interview, Thabo, 1:17). This practicum thus allowed the students to experience the professional life of a teacher, albeit for a limited period of time while technically still students at UP – thus, as it were, with a foot in both worlds: the school and the university. The students in question were all able to reflect earnestly about their personal and

professional beliefs, perceptions and experiences. John even said after his final interview that he had never needed to dig quite so deep into his own identity as was the case for this research.

5.1 Influencers of PMTI

Coming from widely disparate backgrounds, the students manifested a range of motivating influences which in fact reflects the cultural diversity that characterises the University of Pretoria. They were educated at high schools that ranged from expensive and exclusive private schools, through schools formerly known as “white” government schools, to rural state schools lacking in even basic resources.

5.1.1 The influence of personal history

Career choices influencers

The reason behind their choice of mathematics education as a career is an important indicator of how these students’ PMTIs came to be constituted as they are – it speaks of predisposition and motivation. Two of the students, Thandi and Siphon, connected their desire to become teachers of mathematics directly to having negative high school experiences, while Ayesha was persuaded into mathematics education by her father. Martie’s father could reconcile himself to the fact that his daughter did not find satisfaction in Occupational Therapy or Construction Management if she taught a subject which exercised her abilities, like mathematics. Ayesha, John and Martie, actually planned to pursue a career other than teaching. Siphon, by contrast, seems to have been largely motivated by his schooling experiences. Only one student, Martie, owned to a large range of influencing factors; while, for instance, Thabo’s career choice seems to relate to only *two* factors. The three young women, as well as Siphon, indicated very strongly that they felt driven to “make a difference”. The influencers noted in the table below have been identified through inductive analysis of the data. These career choice factors are particularly significant in that they inform more than just career choice – they speak to these students’ individual PMTI.

Table 15

Summary of career choice motivating influences from personal history.

MOTIVATING INFLUENCES	MARTIE	AYESHA	THANDI	THABO	JOHN	SIPHO
BAD HIGH SCHOOL EXPERIENCES		X	X			X
TEACHING WHILE STILL A LEARNER AT SCHOOL	X			X		
CULTURAL OR SOCIETAL FACTORS	X	X	X	X	X	X
WANTING A POSITION IN SOCIETY			X			
PARENT	X	X				
WANTING TO MAKE A DIFFERENCE	X	X	X			X
'I AM A TEACHER – I HAVE TO TEACH'	X					X
MATHEMATICAL ABILITY	X			X		
LOVE OF THE SUBJECT MATHEMATICS	X		X		X	
LOVE OF CHILDREN	X	X			X	

The influence of schooling

All six were affected strongly by their own schooling, and by one teacher in particular: Martie's teacher could not explain - she explains; Ayesha's teacher was a traditionalist - unwittingly she emulates her teacher; Thandi's teacher had gaps in her knowledge - Thandi works hard at hers; Thabo's teacher was absent - he taught and liked it; John's teacher was good, but did not reach out to a shy boy - he does; Siphos teacher was racist - he values everyone equally. Herein lies the dual significance of a being a teacher: she does not only teach, she influences the PMTI of future teachers.

The influence of society

This factor is also common to all six students: they were in some way influenced by the society of which they are a member. Despite the fact that only Ayesha referred *directly* to her Indian culture as a factor in choosing teaching as a career, social background plays a role in each student's mind set, as indicated in the table above. Martie, for example, coming from a good school and well-to-do urban culture, was given freedom of choice in terms of what she wanted to do with her life – all doors were

open to her. Both she and Ayesha were strongly influenced by their fathers whose right to have an input into their lives seems not to have been disputed. Thandi, educated in a private school in an otherwise generally disadvantaged urban society, believes that becoming a teacher of mathematics would give her a certain cachet in her community, despite the fact that *her* teachers seem not to have been very knowledgeable or inspirational. It would seem that in her community, being a teacher, particularly of such a sought-after subject as mathematics, is guaranteed to carry with it a certain status, turning an ordinary individual into ‘somebody’. Thabo’s disadvantaged background gave him an appreciation of the privilege of being able to go to university at all. There is John, to whom freedom of choice comes naturally – sport? Or something more serious? And then there is Siphso, a young black man who had been educated in a predominantly white school, determined to set right racial injustice in the classroom.

The influence of passion

The second most common influencer is the desire to make a difference, which may be rooted in the participants’ personalities. Although Thabo and John did not mention this factor in so many words, they did indicate their passion to make a difference during their interviews. Two influencers are joint third in prevalence, both of which have to do with passion – for mathematics, and for children. While all six want to teach mathematics at this stage of their lives, they are not all equally *driven* to do so. Martie and Siphso indicate their passion for teaching: Martie has tried other career directions, but to no avail – only teaching brings her satisfaction; Siphso speaks with passion of teaching – using his own metaphor, the classroom is a stage where he can right the wrongs of his own schooling and can communicate his love for mathematics. Thabo *loves* to teach, as he realised while teaching his classmates as a learner: he was prepared to wait for three years to acquire the means to study teaching. John also loves to teach, although he was not aware of this when he started his BEd, but he also loves sport, and is unable to say whether teaching mathematics has the ability to hold him in the future. Ayesha has compromised her true desire by choosing teaching above veterinary science. However, she feels she has it in her to do it because she loves children. By contrast, Thandi evinces no passion at all for teaching or the learners and seems to be driven rather by a desire to have a position of authority within the community from which she can bring about change.

5.1.2 The influence of the tertiary environment

Each one, even if they were quite critical of the BEd course, like Martie, felt that being at university had changed them in some way. Martie had admitted that she had learnt to be disciplined in her studying and in pushing herself to do more than she felt like doing; Ayesha felt that she had acquired knowledge about the psychology of learning, “how children think, how you should behave with them and how to deal with children with problems” (SIS, 2:58); Thandi’s knowledge of mathematics increased and she learnt all sorts of theory about teaching: “It’s not just passing on the knowledge that you have to learners, you learn from the learners and they learn from you” (ISI, 2:36); Thabo thought he would just be acquiring more mathematical knowledge and was surprised to find out how much he needed to learn about teaching-and-learning skills; John experienced tertiary training as a maturing process; and Siphso was most deeply affected by the psychology modules he completed.

Each one of these students felt that they were not the same person they were when they left Grade 12, not just because they were older, but because they had seen another side of teaching, had been brought to an understanding of some of the theory that lies behind the classroom practice and were consequently no longer dependant only on instinct or experiences they could remember from when they were learners themselves. Siphso, for example, declared that his image of what makes a good mathematics teacher had been changed during the course of his training: he now realised that teaching skills and an understanding of the psychology of learning were requirements for good classroom practice. He explained the compartmentalisation of his beliefs: he had beliefs that he had carried over from his own schooling, separate from those acquired through methodology training and from those he absorbed through interaction with his peers. These clusters had to be integrated into his own style.

All six of the students mention that they were taught various teaching strategies at university. Thabo, for example, has put what he learnt into practice and reaped the benefit thereof: “All the things we’ve done up to so far, according to me they are useful. When going to school and having done all those things that we have learnt here, I don’t experience a lot of problems [sic]” (ISI, 6:104). John, Siphso and Thabo have made what they have learnt at university their own, judging by what they both

say and by what can be seen in their practices. However, not all of them applied these theories to their practice. For instance, Martie declared that she had learnt nothing new in the BEd programme, nothing that would be particularly useful. From her own admission, the strategies which are observable in her teaching are not university-acquired, but stem from her own schooling and personality. Despite this declaration, the academic discussion around learner-centeredness versus teacher-centeredness appears to have made sense to her: it can be seen that she tries to involve the learners in her teaching, despite the fact that her default teaching persona is Explainer. Ayesha, by contrast, speaks highly of the modules in which she learnt about the theory of learning, and of learning mathematics in particular. However, in her practice, generally speaking, very little of those theories are seen. She is an instructor first and foremost. Therefore it would seem that, in her case, while the theoretical aspects made sense to her, they were not strong enough to displace the beliefs regarding didactics that were established in her identity when she was a learner at school. In this area Thandi parallels Ayesha: she declares her belief in the teaching theories and strategies she learnt about at university, but puts none of them into practice, other than trying to link mathematics to the learners' real world. In her case it would seem that her determination to keep the learners at a distance and not to enter into any sort of interactive relationship with them, outweighs any belief in any theory of learning.

Across all six cases the effect of their tertiary training was evident in the vocabulary they used to describe various aspects of their PMTI or teaching experience, for example, "learner-centeredness", or being a "lifelong learner". Vocabulary, according to Grier and Johnston (2009) is one of the ways in which identity reveals itself.

5.1.3 Influence of the teaching practica

Most of the students (not Martie) expressed a consciousness of the inadequacy of their university training in preparing them for the realities of the classroom. Theoretical knowledge was one thing, but being confronted with learners of different cultures, languages, understanding abilities and emotional problems was entirely another. Some of the students (Thabo, John, Siphon) watched their mentor teachers carefully to learn how to handle the classroom situation; others depended on instinct in order to cope. Even in their inexperience, the effect of the experience of *others* from whom

they have learnt, can be seen. John, for example, starts his lessons with a riddle or some puzzle – he adopted this strategy from his mentor teacher’s practice because he found that it worked well as a tone-setter for the lesson. Thabo was able to compare what his mentor teacher told him (always to stand in front of the class to teach) with what a lecturer said (to move amongst the learners while teaching). He found that for him walking amongst the learners while teaching worked best.

The teaching practicum was generally felt to be a positive experience, in which, some declared, more was learnt than in three and a half years of being on campus. John is more certain now about teaching than he ever was – being in the classroom matched his PMTI so well that, despite hiccups regarding the mathematical content, every day was satisfying. Siphso found his mentor teacher to be a role model worth following, one whose example he could follow and yet who allowed him the freedom of operationalising his own teaching style. Thabo had much the same experience. His mentor teacher, a seasoned mathematics educator, would demonstrate what his years of experience had taught him. Thabo, fresh from the university campus would observe, assess, absorb into his PMTI what he thought worked, and then “I improve right then and there with whatever is being taught here at the university [sic]” (ISI, 6:64). It would seem as if he was comfortably able to straddle the gap in the “two-world” situation described by Feiman-Nemser (1987), by combining them to make his own “world”, suited to his PMTI. Martie did not find that the teaching practica influenced who she is as a teacher – she learned nothing new. Ayesha was unable to identify any particular aspects of teaching practice that helped her to develop as a mathematics teacher, although she did find the advice of the mentor teacher useful and practical – more so than her university training.

5.1.4 Influence of their view of mathematics

Ernest (1988), Thompson (2009) and Cross (2009) amongst others, describe a link between the way a teacher sees mathematics and the way she teaches, ranging from an instrumentalist or traditional view, where mathematics is seen as a set of unrelated procedures and rules which have to be learnt, through the Platonist view or formalist view (Cross, 2009) where mathematics is also seen as a set of rules and procedures, but which must be understood, to the problem-solving or constructivist view, where mathematics is a “process of enquiry” (Thompson, 2009) of which learners should make sense and enter into for themselves.

These three views were found within this group of students, although not without a blurring of the lines of distinction between them. Martie, for example, sees mathematics as “a way of thinking” in which one learns how to “analyse situations”. Yet she sets great store by methods that produce the right answers: “I like to be right!” It would seem that most of her beliefs regarding the subject fall into the constructivist category, with apparently some leanings towards a formalist/Platonist viewpoint. Ayesha, by contrast, sees mathematics as being about numbers and what one does with them on various levels of complexity. It is not finite – but only because new technology allows us to work with numbers we were unable to access comfortably before. She appears to be a traditionalist or instrumentalist, yet without excluding the idea of exploration and creativity. Thandi holds some of the same beliefs: “It’s the study of numbers...” useful for dealing with “things that happen in real life” and a part of science, because it “changes with time and with discoveries” (SSI, 5:6). A possible categorisation of Thandi’s beliefs about mathematics would be both instrumentalist/traditionalist and Platonist/formalist in that she seems to see it as a set of rules concerning numbers, yet believes that understanding is important in order to make sense of the subject in terms of reality. Thabo also speaks of “a science of numbers” (SSI, 4:7), however, he expresses the thought that it helps to solve real-life problems. He sees mathematics as a vast open system about which he believes he knows too little. It would seem then that his view is constructivist, as is John’s. John sees mathematics as the connectivity between aspects of the real world, giving value to things so that they can be placed in equations “for us to link things to each other” (SSI, 2:7). Siphso also believes in the inextricability of mathematics from real life. He adds two other descriptions of his view of the subject: “It’s the logic behind reasoning” and “an art of science” (SSI, 3:55). He does not seem to think that mathematics can be confined to a set of rules and procedures, yet it is governed by logic and reasoned explicabilities.

It would seem that these students’ views of the subject have been largely influenced by what they have heard and learnt at university. Not one of them, for example, even hinted at the linking of mathematics in the classroom with the real world being a notion established in their beliefs during their own schooling. The notion of making mathematics relevant to the world of the learner is therefore one they encountered at university. Ayesha and Thandi have settled in their minds that mathematics education is about learning and understanding the rules and any linking that takes place must be entirely functional - to the point of being ineffective in its brevity.

5.2. The students' perception of their PMTI's

The students' beliefs and perceptions about themselves in terms of the three aspects of PMTI (Mathematics Specialist, Teaching-and-learning Specialist and Carer) which are studied in this research are not necessarily consistent with what was observed in their classroom practice. These beliefs are clustered and held in such a way as to be an intrinsic part of who they think they *are* as teachers, but, paradoxically, not necessarily of what they *do* as teachers. Therefore, if Palmer (2007) is to be believed and “we teach who we are” (p. 2), then, in some of these cases, there are more deeply held beliefs which form the real “who we are” as opposed to the “who we think we should be”, the former of which being the one that is observable in the classroom.

The table below shows how these students ranked the three aspects of their PMTI. All of them placed Mathematics Specialist first, although Thabo said Mathematics Specialist and Teaching-and-Learning Specialist were equally important in his PMTI, and Martie declared all three aspects equal in hers. The other four placed Teaching-and-learning second, and caring last.

Table 16

Results of the ranking exercise

MOTIVATING INFLUENCES	MARTIE	AYESHA	THANDI	THABO	JOHN	SIPHO
MATHEMATICS SPECIALIST	1	1	1	1	1	1
TEACHING-AND-LEARNING SPECIALIST	1	2	2	1	2	2
CARER	1	3	3	2	3	3

5.2.1 As mathematics specialists

Although all six believe that being a Mathematics Specialist is the foremost aspect of their PMTI, they do not all believe that they in fact *are* such specialists. It would seem that they recognise the importance of this aspect and what its position should be in their PMTI even implying that the other two aspects of PMTI are dependent on this one, but they have doubts about their ability to live up to

the level of mathematical expertise that the term implies. For instance, Ayesha explained as follows: “... I *want* to be a subject specialist; I *want* to know my work” (ISI, 1:34). Yet she believes that, because she is able to field learner questions successfully, she in fact *is* a subject specialist. Thandi said almost the same thing: “I *should* be a subject specialist to be able to teach learners good [sic] in school. I *should* be well equipped with the subject knowledge that I can pass on to my learners” (emphasis added) (Q, 2:72). However, she found out during the practica that, in this regard, “lots of work is required before one goes to teach in schools...” (Q, 2:72). She felt that her lack of mathematical expertise was a problem because it meant that she had to research each topic before she taught it, but she could also rationalise her lack of expertise by indicating that this meant she was able to identify what was difficult for the learners because it was also difficult for her. Thus, “I can see [I am] a good mathematics teacher *because* I’m still learning mathematics, I’m not a specialist” (Emphasis added) (ISI, 2:22). John also recognised his inadequacies as Mathematics Specialist, as testified to by his mentor teacher: “He hasn’t come here pretending to know it all. He’s come with questions...” (Mentor Teacher interview, 1:20)

Martie, Thabo and Siphon were the most confident regarding Mathematics Specialist being who they are as mathematics teachers. Thabo indicated that he found it easy to teach because he understood the intricacies of what he was teaching: “It will be easy for me to teach [sic] if I have a sound knowledge of the subject” (Q, 2:124) and he believes his knowledge of schools mathematics is good. Martie is aware of the emotional aspect associated with the learning and teaching of mathematics: “People in general have this psychological block against, well, mathematics” (SSI, 7:116). She, however, loves mathematics and is fully persuaded of her expertise in the subject. Her mentor teacher in fact repudiated Martie’s ranking of the three PMTI aspects, saying that in fact these three aspects were not on a par in her PMTI – she was predominantly a Mathematics Specialist. Siphon believes himself to be “covered in that department” (SSI, 3:477) when it comes to knowledge of his subject.

These students attach great value to “knowing your subject”. They all seem to believe that a mathematics teacher who is not a Mathematics Specialist is not a good teacher. However, the belief that this aspect of PMTI should be the most important does not necessarily *make* it so in the

individual. When the six participants were interviewed as a group, they emphasised the time required to prepare and to know what to teach and how to teach it. John explained as follows:

I spoke to my mentor teacher and it takes years just to put a file together that you know the work and that you can actually just stand in front of the class and say, right, today we're doing this. And to be able to do that is just, takes time, patience and a lot of effort and, ja, you've got to develop every single aspect of yourself, of your teaching of...you've got to get your personal life in order just to be the teacher. You have to just bring everything together just to make a difference. (Group interview, 1:189)

His colleagues were in agreement – being a Mathematics Specialist means more than just knowing the rules. It also requires understanding applications of the rules and being able to make those applications clear to others; it is more than just being able to do sums on paper: “It’s all nice on paper, writing exams... but once we go there [into a classroom] Ma’am, it’s different...” (Group interview, 1:147). It would seem that the students had come to understand that being able to do sums was not necessarily all that is required to be a Mathematics Specialist. One has to combine that ability with knowledge of how to make the subject accessible to learners.

5.2.2 As Teaching-and-learning Specialists

The six participants all seem to believe to a greater or lesser extent that they know how to teach mathematics. They believe that they have the necessary skills and techniques to convey information successfully. Most of them acknowledge the value of university modules in which they learned about how children learn. None of them mention their lack of experience in this regard. In fact, most of these students referred directly or indirectly to an instinctive knowledge of how to teach. Ayesha went as far as to say that, “One can’t really teach someone how to teach, I think it comes to you naturally...” (ISI, 1:48).

Martie, who reported that her university training added very little if anything to her knowledge base, admits to having acquired different methods for teaching specific topics, which she finds useful because she believes that learners learn in different ways. While still a learner at school, teaching her co-learners, she was successful because she could *explain*. She had a better idea of how to help the

learners understand than did the teacher. So she perceives Teaching-and-learning Specialist to be part of who she is, and that her expertise in this regard was increased by psychology modules which did not form part of the BEd programme. Ayesha sees herself as a natural teacher, but also espouses the notion of repeated explanation to facilitate understanding. At the same time, discipline is vital in her understanding of what it means to be good mathematics teacher. She described her understanding of discipline during the group interview:

You should be strict for discipline in class because they need to listen to you but you should also be approachable because if they don't understand anything, they need to ask you and if they're too scared to ask you, you're not doing your job. (Group interview, 1:201)

Thandi also indicated that the use of different methods for explaining a concept was the correct way of teaching mathematics. However, it would seem that neither what she heard at university nor what she observed her mentor teacher do could be readily accepted into her understanding of teaching-and-learning expertise. In fact, she declares that, "You can see the other teacher doing...teaching in this other way and then when you try it and then it won't work for you [sic]" (SSI, 5:123). The solution lay within her own PMTI: "You have to develop your own way of teaching that the learners would understand..." (SSI, 5:123). Thabo's dominant belief is that lessons should be learner-centred, something he learnt about at university. In the group interview he described how he has learned to use different strategies in keeping the focus in the learners and their understanding:

I've also realised in terms of the teaching strategies that we have to vary the strategies to accommodate all the learners because now, as he [John] was saying, the learners sometimes they could give you that look with which they can be quite... in a way that you'll see that they don't understand anything. So you must start asking them questions or you must try to explain whatever you're explaining in a different way and then if you've got more time you can even go through in their groups and then try to engage with them... (Group interview, 1:70)

His own schooling was teacher-centred and described by him as boring. Looking back at the teaching style he used as a learner replacing the teacher, he describes *himself* as boring. John is concerned about boredom too. His dominant belief is in the necessity of creative involvement of the learners in every lesson. Involving individuals and solving misunderstandings on a one-to-one basis is not only important for the learner, but satisfying for the teacher:

In that instant? You see almost a light go on above his head, it's like ka-ching! He's won the lotto or something, he just lights up, ja. Everything, his whole facial...his body language- from slouching down just looking at the work, to all of a sudden sitting up like this, and telling you exactly what you've just done. (Group interview, 1:66)

Sipho is driven to teach in such a way that the learners are continually encouraged, and so he has adopted a teaching style which can best be described as entertaining. In the group interview he explained that it is vital to adapt to the 'audience': "You have to be flexible and for me, then, you can't really say what does it mean to be a teacher because it changes every day, it changes with every class" (Group interview, 1:86). He sees himself as someone who knows and loves his subject and who knows and loves the learners, particularly in view of their cultural diversity, so his Teaching-and-learning role is characterised by his determination to integrate these two loves – the subject and the learners. John believes that if he misses the signs signifying confusion in the learners, the lesson itself is affected:

You can see it in the children's attitude towards the work, towards what you're saying, you can see their facial expressions. I've picked up on a lot of negativity in the class, as soon as something goes wrong everyone starts throwing their toys out the cot, so to speak, so the atmosphere gets ruined and then you have to start over from the beginning, just so that they calm down, and step by step manage to process everything that you've said. (Group interview, 1:56)

Generally speaking, all six participants have sustained the effect of their own schooling in this aspect of their PMTI's. Their experiences as learners created in them an understanding of how to teach (John) and how *not* to teach (the other five students). They have also, to varying degrees, made some of the theory they learnt about at university, like learner involvement and making mathematics relevant to the learners' world, their own. Added to this are also their own personalities: Martie is friendly and wants everyone to understand; Ayesha is strict and wants her classes to be very disciplined so that she can teach; Thandi is aloof and wants the learners not to bother her; Thabo is kind and serious and wants everyone to enjoy the subject; John is caring and wants everyone to be at ease in his class; Sipho is jovial and wants everyone to understand that they are of equal value to him.

The teaching practica also brought about change in the Teaching-and-learning aspect of their PMTI. For example, in the group interview the students discussed the notion of right and wrong in the

mathematics class: when they were learners themselves there was no grey area in this regard, yet now they have come to understand that right and wrong should be traced to thinking processes and differently constructed understanding. Siphso explains how he dealt with a specific learner:

The way he was approaching the problem, well, as a teacher you know... so some of them they're not logical but that doesn't really mean that his answer's wrong, his thinking is wrong. He is correct, you just have to understand, that's why you have to be very flexible. You have to understand why. (Group interview, 1:170)

So, in terms of their PMTI's, there appears to be an amalgam of what they understood and accepted as true about teaching - while still learners, while in the lecture hall, while in the school on teaching practice - combined with their own personalities that has made them who they are at this point as teaching-and-learning specialists.

5.2.3 As Carers

With the exception of Thandi, all the participants frequently expressed their concern about the learners and their involvement in the lessons, as well as their own involvement with the learners, despite the fact that all (apart from Martie, for whom all three aspects were equal) of them placed this aspect below the others in their ranking exercise. There is an awareness among them that mathematics is not universally loved by learners, and is in fact often associated with fear or boredom. There is therefore a noticeable inclination to "make a difference", to involve the learners in an enjoyable way and to help them to experience mathematics as challenging rather than frightening. Martie, for example, recognises that the negative emotions associated with the subject may also be attached to the teacher and does her best to show herself as a continually, smiling, caring, approachable teacher.

John stands out in this regard: in his own words, "Being a pastoral role is for me the main thing" (ISI, 4:20) He, perhaps because of his own experiences as a quiet, introverted learner at school, is predominantly concerned with reaching out to the learners through relationships, possibly

established on the sports field rather than in the classroom. In the group interview he described a situation in which the “pastoral role” had to take pre-eminence over the lesson itself:

JOHN: ...if a child is upset he doesn't learn. I did an actual lesson with a boy where he just broke up with his girlfriend ...And he sat in my lesson and I asked him to do this and I tried to interact with him but there was just no breaking through that feeling that he had right there. So the learning went out the window, eventually I said...

INTERVIEWER: How did you find out that he had broken up with his girlfriend?

JOHN: Well, he told me and we'd talk a lot and he told me and, ja, after that he just wrote down stuff so I said, you know what, go home, think about it, don't worry about this work. (Group interview, 1:158)

Thabo, also concerned about the learners, is driven to see the learners understand mathematics the way he does, to see them love the challenge and rise to it: “I prefer involving the learners because I believe if they're involved in the lesson they learn more than when they're just listening” (ISI, 6:72). As he speaks of helping learners to understand, he sits forward in his chair, becomes more animated:

...even after school I'll make time for them so that I can help them with those problems. If I'm not able to help them at that time, I'll promise them that when I go home I'll find information about that and then when I meet them again I'll explain it to them. (ISI, 6:48)

Sipho, denigrated at school because of his colour and despite his mathematical prowess, is determined to ‘make right’, to treat the learners with respect, to the point of trying to speak their various languages even if they are far removed from his own. His school experiences were “an eye opener so I just decided that I wanted to make a change, make a difference and to prove that particular teacher wrong...” (ISI, 5:28). He believes that making the effort to understand the language of someone else is a sign of respect: “So with the language, taking just the language into account, I try to accommodate them” (ISI, 5:64). Sipho is very aware that in the class he is dealing with real people:

SIPHO: I experienced that it is very different in theory and in practice, very different. You know, in theory we would say, this is how it should be... but once you're there, hey, challenges are...you have to cater for each and every individual.

INTERVIEWER: Because you're dealing with real people.

SIPHO: With real people, real situations... and no theory can account for that because it changes every time. (Group interview, 1:23)

Ayesha and Thandi are somewhat different. Ayesha, while believing that “children are my second passion” (ISI, 1:23) and expressing her willingness to be available to them and to help them overcome the learning impedimenta resulting from the fact that “some people are depressed, some people have ADHD and ja...” (ISI, 1:15), holds herself aloof from her learners. This may be attributable to her belief that teachers should be moral preceptors and role models for their learners. In the group interview she explained:

And it’s not like we all have perfect lives so everyone has their problems and we need to be a little more understanding to the children. Firstly because, mostly because they’re not adults. Some of them don’t even know how to deal with these problems so we have to care for them and ja... (Group interview, 1:139)

Thandi expresses her beliefs regarding caring only in theoretical terms: “It is part of every teacher in each and every learning area, even mathematics. Learners are made up of their social space/world” (Q, 2:77). When pressed to explain what this really means to her as a teacher, she goes no further than to say that if someone is sleeping in her class she would want to know why, in case “that someone is dying and I’ll be responsible” (ISI, 2:28). She evinces no understanding of the link between the theory of learner involvement and actually caring for the learner.

There is a considerable range of beliefs regarding this aspect of PMTI discernible in this group of students. At the one extreme there is a deep conviction that relationships are the basis for effective teaching (John) and at the other there is the belief that the learners are in the classroom to learn, and that is all (Thandi). In between these two poles is the general belief that teaching should focus on the learner and his/her needs if effective learning is to take place.

In a general discussion about the three aspects of PMTI (Mathematics Specialist, Teaching-and-learning Specialist and Carer) during the group interview, all the participants concluded that not one of the three aspects outweighed the other in importance. Siphon explained succinctly, “They’re all equally important; you can’t really assign value to it” (Group interview, 1:113). Thabo had changed his original opinion (see Section 4.1.4.2) to the following stance:

I can say they are equally important, that you have to know your subject, you have to know how to teach, and then you have to also take care of the learners because now if they've got problems and then you don't take care of those problems it will be difficult for them to learn. So I think they're equally important. (Group interview, 1:105)

John was more expansive in his description of how he now understood these issues:

So you've definitely got to know your subject whether you...you've got to know how to teach the kids first of all. So you've got to know how to interact with them, how to deliver that knowledge to them so that they will understand and be able to take that knowledge forward, not just lose it the moment they walk out your class type of thing ... you've got to know the feeling, the atmosphere, the child's sense of being in that class- what's happening with him, all the type of stuff just to make him comfortable enough to actually want to learn the subject. And that in life will make things go easier but ja, now that I think about it, they all have to be equal, need to be on one page. (Group interview, 1:103)

5.3 Actualisation of their PMTI's

All six students were observed teaching mathematics in the schools to which they went to do their teaching practica. "We teach who we are" (Palmer, 2007, p. 2): the objective in observing these students in action in the classroom was to see how the 'who we are' is revealed in 'how we teach'. "Nebulous" is the adjective used by van Zoest and Bohl (2005, p. 318) to describe the art of teaching. In this study, the students' PMTI is further examined as it actualised in the classroom and is revealed through that art. In investigating the three aspects of PMTI as identified by Beijaard et al. (2000), a recognisable identity begins to materialise.

5.3.1 Mathematical expertise

The undergraduate mathematics curriculum for pre-service teachers is designed to take the students well beyond what is required at school level, so that they have a perspective on the content they will eventually teach and will have an understanding of school mathematics that is enhanced by the mastery of mathematics at a higher level. It is the assumption of the university's curriculum designers

that the basics, such as, working with the four basic operations or dealing with rational numbers, are in fact in place. However, this is not necessarily the case, despite the fact that all six participants passed their final mathematics modules at Third Year level. Thandi, for example, by her own admission, finds the subject difficult and challenging: “I have to learn everything [before a lesson] and then go to the learners and then present the lesson and I know where I maybe find the chapter difficult and stuff. Then I go to learners and when I explain I know which parts are difficult and stuff [because I found them difficult myself] [sic]” (ISI, 2:22). The absence of a broader knowledge is observable in her classroom practice – glaring mistakes are not corrected. For example, a learner whom she invites to do a trigonometry sum on the board labels a right angled triangle incorrectly: the hypotenuse he labels ‘opposite’, the opposite he labels adjacent; Thandi makes no effort to correct him until the mentor teacher calls her over and asks her to fix the mistakes on the board. Questions that lie beyond the prepared scope of the lesson are ignored: while a learner is doing another sum on the board, another learner asks Thandi a question regarding the relative positions of the reference angle and the sides. She looks blankly at the questioner and turns to watch the learner at the board. She is also seen to refer frequently to her file during the lesson, availing herself of prompts for the next part of the lesson. At the other end of the spectrum lie Martie and Thabo, whose facility within the subject is equally observable. In fact, in Thabo’s case, the concern expressed by his mentor teacher was that he frequently overestimated the level of understanding of his learners, resulting in miscommunication:

MENTOR LECTURER: ... Thabo knows the subject mathematics very well. He can be good to lecture the university students [sic] ... He is good in teaching, but leaves the learner behind. (Mentor Teacher questionnaire)

Although all six students said that subject expertise was their top priority, there are shortcomings in some of them in terms of their expertise in this regard. John, while making no mathematical errors in his teaching, is aware of the fact that he ‘does not know it all’, asks questions of his superiors and attempts to fill the gaps in his knowledge with research; Thandi has to study each topic in several textbooks before she ventures into the classroom and is unable to answer questions which lie beyond the scope of her pre-lesson study. By contrast, Martie, Thabo, Ayesha and Siphon are extremely confident of their mathematical expertise in the classroom, based both on their achievements while still learners themselves, and on their success in the tertiary-level modules they completed. Martie, in

particular, says, “I’m absolutely sure that I know what I’m doing.... and I know, well, I’m good at what I do. Um, I know what I’m teaching them is right...” (SSI, 7:328)

Ayesha has a formal approach to both the subject mathematics and the way it is to be taught, and even tends to be traditional in her presentation of the concepts she is teaching. Martie is also formal in her approach in that she is, by preference procedure and process orientated, while simultaneously being focused on bringing the learners to a point of understanding. Thandi’s approach to mathematics in the classroom is defined by the limitations in her subject knowledge: she teaches a concept and then allows the learners to develop the concept further while they work on the board and even answer questions. This is *not* in fact a form of constructivism in action: she is more at ease with the subject matter in hand when she does not have to present it herself. Thabo is also formal in his approach to mathematics in the classroom; he believes in teaching until understanding is reached, allowing the learners very little leeway for self-motivated discovery. John and Siphso, by contrast, teach by leading the learners to the discovery of the truth that they were intended to find as an outcome of the lesson. Both ask questions that prompt the learners toward understanding. For example, John in a discussion about algebraic fractions asks, “What is the value of the x – do you think it can be anything?” Their approach is certainly more constructivist than can be seen in the classroom practice of the other four students.

5.3.2 Teaching and Learning

From a purely visual point of view, these six students present completely differently in the classroom. Martie is friendly and outgoing, smiling frequently and encouraging the learners with gentle laughs and motivational words like “Of course!” and “Nearly there!”; a gentle shake of the head for “no” and a vigorous nod for “yes!”. Ayesha maintains a formal distance: she teaches from the front of the class, rarely leaving the space between the teacher’s desk and the board. Even the cardboard triangles she was using to illustrate a point were shown to the class from there. Her expression is friendly and her delivery calm and formal. John, by contrast, walks down the aisles of the classroom, engaging the learners by asking them questions and periodically making them laugh with his quirky comments. His delivery is animated and his facial expression is friendly, often lit up with smiles or laughter. Thabo also walks down the aisles in the classroom, despite the fact that his mentor teacher advocated

standing in one spot in the front of the classroom, teaching with visible enthusiasm and a smiling face. Thandi, however, smiles not at all, remains in front of the class, or to the side near the door, and teaches with a deadpan expression and voice. She only ventures down the beginnings of the aisles when the learners are writing down sums. Siphso moves all around the class, talking in an animated way and gesturing with his hands. He frequently bends over a learner's desk talking briefly to individuals here and there as he is teaching, not just when the learners are writing.

Teaching strategies

Despite her easy going manner, Martie's lesson structure is quite rigid. She believes in repeated explanation, but has developed a strategy in which she begins with the most straightforward explanation, "and then if they don't understand I'll go into more detail and do it in different ways" (ISI, 3:42). She encourages the learners to make little note "boxes" in their books: "Make yourself a little note, here's like a little step for you 'how to do' the specific sum" (ISI, 3:46). She believes that presenting a concept in different ways repeatedly will ultimately result in comprehension. As she teaches she asks questions prompting learner response in a leading way so that the learners 'get it right'. She is confident in what she wants to achieve in a lesson and how to achieve it: "I'm always certain about what they do and why they do it and all the kids are being able to think for themselves so that's better" (ISI, 3:50).

Ayesha believes in drilling steps: if a procedure is broken down into manageable and easy-to-remember steps, the learners will achieve the required results. Repetition of explanation is valued equally: "I explain to them as many times as they want to but I haven't reached a point where I can't explain to them anymore. But I hope that point never comes" (SSI, 6:406). However, she also wants to infuse understanding and enjoyment into the learning process, because this gives her satisfaction: "The actual teaching, I have experienced it quite a few times that after I have explained to the learners I see the "Oh!" and it feels so good to see that..." (ISI, 1:42). In fact, she says that if this strategy were to fail to bring about understanding she would not know what to do.

AYESHA: Ok, what I think would make me nervous is when learners don't understand.

INTERVIEWER: No matter what you do.

AYESHA: Yes, yes. When I don't know what to do with the situation, I think that would make me a little nervous. (SSI, 6:394)

In the observed lessons, Thandi tried to demonstrate the usefulness of the trigonometry she was teaching by relating the concepts to measuring triangular distances in the real world. She believes in demonstrating the relevance of what she is teaching: "So I'll say a good mathematics teacher is someone who is capable of relating mathematics to the real life situations" (ISI, 2:7). She does not repeat explanations, nor does she negotiate meaning with the learners in any way. She pauses for long periods while she is teaching, during which time the learners wait expectantly. Sometimes she uses these pauses to consult her file or textbook. Thandi's teaching follows the pattern of teacher-speaks-learners-do.

Thabo, while confident of the theoretical aspects of teaching and learning - "I have learnt skills and have knowledge in preparation, implementation and evaluation of the teaching and learning process" (Q, 1:127) - is nevertheless conscious of his lack of experience and knowledge when it comes to the actual teaching of mathematics:

INTERVIEWER: Ok, and at this point, although you're not experienced, do you feel you know how to teach mathematics?

THABO: No, I'm still willing to learn more. (ISI, 6:58)

He teaches with precision and great attention to detail, and, like Thandi, tries to link the mathematical concepts he is teaching with the real world. He strives toward learner involvement, but does not give them long enough to think before answering his own questions.

John, despite his claim of only having four or five good teaching ideas come to him during his tertiary training, uses several strategies while teaching. He believes in starting each lesson with an 'attention-grabber' like a riddle, a puzzle or a joke of some sort. He does not use a declamatory style of delivery, but conveys information through asking leading questions. Facts arrived at through this method he then writes down on the board in a clearly delimited space called the "knowledge box". Everything that is written in the knowledge box has been agreed upon by the class as understood and

accepted truth. He uses a laptop and a smart screen to bring all sorts of examples from the outside world into the classroom to make the lesson relevant to the learners and not boring.

Sipho teaches using whatever comes to hand to illustrate the concepts he is talking about. He is concerned about “the psychological part of it” and tries to make his lessons entertaining and understandable. The question that underlies his teaching, he says, is “what do you have to do in order for them to listen to you and how will you do it for them to listen to you and to understand it at the same time?” (SSI, 3:477). He therefore frequently changes the tone of his voice, his facial expression and his physical position in the classroom, all to keep the learners’ attention so that they can be brought to a point of understanding the concepts.

There is no uniformity in the actualisations of these students’ PMTT’s. Each one’s style and classroom dynamic seems to be influenced and guided by their own background and paradigm, of which their communal tertiary training appears to form just a small part. In fact, the one belief they all speak of and seem to try to bring into their teaching is the notion of making mathematics relevant by relating one’s teaching to the real world.

5.3.2.1 Evidence of understanding

Five of these students share an awareness of the fact that the mathematics classroom is diverse in terms of both culture and ability of the learners. Martie, despite having been taught about classroom diversity in the South African context at university, had not translated this information into reality. In the classroom therefore, she at first thought that she was just being confronted with learners who listened and some who did not. However, “Eventually I got [realised] that certain learners are slower than others” (SSI, 7:148). Here she applied what she had learnt in the psychology modules she did, and explained that some people can do with a direct explanation, while others require a creative one. The problem, according to her is that

...often the smarter ones would try to make things more complicated than they really are. Then you would have to find a way to get it almost up to their level to break it down again. So you just have to do different things. (SSI, 7:164)

Ayesha is also aware of this diversity: “There’s different levels, there’s learners that learn quickly, there’s learners that are learning slow [sic]. You have to explain to them two or three times, so [in repeating explanations] I was just keeping my options open” (SSI, 1:236). Thandi evinced no such recognition, although she did say that she believes some learners learn better when taught by other learners, which is why she invites learners to the board to teach and explain their answers to the questions. Thabo is certainly cognisant of classroom diversity in theory, but finds it difficult to accommodate this diversity effectively: “Then I must try to vary the teaching strategies in order to accommodate all of the learners in the classroom. [sic]” (ISI, 6:92). John is extremely aware of the fact that some learners experience more difficulty in doing mathematics than do others. Sometimes, he says, that same learner, “a kid that struggles to learn”, may be a good sportsman, in which case “You have a different view of them and you can focus on their strengths and bring it into the classroom” (ISI, 4:24). Siphos is acutely aware of diversity in the classroom, but rather from a cultural point of view than mathematical ability. However, he recognises that different abilities are present, and actively tries to avoid embarrassing learners whose abilities are not on a par with the others in the class: he avoids asking these individuals questions to “save their embarrassment” (SSI, 3:215).

Perceived indicators

There are a number of techniques that these six students use to determine whether their learners have understood the work or not. Thabo, for example is conscious of the class atmosphere: “the excitement, also the excitement in the classroom would show you that they’re they...they...they do understand the concept, they have grasped the concept” (SSI, 4:181). Most of the students however believe that body language is one of the most obvious indicators of understanding: Thandi explains, for example, “I read their faces if they understand, they’re with me or if they’re just lost...” (SSI, 5:71).

Eyes: Martie believes that the learners’ eyes reflect their level of understanding: “Um, you can see their eyes are either like it looks like a curtain hanging in front if they don’t understand and if they do understand you can see there’s somebody home” (SSI, 7:304). Thabo describes this as follows: “they give you that look, that weird look” (SSI, 4:185). Ayesha also looks at their eyes, but only, it would seem, as a confirmation of understanding: “They go ‘Oh!’ I actually love that look, I love it, it makes my teaching worth it...” (SSI, 1:351). John says, “I gather exact expressions. So as soon as I get those

expressions of blankness or don't-know-what-I'm-doing, I engage that child immediately and the mindset of the child and of myself just changes completely" (ISI, 4:68). His own presentation is thus changed by what he observes. He believes that, even if a learner does not fully understand, eye contact allows him to know "they're engaging, they don't understand, but they're still there" (SSI, 4:133).

Questions: Martie believes that it is important to listen to the kind of questions that learners ask – she says this gives her an immediate inkling about what they do not understand. Ayesha believes in asking chorus-type questions which she formulates by making open-ended statements that she pronounces with a rising tone to her voice like, "Angle A is equal to...?" or "Angle B is opposite Angle E, isn't it?" or "Side AB is equal to side BC, yes, no?" She says that she believes that this strategy is successful because it enforces discipline in the class - "Uh, the learners feel that 'she's on my back the whole time' and they do work, they don't mingle" (SSI, 1:253). Ayesha also uses individually posed questions as an aid to class discipline; the learners must "be awake and they'll think 'she might ask me now, she might ask me now'" (SSI, 1:134). John also posed questions eliciting a group response because he believes this strategy gives him an overview of the class: "I suppose it's to see where everybody is ... So in ...general you've got to have the whole class active in the role" (SSI, 4:125). To John this is essential, because "You've got to pick up why or how they're learning" (SSI, 4:133). Siphso believes that he can access individual problems just by paying attention to group responses. Thabo believes exactly the opposite: he asks questions of specific individuals because this, he says, allows him to determine whether they are 'with him'.

Homework: Martie found homework a good indicator of understanding: "I find very often that a lot of the children that goes home and doesn't do their homework are the ones that don't understand [sic]" (SSI, 7:300). Thabo, however, found homework useless because the learners did not do their mathematics homework anyway and so he had to try to help them finish all the work in class. The problem with rushing along in class, Thabo discovered, was that there was little time or opportunity to encourage the learners to be "critical thinkers" who reasoned things out for themselves.

Classroom patrol: Martie checks class work in two ways: she does classroom 'patrol', leaning over learners' desks, marking specific sums and answering individual questions; she also has the learners

write their answers to a specific question on a plastics sleeve with a piece of paper inside it, which they then hold up for her perusal from the front of the class. She believes it is important to ‘nip misunderstanding in the bud’ by dealing with it immediately during the lesson. Ayesha walks around checking books to see whether the steps she has taught have been followed, or, if not, whether the answer is still correct. This she sees as fool proof evidence of understanding: “I see that they have followed the steps or even if they did it another way and they still got it right then I know they have understood it” (SSI, 1:351). At the same time she gains an overview of the learners’ work and “if I see a common mistake I know I should emphasise on that [sic]” (SSI, 1:262). Thandi also believes in classroom patrol when the lesson is “done”, but while she does “give comments”, she feels, “I don’t need to give the learner the answer and then I will come back later and then check the answer if it’s correct[sic]” (SSI, 5:81).

All six of these students were very much aware of the need to find evidence of understanding of the concepts they are teaching. They use a variety of strategies to find such evidence, ranging from the observation of the learners’ body language to how their homework is done. However, in some cases the strategy seems more theoretical than practiced: Thandi, for example, at no point in the observations returned to a learner to see if his answer was correct; Ayesha, while receiving chorus answers to her questions did not actually react to the fact that probably half the class did not respond positively at all to her questions.

5.3.2.2 Teacher/Learner-centeredness

To several of these students, learner-centeredness does not just imply allowing learners to construct meaning for themselves, but also to encourage them to think for themselves: “There’s more to understanding the work... it’s about teaching them life skills...” (Martie, SSI, 7:284). John echoes this thought – he encourages his learners to be reflective: “If they...they are able to do it at that level, they can take that straight through their entire life” (SSI, 2:153). Nevertheless, the locus of control, in the sense that Thompson (2009) uses the expression – where the control of activities in the classroom lies – remains firmly in John’s hands.

Some of the students see learner-centeredness as learners responding to questions the teacher poses and involves little participatory initiative from the learners’ side. Ayesha, for example, explains her

involvement of the learners as follows: “Every time, almost after every sum I want to make sure they are following, I always ask them if they’re following, if they understand and if they have any questions” (ISI, 1:74). In fact, Ayesha believes that she needs to be talking most of the time if discipline is to be maintained in the class: “If I stop talking they stop listening, so that’s why I think I continue to talk” (SSI, 1:154). Learner participation therefore lies between strict boundaries in Ayesha’s class, otherwise she gives them “the look”. Thabo also believes that posing questions frequently implies that the lesson is learner-centred; according to him this strategy encourages them “to be critical thinkers, I think” (SSI, 4:113).

John takes a diagonally opposite view: “Not interacting with someone is...is...is one person talking at a time, is one person teaching a class of quiet kids” (SSI, 2:201). He believes in complete learner involvement throughout the lesson; this implies that from the moment the learners enter the class he sets out to “get” them with a riddle or puzzle, and then to hold their attention by drawing information from the learners through posing questions throughout the lesson. His technique makes the learners think that they have discovered the way a concept works by themselves. When a learner gives an incorrect answer, John invites him to reflect on that answer, asking, “Are you sure?” In this way, John believes, the learner gets a better ‘grip’ on the concept: “He goes through the whole process again checking and rechecking ... so in the end he figures it out for himself in his own head and then he comes with, “Oh yes! Ok, I know why...where I went wrong, why I went wrong” (SSI, 2:145).

Thandi believes that learner-centeredness means that individual learners should be allowed to come to the board, solving problems with the assistance of the rest of the class, because “they learn best when they hear stuff from their fellow...fellow learners” (SSI, 5:79). Thabo would like to involve the learners more, but says he lacks the skills to do so successfully, the truth of which was demonstrated in a videoed lesson. In the video clip he is seen to be linking hyperbolae to the making of lenses, as well as to the location of ships at sea with a programme called LORAN before the invention of GPS technology. He had hoped to draw the Grade 10 learners into discussion of the uses of hyperbolae, inviting them to “Look! Look at the shape!” and drawing pictures on the board of different lenses – but to no avail. The learners were unable to participate because the discussion was beyond their understanding and experience. However, he could have made the *very* examples that he used relevant

and interesting by, for instance, using spectacles worn by learners in the class as a starting point for a discussion about lenses; he could have found out how many of the learners had ever been to the sea/ on a ship or a boat and why it would be useful to employ this hyperbolic system to find objects at sea. Siphso also believes that allowing the learners to teach is a way of allowing them to demonstrate their understanding of the topic. At the same time, he believes it gives scope to a learner who is “jumping for attention” and who wants to be seen. Siphso’s open invitation for class participation often results in a sacrifice of class discipline. However, this is not of concern to Siphso; he wants to make the class “a little social; make them see it in a social way, more like chatting, talking to me and asking me about mathematics, the actual content, reality” (SSI, 3:271).

While these students have a strong sense of the ‘rightness’ of a learner-centred classroom, their interpretation of the concept varies dramatically. John, for example, believes in involving the learners through every step of the lesson, while Thandi believes her lesson is learner-centred if she gives the learners the opportunity to write sums on the board. For Ayesha, allowing the learners more scope for participation in the class means discipline problems – for Siphso that is no concern at all. Thabo’s own reserved nature and his misjudgement of his learners’ abilities makes it difficult for him to bring about the learner-centeredness in which he says he believes; while Martie has no such difficulties – her friendly and outgoing personality invites enthusiastic responses from the learners.

5.3.2.3 Flexibility

If flexibility in teaching can be seen as the teacher’s adaptability to situations that arise in the classroom, then such flexibility can be investigated in terms of planning and the preparedness to deviate from such planning. This preparedness may be closely linked to what the teacher believes is the purpose of such planning.

Martie, for example, believes that planning a lesson allows her to keep a few steps ahead of the cleverest learners in the class. This is also Thabo’s experience, based on the fact that, “There are learners in the classroom that would always like to challenge you to see whether uh, to see whether you...you...you are knowledgeable in the subject” (SSI, 4:201). Martie therefore sees a thorough lesson plan as providing a framework for being flexible: “If you have a framework on which to work, you can pretty much cover it any way you want.” If she is thoroughly prepared, she is able to field even challenging questions, and can offer a variety of mathematical strategies to do a sum, depending

on what the learners find easier. Therefore, Martie is seen to allow discussion around a method or concept in the classroom because her preparation is not narrowly focused on the precise lesson content.

For Thandi, the exact opposite is the case. In her case, planning means that a strict order of activities is established around which she then does extra research in order to be able to teach the lesson content. This includes finding real world examples to illustrate her lesson. In the classroom she can therefore not allow any deviation which might take the lesson beyond these strict boundaries, because it would then mean venturing into the unknown. Thabo also sees planning as providing the order of activities in the classroom, but to him this rather means that the lesson then proceeds in a logical and orderly fashion, helping him to remember everything that the lesson should contain. This is important to him because,

Mmmm, sometimes uh, I would forget about the...the...the important concepts that I have to involve in the...in the integration of the lesson. And then...and remember them towards the end of the lesson and then, but uh, as soon as I remember them in the lesson, I would...I would... I would tell the learners about it. (SSI, 4:257)

Sipho also associated planning with creating a sequence of events in the classroom; it provides a structure to “organise yourself”. However, to him this does not imply rigidity, since the presentation of the lesson content depends on the classroom dynamics: “A different audience and you present it differently. It ...it all boils down to...to the...to the audience, how they respond” (SSI, 3:356). If a problem arises with regard to understanding, the lesson plan comes to a halt, he says, since progress cannot be made before such obstacles are cleared out of the way.

Planning is necessary for the maintenance of good discipline, according to Ayesha: “You need to keep them busy and on their feet the whole time, so you have to be prepared for every lesson” (SSI, 1:362). If every moment is not planned and accounted for, she believes the learners may become unruly and therefore she would lose control of the lesson. For John, who actively promotes interaction, this is not a problem. His planning is designed to accommodate deviations: “As much planning as you can do, will never prepare you for the questions that boys ask...” (SSI, 2:241). For him then, planning provides a structure to which the lesson returns after such a deviation: “So,

you've always got to expect the unexpected but you've got to have that plan in place to go forward with your lesson." Planning does not provide certainty of what will happen in the classroom – the only thing he believes he can be certain of is the atmosphere he establishes there.

For Thabo, planning also means reflecting on previous lessons around a specific topic: "I would adapt and then change there and then because I would have seen my...my...my...my uh, mistakes there and then and try to fix those mistakes" (SSI, 4:249). Siphso sees reflection in a slightly different light. To him it means "keeping it fresh" (SSI, 3:356). Therefore, planning allows him to think of new ways of presenting a lesson, all of which must be equally flexible because, according to Siphso, one must be willing to adapt when working with a diversity of people.

Flexibility in teaching seems to be directly related to the degree of the student's comfort with the mathematical concept that is being taught. This, in turn, is strongly linked to their self-confidence. All except for Thandi felt that they could not easily be stumped by their learners regarding the mathematical content of a lesson. Ayesha, however, believes that a detailed lesson is essential and should be adhered to as a measure to maintain class discipline.

5.3.2.4 Evidence and purpose of caring

The pastoral role which the South African education department requires that teachers fulfil is subject to interpretation as to what its practical outworking may be. To one of the students in this study it means simply being approachable as she stands next to the learner's desk and looks at his mathematics exercise book. To another, it means counselling a learner, if called upon to do so, in terms of the issues in his life that may or may not have anything to do with the classroom.

Both Martie and John state unequivocally that learners cannot learn if they are upset. Therefore they, as caring teachers, have to deal with the issues at hand, if possible, so that learning can continue. For Martie this pastoral care includes the provision of a "safe" environment where confidences may be shared: "So I would like the learners to know that they're safe in my classroom, that around me there's a safe environment where they'd be able to confide in me and come talk to me about whatever" (ISI, 3:42). When asked whether he thought it is a good idea to be available to the learners outside of class, John explained that being an interactive type of educator means that "I'm there for

their whole experience of school.” That, he said, means that “I’m there for teaching, I’m there to help them with life as well” (SSI, 2:297). Thandi does not interpret caring like this at all. She believes that she needs to be approachable as a mathematics teacher, and, if absolutely necessary, will see a group of learners after class to sort out mathematical problems. She totally rejects the notion of being a ‘life counsellor’.

Most of these students recognise that mathematics is often associated with negative emotions. The confidence of a learner to tackle the work in her classroom is extremely important to Martie, because a lack of confidence, she believes, is associated with a poor performance. If issues crop up that undermine such confidence, like despair related to the difficulty of the work, or simply being ‘fed up’ with school, these emotional issues must first be addressed before any mathematics can be done. Thandi believes that she needs to be approachable in the classroom so that the learners feel at liberty to ask questions when she walks around the class and stops at desks here and there: “Ja, so if you are not approachable they won’t ask questions and then if you come to that desk and then they will try to hide their work because they are scared you’re going to make some comment which they won’t like...” (SSI, 5:91). These students believe that when a learner is resistant to mathematics, the outcomes of the lesson will not be achieved – not because the learner does not understand, but because the learner is not emotionally available for learning. Martie also associates the establishment of personal relationships with better results.

MARTIE: You give that child that little bit of extra personal attention they often tend to... um, develop better and they um, perform better and achieve better results... They do, they really do and they feel that there’s a connection, you really care about them, you really want them to get this. (SSI, 7:134)

According to John’s mentor teacher, John has been able to use the relationships he establishes with his learners as a strategy to gain their cooperation: “He’s used a very gentle humour even though many of our boys are not gentle and he’s been able to connect with certain key figures in the class so that he’s got them on his side and that’s been a very good” (Mentor Teacher interview, 1:16). John believes firmly in the value of establishing relationships; he says it makes teaching and learning easier because the learners are willing to “engage”. In building relationships on the sports field, John

believes he creates a bridge over which learning can take place: “So you have a different view of them and you can focus on their strengths and bring it into the classroom” (ISI, 4:24). This “different view” of the learners also applies to John himself – his learners can see *him* differently: “It makes the boys more comfortable to ask questions in class, in other words, I’m not just this figure that just stands up there, and if you put up your hand you’re shaking already just to ask the question” (SSI, 2:209). Thandi, however does not believe in the establishment of relationships at all: “No, I don’t. No, I don’t, just be professional and approachable and then learners will be able to approach you... relationships, no” (SSI, 5:155). In her opinion such relationships can too easily be interpreted as favouritism. She does not believe that she needs to be available after class other than if a group of learners need mathematical assistance.

Thabo believes that caring is all about encouragement; it gets results in terms of achievement in the mathematics classroom: “Then the performance changes because of that” (SSI, 4:177). For this reason Thabo believes in being available after class, although the interaction is never on a personal basis. Despite the fact that he, like John, makes every effort to know the learners by name and to set them at ease so that they can talk to him freely, “It was mainly about mathematics, it was mainly about mathematics” (SSI, 4:305). For Siphso, encouragement had a more personal purpose. He believes that as a Carer he should strive to see that learners are not “crushed” in any way in his classroom. He values each learner and wants them to experience his classroom as a place of safety where they are able to risk being themselves and saying what they think or feel: “They all have to contribute something in the classroom” (SSI, 3:231). In particular, Siphso strives to overcome barriers based on language and colour differences.

However, there is a danger attached to caring, particularly for the inexperienced young teacher. Familiarity can very often be the result. A professional distance needs to be maintained. As Martie explains, “You need a line” (SSI, 7:268). She sees this “line” as enabling her to show the learners that “they’re not my buddies.” So, “if I need to be strict, I’m going to be strict and if I need to be honest and you’re doing something wrong I’m going to be honest enough to tell you that...” John gets to know his learners by name in order to establish an immediate rapport with them: “I got one of the boys’ names he immediately opened up to me and then we started a whole learning thing going back and forth on the sports field” (ISI, 4:36). However, John is cognisant of the dangers of over-

familiarity: “It’s a very dangerous place to be [while] keeping the professional boundary, but it’s a necessary place that you should be at” Martie draws the line at being available for casual communication purposes after hours: “There are hours when I’m going to be available um, if you really do have a crisis it’s ok um, but otherwise don’t” (SSI, 7:376).

Summary

Influencers: According to the conceptual framework, there are three parts to the study of PMTI: what its influencers are, what the individual perceives it to look like, and how it manifests in the classroom. In the six cases in this study, trends could be identified in terms of influencers, despite the maximum diversity of the sample.

- All six were influenced by their schooling
- All six were influenced by the society of which they are a member.
- All six want to make a difference
- All six are driven by passion of some sort: for teaching (Martie and Siphon), for mathematics (Martie, Thandi, and John), for children (Martie, Ayesha and John)
- Each one had been changed by the BEd course in some way: all through the acquisition of education vocabulary like ‘learner-centeredness’, Martie through learning self-discipline, Ayesha and Siphon through the educational psychology modules, Thandi and Thabo through learning about the theory of teaching and John through learning to take his studies seriously
- All but Martie found the teaching practica to be more useful in terms of ‘how to do it’ than their tertiary training. Martie said she did not learn anything new while on teaching practice.

Three of the students (Thabo, John and Siphon) found the teaching strategies they learned about at university to be useful, and they applied these to their own classroom practice. Martie, however, declared that she had learned nothing new at university; the teaching strategies she used in the classroom stemmed either from what she learned at school, or from what she developed herself. Both Ayesha and Thandi speak highly of the teaching strategies and learning theory they had studied at university, but neither demonstrate application of such theory to their own classroom practice. For instance, learner-centeredness is something they both laud, but both are instructors who do not enter

into noteworthy interaction with their learners since they both see mathematics as largely a study of rules.

The way these student view the subject mathematics is relevant to who they are as mathematics teachers, as Ernest (1988) postulated. Both Ayesha and Thandi have a traditionalist or instrumentalist view: mathematics is a set of rules and facts to be used to achieve a certain purpose, although Thandi also focuses on the link between mathematics and the real world, which indicates a tendency towards a Platonist/formalist viewpoint. Martie, in her description of her view of mathematics, speaks of a way of thinking, allowing one to analyse situations. However, she also sees mathematics as something that can be learnt and known, as she has done and about which she can say, “I like to be right!” By contrast, John, Thabo and Siphon see mathematics as vast, unknowable and intrinsically linked to the real world – the problem-solving view.

Perceptions of their PMTI's: Martie was the only student who ranked all three aspects (Mathematics Specialist, Teaching-and-learning Specialist and Carer) of her PMTI equal; the other five ranked Mathematics Specialist first. Martie, Thabo and Siphon were the most confident of their mathematical expertise, while the other three, Thandi in particular, were aware of shortcomings within their knowledge. All six students were in agreement that just knowing mathematics was not enough to make one a good teacher – one has to understand how to make it accessible to the learners. All six students believe that they have an instinctive knowledge of how to teach. However, they attested to the usefulness of teaching strategies that they learned about both at university and from their mentor teacher, provided that these could be assimilated into their own individual teaching style. Two students (Thabo and Martie) ranked Teaching-and-learning Specialist equal to Mathematics Specialist, but the other four ranked it second to Mathematics Specialist. The students have retained in their PMTI's the images of their own schooling, and their perception of who they are as Teaching-and-learning Specialists is filtered through that lens: Martie sees herself as a better teacher than the teacher who could not explain; Ayesha believes she is a more learner-centred teacher than the person who taught her at school; Thandi believes she knows how to teach and can make a difference by not skipping work in the textbook as her Grade 12 teacher did; Thabo learnt to love to teach while his teacher was absent; John was taught well and so must also teach well; Siphon was taught in a negative, degrading manner – he teaches in a way to create a positive, encouraging

environment. All six students appear to be conscious of the fact that learners need encouragement and that those who are upset or in trouble in some way are not able to learn as they ought in the classroom. They all perceive themselves as caring professionals. In the cases of John and Siphon, Carer seems to be on the forefront of their PMTI's. Martie and Thabo, while caring for their learners, are not driven by this care as are John and Siphon. Ayesha, despite her declared love of children does not seem to be particularly caring other than in theory, and in Thandi's PMTI the Carer aspect seems to be hardly developed at all.

Actualisation of their PMTI's – mathematics expertise: These six students present varying levels of mathematics expertise. Thandi, for example, finds the work difficult and has to research the content very carefully before each lesson. She also does not seem to perceive mathematical errors in the work done on the board by learners. Thabo, Ayesha, Martie and Siphon demonstrate a facile handling of both the mathematical content and the questions that arise in the classroom, and are confident of their ability to handle any problems the classroom may present in this regard. John is not very confident when discussing his mathematical knowledge, but is able to conduct his lessons with no hint of mathematical uncertainty.

Actualisation of their PMTI's – teaching-and-learning strategies: John, like Siphon, leads the learners to understanding of the concept he is teaching; the other four students have a formal approach to the teaching of mathematics, tending not to involve the learners in the actual 'teaching' part of the lesson. It is therefore not surprising that these four students also tend to be Explainers. All six have adopted strategies which they believe facilitate learning: Martie explains and re-explains, recommending that the learners take notes; Ayesha believes in drilling concepts; Thandi tries to relate concepts to the real world, and allows learners to explain their understanding by doing examples on the board; Thabo also tries to link mathematics to the real world, asking questions but without giving the learners enough time to think and answer before he answers his own question; John starts a lesson with an "attention-grabber" and proceeds to teach using leading questions, the answers of which yield facts to be written in the "knowledge box" area on the board; Siphon walks around the class, talking, waving his arms about, stopping to chat to individuals while he checks their work, all to make his lessons fun and to keep the learners attentive. All except Thandi believe that different

strategies are necessary in a classroom where there are learners of differing abilities and learning styles.

Actualisation of their PMTI's – evidence of understanding: These six students have also come to accept certain indicators as evidence that the learners have understood the concepts in question. Ayesha, Martie, Thabo and John take note of the expression in the learners' eyes. Martie listens to the kind of questions the learners pose, while Ayesha, Thabo, John and Siphon pay particular attention to learner responses to chorus-answer questions *they* pose. Martie finds homework useful as an indicator of understanding; Thabo does not – he finds the learners do not do the homework, so he has to help them finish the work in class anyway. Martie, Ayesha and Thandi do 'classroom patrol', checking learners' books as they work. In this way it is possible to see immediately if steps are being followed correctly or not.

Actualisation of their PMTI's – teacher/learner-centeredness: All six students also espouse learner-centeredness as a theory. However, they do not seem to have the same understanding of what learner-centeredness means. To Ayesha, it means the learners answer questions she poses; Thandi believes that her classroom is learner-centred because learners do sums and explain their work on the board; Siphon also uses this strategy, but does so because he believes it gives him insight into learner understanding. Thabo experiences difficulty in making his lessons learner-centred, which he believes would be the right thing to do – he does not think he has mastered the skills to do so yet. John and Siphon involve learner from the beginning to the end of the lesson. Martie is friendly and outgoing, so the learners interact with her willingly throughout the lesson too.

Actualisation of their PMTI's – flexibility/rigidity: In planning their lessons, Martie, Siphon, John and Thabo believe that they are providing a structure from which they can deviate if necessary. Ayesha uses her lesson planning to make sure the learners are busy all the time – flexibility is not an option. Thandi does not plan her lessons to be flexible. Her planning is rigid around the content that she has prepared for the lesson. She is not comfortable with flexibility in her classroom practice. Much the same picture presents itself when it comes to evidence and purpose of caring.

Actualisation of their PMTI's – evidence and purpose of caring: Thandi is able to discuss the theory of the nurturing role to be played by a teacher, but she has no intention of implementing any such role if it requires more time than is available in class. Thabo and Ayesha are concerned about the learners for the sake of the mathematics on the grounds of learners not being able to learn if they are upset; Martie and John are concerned about the learners for their own sake. Siphso is driven to make sure all learners realise that he values them equally.

My perception of their PMTI's: What has become particularly evident to me in this cross-case analysis is how very closely linked the students' PMTI's are with their own personalities. Martie is cheerful and outgoing – she teaches with warmth and confidence; Ayesha is somewhat more reserved and teaches in a formal way; Thandi is sure of herself and quite determined to do things her way – she teaches without involvement with her learners; John is warm and caring and reaches out to his learners during every stage of the lesson; Thabo is quiet and reserved – he teaches with calm confidence; Siphso has an enthusiastic and effervescent personality and his classroom is a stage for him and his learners to engage actively in the work at hand. Each one wants to make a difference 'out there', each one has strong opinions about the right and wrong ways of teaching, all have been through the same tertiary training - yet each one is unique and distinguishable from the others.