6. Conclusions

The aim of this study was to investigate the professional mathematics teacher identity of students who have come to the successful completion of their BEd degree at UP, and to observe the actualisation of this identity in the classroom. The research began with questions which were designed to give insight into development of this identity as well as how the student herself perceives it.

Who is the pre-service teacher at the University of Pretoria in terms of her Professional Mathematics Teacher Identity and how is this identity actualised in the classroom?

a) In what way do the influencers of PMTI shape its development?

b) What are this student's perceptions of her PMTI?

c) How is this identity actualised in the classroom?

In order to answer these questions, I conducted an explanatory, interpretive case study in a single case, embedded design. I selected six students from the class of Fourth Year mathematics education students, basing my sampling on biographical information drawn from a questionnaire which was completed by the whole class. With these six students I then conducted individual interviews, prior to them leaving the campus to do their final two-term long teaching practicum at schools of their choice. During the practicum I observed each of the students teaching mathematics in that school, and I interviewed their mentor teachers who had also been asked to complete a short questionnaire regarding what they had observed of the student's classroom practice. At the end of the first half of the practicum, the students were again on campus and I interviewed them as a group. I interviewed them finally on an individual basis at the end of the practicum. The data gathered by these means were coded and analysed bearing in mind the questions on which the study is based.

This chapter is structured around these questions, answering each of them according to the conceptual framework. This is followed by a description of the implications of this study and finally a

discussion of the limitations of this study as well as suggestions for further research. This is, in effect, what Wolcott (2009) suggests: "a conservative closing statement that reviews succinctly what has been attempted, what has been learned, and what new questions have been raised" (p. 114).

6.1 Who is this student in terms of her PMTI?

The literature that formed part of this research (see Section 2.1) indicated that, despite all that is written about professional teacher identity, there is not much that is definitive (Fearon, 1999; Abdelal et al., 2006 Castanheira, Green, Dixon & Yeagerb, 2007, Beauchamp & Thomas 2009). Most of the authors who commit themselves to definitions rely on descriptions of the development or characteristics of such an identity to frame their thinking of what it is. I have found that PMTI emerges through study of certain describable aspects that are part of its constitution, as in fact posited by Beijaard et al. (2000), and that this strategy is what allows identity to be the "important analytic tool for understanding schools and society" of which Gee speaks (2000, p. 99). In this study, these aspects were: Mathematics Specialisation, Teaching-and-learning Specialisation and Caring. These were studied from two viewpoints: how the students saw themselves in terms of these three aspects - Beijaard et al. (2000) worked on the assumption that "teachers' perceptions of their professional identity reflect their personal knowledge of this identity" (p. 750) - and how these three aspects 'played out' or were actualised in their actual classroom practice.

In the literature (see Summary, Chapter 2) I find four major descriptive themes of professional teacher identity: the notion of this identity being at the cross-roads of what is personal and what is social; its changeability and susceptibility to context i.e. 'Who I am at his moment in this context'; the idea that there are certain aspects of this identity that are rigid and do *not* change; and ultimately 'we teach who we are' or self-in-practice i.e. the postulation that identity is seen through function. In the four diagrams below I link each of these themes to my findings, showing that these themes are to be found in the results of this study, and that my study confirms the work of the academics mentioned.

Teacher identity in the literature: Interaction between the personal and the social

References:

Ernest, 1988; Wenger, 2000; Chanfrault-Duchet, 2004; Smagorinsky et al., 2004; Walshaw, 2004; Lasky, 2005; Varghese et al., 2005; Timostsuk & Ugaste, 2010

(See Sections 2.1.2 and 2.3)

Link to findings of this study:

Personal history (schooling, family, culture); tertiary training and practica } *Society–based influencers*

↓

Influence PMTI, which is personal

For each of the students, in some way, the effect of *each* of the influencers on *all* aspects of their PMTI can be seen.

For instance, Martie:

Personal history - her teacher who was unable to explain well. View of mathematics } *This makes of her an Explainer*

↓

Affects Carer: interaction with learners is to help them understand her explanations

Tertiary training Teaching practica } *She claims have not influenced her*

↓

So Mathematics Specialist depends on her always being right, and Teaching-and-learning Specialist and Carer depend on her instincts.
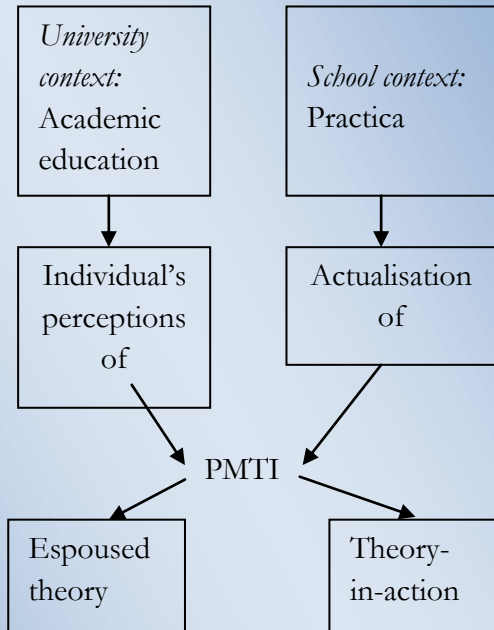
Teacher identity in the literature: Who I am at this moment in this context i.e. it is changeable and susceptible to context

References:

Boaler et al, 2000; Day & Leitch, 2001; Stronach et al., 2002; Danielewicz, 2001; Beijaard et al., 2004; Walkington, 2005; Roth & Lee, 2007; Ma & Singer-Gabella, 2011; Vloet & van Swet, 2010; Lutovac & Kaasila, 2011

(See Section 2.4)

Link to findings of this study:

University context: Academic education

School context: Practica

Individual's perceptions of

Actualisation of

PMTI

Espoused theory

Theory-in-action

i.e. the university student's PMTI in the lecture hall looks different from the student teacher's PMTI in the classroom.

All six students admit to changed PMTI since leaving Grade 12: their journey has brought maturity, self-discipline, knowledge of psychology and education theories.
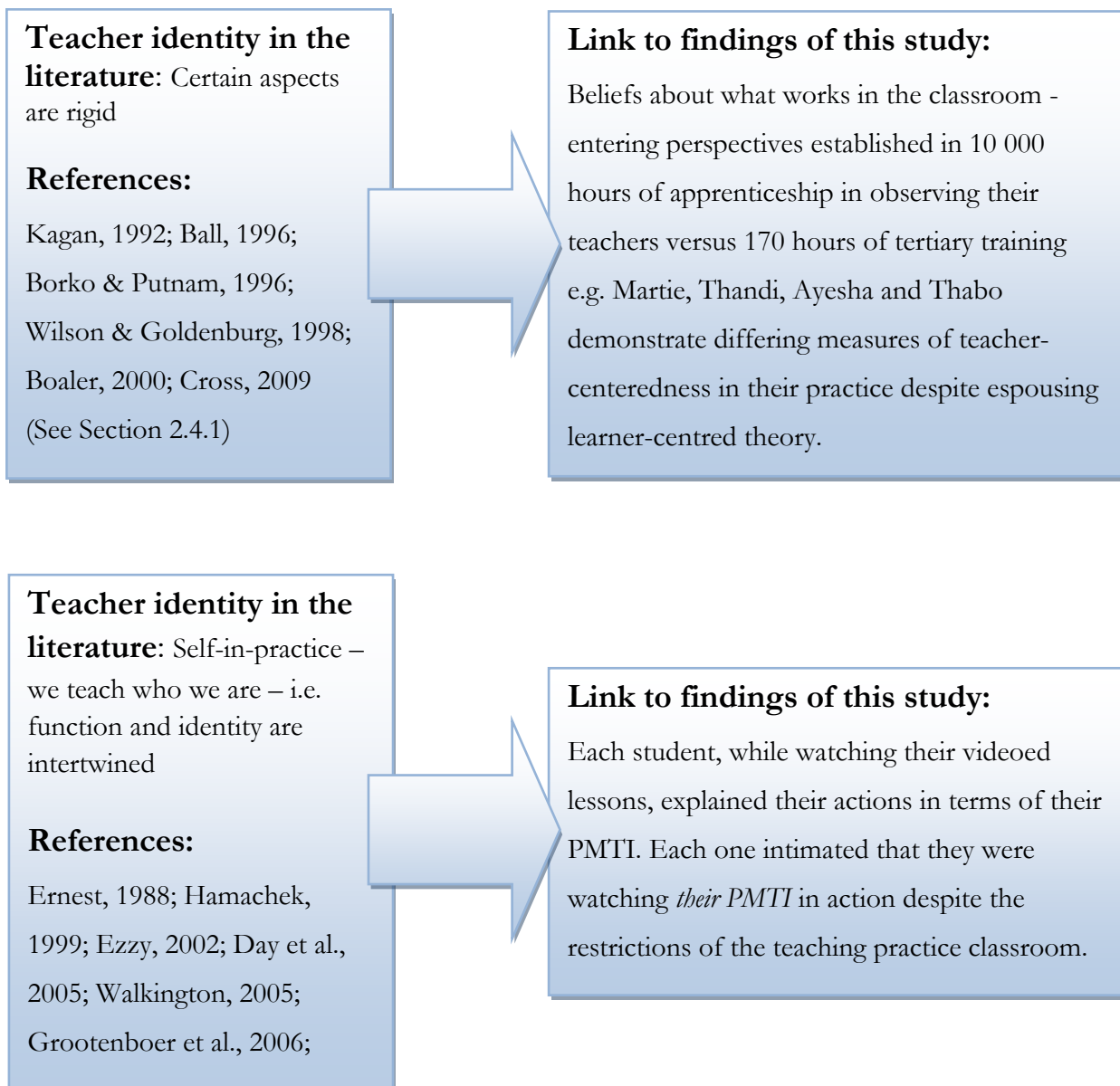
Teacher identity in the literature: Certain aspects are rigid

References:

Kagan, 1992; Ball, 1996; Borko & Putnam, 1996; Wilson & Goldenburg, 1998; Boaler, 2000; Cross, 2009 (See Section 2.4.1)

Link to findings of this study:

Beliefs about what works in the classroom - entering perspectives established in 10 000 hours of apprenticeship in observing their teachers versus 170 hours of tertiary training e.g. Martie, Thandi, Ayesha and Thabo demonstrate differing measures of teacher-centeredness in their practice despite espousing learner-centred theory.

Teacher identity in the literature: Self-in-practice – we teach who we are – i.e. function and identity are intertwined

References:

Ernest, 1988; Hamachek, 1999; Ezzy, 2002; Day et al., 2005; Walkington, 2005; Grootenboer et al., 2006;

Link to findings of this study:

Each student, while watching their videoed lessons, explained their actions in terms of their PMTI. Each one intimated that they were watching *their PMTI* in action despite the restrictions of the teaching practice classroom.

Figure 11. Literature linked to findings

However, the literature does *not* suggest that the perceptions of the individual's PMTI can be compared with actualised PMTI in the classroom to see if there are discrepancies. In this study actualisation was investigated in terms of several aspects, following the example of Thompson (2009): mathematical expertise, teaching-and-learning, including evidence of understanding, teacher/learner-centeredness, and flexibility, as well as evidence of caring, the latter in keeping with Beijaard's categories and the requirements of the national education policy of South Africa. This actualisation is discussed separately from the individuals' perceptions of their PMTI and discrepancies are pointed out in each case discussion in Chapter 4. Conclusions regarding these discrepancies are considered in Sections 6.1.2 and 6.2, following an analysis of the influencers of PMTI. As Beijaard et al. (2000) point out, PMTI does not develop in isolation, but is influenced by factors that affect its development. These influencers are discussed in the following section under three headings: Personal history, Tertiary training and Teaching practica.

6.1.1 Influencers

Four influencers of PMTI were examined in this study: the six students' personal history or biography, their experiences in the tertiary environment and teaching practica and their view of mathematics. The first three aspects were selected to parallel the three influencers identified by Beijaard et al. (2000), while the fourth one was promoted in the writings of such researchers as Ernest (1988), Thompson (1992) and Cross (2009).

Personal history: schooling

According to the literature (Knowles, 1992; Kelchtermans, 1993; Sugrue, 1997; Beijaard et al., 2004; MacGregor, 2009), students bring with them to university the influences of their past. The strongest influence for the six students in this study lay in their personal background, in particular their schooling, even if this was not explicit in discussions with them. The statements in the table below were not made by any of the students, per se, but are rather my interpretation of the information they imparted across the various communications with them. Each statement draws together the dominant element of the student's personal history with the dominant element in the actualisation of the student's PMTI.

Table 17

Personal history influencers: implicit statements

IMPLICIT STATEMENT	STUDENT
My teacher could not explain - I must explain	Martie
My teacher was a subject specialist and disciplinarian – I must maintain discipline and I must know my subject	Ayesha
My teacher had authority – I must teach so that I have a position of authority	Thandi
My teacher was often absent – I taught and liked it	Thabo
I was shy and retiring at school – I must reach out and draw learners out of themselves	John
My teacher was racist – I must treat all cultures and languages equally	Sipho

When Martie was at school, she found that her mathematics teacher was someone who struggled to explain a concept. Martie re-taught what he had tried to teach and derived great satisfaction from it. Martie is seen to teach with great enthusiasm and passion, and to be an 'explainer' – one who seeks to impart understanding of the mathematics concept in question. Ayesha is critical of her traditionalist teacher, yet she values this teacher's mathematical expertise and even her strictness. Unwittingly, she emulates her: in Ayesha's classroom practice she is seen to be a traditionalist or instrumentalist teacher who teaches for learner achievement by emphasising procedure. Thandi holds herself aloof from her learners – her interaction with them is limited to one direction only: she imparts knowledge to them. To her way of thinking, a teacher is 'somebody' in society, and relationships with learners have nothing to do with that image. Thabo's most vivid recollection of his schooling is of being given the opportunity to teach in the absence of his mathematics teacher: as a learner he excelled in the subject, and loved actually teaching it. When Thabo is standing in front of a class, his joy in both the subject and the teaching thereof is patently visible. John says he was a shy and reticent boy while at school, not drawn out of his shell by his teachers. The one aspect of John's PMTI that stands out in everything he says and does, is that he values relationships and strives to reach out to his learners on an emotional level. Sipho walks around the class, pausing to talk and laugh with individuals everywhere. He goes out of his way to show the learners that he values each one as an individual, showing that he as a young black man does not discriminate in any way between white and black learners, unlike his own high school teacher.

Personal history: career choice influencers

The factors which guided these students' career choice are also significant influencers of their PMTI's. For four of the students, their schooling was also a career choice influencer, either initially (Thandi, Thabo, Sipho) or later (Martie). At the same time, as discussed above, their schooling had a strong influence on their PMTI's. The society from which these students come (see Section 5.1.1) also influenced their career choice as well as their PMTI's, despite the fact that Ayesha was the only student who referred directly to her Indian culture in this regard. For example, in Thandi's community, being a mathematics teacher makes one "somebody"; in Sipho's background, classroom racism was evident and makes him determined to right that wrong; Thabo comes from an environment where education is a privilege, yet teachers are often not present in class; Martie and John come from societies where career choices are plentiful, thus the choice they actually made speaks of a real desire to teach. Smagorinsky et al. (2004) explain: "One's identity, then, is not simply the emergence of internal traits and dispositions, but their development through engagement with others in cultural practice" (p. 21).

Personal history: passion

The single factor which all six students claimed to recognise within themselves is the desire to "make a difference". They felt that there was that within their PMTI which made them inherently *teachers* and which received satisfaction from the "aha" moments when learners understood what was being taught. However, the passion that is evident in their discussion of their PMTI's is not necessarily about the same thing. For instance, Martie, Thabo and Sipho express their passion for teaching; John and Ayesha speak of their love for children and Thandi is passionate about the notion of being a teacher of mathematics.

Tertiary training and teaching practica

Of secondary importance in all of their PMTI's were their experiences both at university and during the teaching practica. While each of them developed a deeper understanding of the psychology of learning and teaching, the theories they professed to adopt did not dominate their classroom practice and were mainly evident in what they *said* in the interviews. In this regard, Ball (1988) calls teacher education "a weak intervention" (p.40), not changing the fact that individuals "are most likely to teach math just as they were taught" (ibid., p. 40). To some extent, the teaching practica allowed

them to weigh up what they had learnt in the university lecture hall (i.e. the theory) with what they saw and experienced in the school classroom (i.e. the practice). This is exactly what Feiman-Nemser and Buchmann (1985) call the two-worlds pitfall. For some, like Thabo, this meant that he could choose between these to do what worked for him. Others, like Thandi, claimed they could develop their own teaching style.

View of mathematics

Their view of the subject mathematics was generally not well verbalised and it would seem that they had given little thought to the notion of what mathematics really was in their understanding. Using Ernest's (1988) categorisations

- Instrumental view $\Rightarrow$ teacher instructor $\Rightarrow$ compliant learner
- Platonist $\Rightarrow$ teacher explainer $\Rightarrow$ learner receiver of knowledge
- Problem solving view $\Rightarrow$ teacher facilitator $\Rightarrow$ learner constructing understanding

as they apply to these six students, the following picture results:

Table 18

Application of Ernest's (1988) categorisations to these participants

STUDENT	VIEW OF MATHEMATICS	TEACHER ROLE	LEARNER ROLE
MARTIE	Platonist Problem solving view	$\Rightarrow$ Teacher explainer	$\Rightarrow$ Learner receiver of knowledge
AYESHA	Instrumental view	$\Rightarrow$ Teacher instructor Teacher explainer	$\Rightarrow$ Compliant learner
THANDI	Instrumental view	$\Rightarrow$ Teacher instructor	$\Rightarrow$ Compliant learner
THABO	Problem solving view	$\Rightarrow$ Teacher facilitator Teacher explainer	$\Rightarrow$ Learner constructing understanding Learner receiver of knowledge
JOHN	Problem solving view	$\Rightarrow$ Teacher facilitator	$\Rightarrow$ Learner constructing understanding
SIPHO	Problem solving view	$\Rightarrow$ Teacher facilitator	$\Rightarrow$ Learner constructing understanding

These six participants thus do not conform exactly to Ernest's model particularly in terms of the role they play in teaching the subject: the reason for this may be that Ernest based his model on seasoned teachers; these are pre-service teachers. Their views are somewhat inchoate; they are not firmly established in the sort of role that they will play as professionals. Ernest (1988) declared that "Teaching reforms cannot take place unless teachers' deeply held beliefs about mathematics and its teaching and learning change". It would seem that, in terms of pre-service teachers at least, these "deeply held beliefs" about the subject are not easily expressed by them, and that these beliefs are more easily studied through observing the way they teach.

6.1.2 The students' perceptions of their PMTI

As Mathematics Specialists

All these students prioritise being Mathematics Specialists. However, there are only three participants in whose PMTI's this prioritisation actually seems accurate. Martie, Ayesha and Thabo seem mostly concerned about the accuracy of content knowledge they communicate to their learners and the enthusiasm they are able to engender for the subject in their learners through linking the topics to reality. For Thandi, subject specialisation may well be important, but her lack of subject knowledge tells a story of its own: although she does emergency research in several textbooks before teaching a lesson, she has not made a concerted effort to change the overall level of her mathematics expertise. It has not, in fact, been important enough for her to do so. John says he believes that subject specialisation is of supreme importance, but this statement is belied by nearly every other statement he makes, which speaks of relationships and care. Sipho, while loving the subject, is continually occupied with redressing the wrongs of his learner-hood and making every learner in his class feel valued and worthwhile.

As Teaching-and-learning Specialists

Martie, the patient, friendly Explainer, expects her learners to listen carefully to what she says (and says repeatedly) so that they may be able to do the work correctly and achieve good results. Ayesha instructs. Her learners must at all times be busy and cooperative, so that discipline is maintained. Thandi also instructs, but without the mathematical knowledge to make her instruction coherent. Not only must her learners be compliant, they must teach large portions of the lesson as well. Thabo

wants to facilitate learner participation in a fully learner-centred lesson, but he pitches the content of the lesson so high that his learners are unable to understand - which forces him into becoming an Explainer. John truly is a Facilitator – his learners participate consistently, constructing their own understanding under his guidance. Sipho is a Facilitator, but is so focused on setting every learner at ease with his clowning (his own comparison), that, although the learners are constructing their own understanding, they do not have much time to do so.

As Carers

Martie demonstrates her care for her learners continuously - she encourages, smiles, draws them out with gentle humour, but does not encourage spontaneous interaction with the learners. Thandi, who evinces no interest in or rapport with the learners, speaks in glowing terms of the importance of the pastoral role of the teacher, "It is part of every teacher in each and every learning area, even mathematics. Learners are made up of their social space/world", but both declares and demonstrates that she has no intention of building relationships with her learners and will certainly not be available to them after class time. Ayesha is critical of the traditionalist or instrumentalist mathematics teacher she had at school, but is quite traditional in her own style of teaching and, although she considers her practice to be interactive, holds herself aloof from her learners and only interacts with them between very restricted demarcations. Thabo cares for the learners inasmuch as he wants them to do well – to that end he is willing to go beyond the call of duty to help them do so. For John, teaching is *about* caring and drawing reticent learners out of their shells. Sipho is passionate about making every learner in his class feel equally valued and appreciated.

In summary: While certain of these students say they *are* something which in fact they are *not*; others say they are definitely *not* something, which in fact they *are*. This mismatch within their own PMTI's is not evidenced by any apparent internal conflict. Where Beijaard et al. (2000) assumed that "teachers' perceptions of their professional identity reflect their personal knowledge of this identity" (p. 750), it is possible that the incongruence of their PMTI perceptions and the reality of their actualisation may be attributed to their *not* having "personal knowledge of this identity". Possible explanations for this lie within their inexperience: they have had very little opportunity to test the robustness of who they think they are against who they *actually* are in the classroom; they have acquired neither the habit nor the skills of true reflection. This brings into question the validity of

conclusions concerning professional identity that are based purely on narratives or personal perceptions of such an identity, such as those reported by Alsup (2006) and MacGregor (2009), in the absence of accompanying classroom observations. It is possible that what people *say* about their PMTI is not who they actually *are* in the classroom.

6.2. How are these PMTI's actualised in the classroom?

> When someone is asked how he would behave under certain circumstances, the answer he usually gives is his espoused theory of action for that situation. This is the theory of action to which he gives allegiance, and which, upon request, he communicates to others. However, the theory that actually governs his actions is this theory-in-use. (Argyris & Schön, 1974, p.6)

Often the espoused theory and the theory-in-use observed in the study of these six participants were not congruent. It may be concluded that, if Palmer (2007) is correct and actually "we teach who we are" (p. 2), then the "who we are" of four out of these six students is not who they *say* they are, judging by their teaching. However, when appraising their mathematical expertise in terms of their ease of use of mathematical concepts, it would seem that all six have a fairly accurate idea of themselves in this area. I suggest that the match between their perception of themselves as Mathematics Specialists and their manifested mathematical expertise is ascribable to the non-subjective nature of mathematics assessment. The students know full well how they fared in the mathematics modules at university. Martie, Ayesha and Thabo, and to a slightly lesser extent, John and Sipho express their confidence with the subject matter, and rightly so, if their observed practice and the observations of their mentor teachers can be counted as evidence. Thandi is equally accurate in her assessment of her own mathematical abilities –she finds mathematics difficult, and this is evident in her practice. Perceptions of Teaching-and-learning Specialist and Carer on the other hand, may be subject to nuances of opinion, beliefs and ideology.

All of them are confident of their teaching-and-learning skills, except Thabo, who says he is still lacking in this area. Nonetheless, Thandi's beliefs about herself in this regard are not all founded on evidentiary truth: she is so uncertain of her subject expertise that she pauses for lengthy periods

during her lesson, frequently consults her file and seems dependent on learner-teaching. All the students were, in varying degrees, aware of the diversity which categorises South African classrooms. However, other than explaining and re-explaining, the strategies of which these students speak for dealing with diversity are largely not visible. Sipho, however, implements different languages in his explanations in the hope of improving understanding.

All the students use general means of assessing whether their learners have understood the lesson; they look at body language; facial expressions and the look in the learners' eyes which indicates that they are "engaging" or not. They employ a variety of questioning techniques. Some of these students attach great value to chorus responses, like "yes" when the class is asked whether they understand. Mostly they believe that they are able to gauge understanding by checking the classwork done by the learners as they walk from desk to desk. However, their lack of experience has made them unable to determine whether these techniques give them an accurate picture of the actual levels of learner understanding in their classes.

All the students, without exception, believe that learner-centeredness in the mathematics classroom is appropriate and desirable. However, only John and Sipho actually demonstrate this in their classrooms. The other four students give little opportunity for learner discovery: they teach and explain, answer what questions there are and give exercises to be done as classwork. Two possible reasons are postulated for this disparity between belief and practice: these students may believe that they are in fact operating in a learner-centred way; or what they *say* they believe, and how they believe they should *act* are not integrated effectively in their PMTI's.

The students showed varying levels of flexibility in their classroom practice. For Martie and Thabo, planning allows them to be flexible in the sense of not being 'caught unawares' by challenging learners. John and Sipho plan for deviation from the lesson plan: they believe that a lesson plan provides structure, but not rigidity and they leave space to manoeuvre both for themselves and their learners in terms of the lesson plan. Ayesha and Thandi do not readily deviate in any way from their lesson plan: Ayesha because she needs to keep all the learners busy all the time for discipline reasons and Thandi because deviation from the plan would literally mean venturing into the unknown.

To John, the pastoral role is "the main thing". He is involved with his learners in the sense of caring about their daily lives and the issues they face. Martie and Sipho also care for their learners in that sense. They believe that a learner cannot learn if he is upset, and conversely, that achievement improves if learners are encouraged and comfortable in the class. Sipho strives to treat all learners with respect and concern so that each can feel free to contribute to the activities in class. Ayesha and Thabo, however, seem to see their caring role as assisting in the removal of obstacles to learning, rather than as involvement on a personal level. Thandi is not involved in nurturing of learners at all.

These students thus demonstrate that while they may certainly be teaching who they are, this is not necessarily who they *think* they are. They may believe that they are Mathematics Specialists, teaching-and-learning specialists and Carers, but when they are observed at work in the classroom these specialisations are not necessarily, or at least not consistently evident. There were six participants in this case study: each one holds their own beliefs in a unique way, and each one actualises their PMTI in a unique way. Six disparate PMTI's were examined, with very little commonality to be seen between them. Thus, while Beijaard et al. (2000) posit that "teachers' perceptions of their professional identity reflect their personal knowledge of this identity" (p. 750) on the one hand, and Palmer (2007) states that "We teach who we are" (p. 2) on the other hand, my findings do not refute the findings of these researchers. Instead, this study extends the findings of Cross (2009) who describes clusters of conflicting beliefs which co-exist in apparent harmony: I posit that PMTI based on espoused theory and the actualisation of that PMTI through theory-in-use can co-exist harmoniously *in the absence of a reflective practice*. Thus Beijaard and Palmer are both correct. However, investigating perceptions without a study of their actualisation and vice versa will result in an incomplete picture of PMTI.

6.3 Reflections

This study suggests that the professional identity of pre-service mathematics teachers can be specifically identified and investigated. More than that, it can be investigated in terms of the participant's perceptions and beliefs, which extends and confirms the findings of Rokeach (1968) and Albion and Ertmer (2002), as well as through the actualisation of this identity in the classroom.

6.3.1 Reflection on the conceptual framework

The conceptual framework, compiled by culling aspects from the research of such academics as Beijaard et al. (2000), Thompson (2009) and Ernest (1988), allowed for the investigation of PMTI in terms of three aspects: Mathematics Specialist, Teaching-and-learning Specialist and Carer, influenced by four dominant factors: the individual's personal history including schooling, her tertiary training, the accompanying teaching practica and her view of mathematics. The PMTI so influenced could then be observed in action in the classroom during the final teaching practica, and analysed in terms of five key indicators: mathematics expertise, evidence of understanding, teacher/learner centeredness, flexibility/rigidity in teaching and evidence and purpose of caring.

While this framework did not specifically address such aspects as norms and values, attitudes and emotions, which are mentioned by some researchers as part of PTI, these aspects nevertheless emerged in the study across the elements within the framework. I believe that the framework I used served its purpose well and allowed me access into PMTI in a way in which a less precise framework would not have done. However, during the initial interviews with the participants, a question was asked concerning the reason for which they chose mathematics education as a career. The answers this question elicited have proved to be significant and have provided one of the keys to understanding PMTI. In each case the reason for the career choice is linked to who the individual is in the classroom (see Section 5.1.1). For this reason, I believe 'Career choice reasons' deserves its own category under Influencers in the Conceptual framework. I also found that the students described their passion for some aspect of teaching – the conceptual framework does not provide a niche for discussion in this regard. Yet this passion is a significant part of PMTI and speaks of who the individual is as an educator. Such passion is both an influencer of PMTI and an intrinsic part of PMTI. It would therefore have to be represented in all three categories of the conceptual framework as an influencer and a part of PMTI which can be actualised in the classroom. The notion of personality is also not specifically addressed in the Conceptual framework, but in listening to the students speak and in observing them teach, it became clear to me that personality deserves recognition in the Conceptual framework.

6.3.2 Reflection on the methodology

My aim with this research was to investigate the PMTI of the undergraduate education student nearing the end of her studies. In order to do so, judging by the literature (Kvale, 1994; Patton, 2002), I needed to pursue a qualitative route allowing me not only to observe, but to *talk* to the students so that I could find out who they are as nascent professionals. Thompson (2009), for example, whose doctoral study is similar to mine in that she was concerned with what teachers believed that made them who they were in the classroom, chose case study as the most appropriate method to allow her to investigate this. Like Thompson, I believe that had I used only a questionnaire or non-qualitative methods I would not have gained access to the identities of the participants as I did. Instead, the questionnaire used in this research served only to provide contextualising information for a qualitative study. In retrospect, I see that it was useful to conduct both individual interviews and a group interview: as Morgan (1997) observed, it permits the researcher "to observe interaction on a topic" (p. 10). The students were enthusiastic in their responses to each other's' experiences and gave me the opportunity to listen to them discussing the teaching practicum in the light of mutual concerns and enjoyment.

However, in the use of a case study methodology, it is necessary to select a limited number of cases. I used the questionnaire completed by all the students in the sample to help me make my selection. Several possibilities presented themselves: a homogeneous group, or a randomly selected group in which homogeneity might have occurred inadvertently, or a purposely selected maximum variation subsample. In hindsight, I believe that the maximum variation choice was the right one to make: the participants in this study represented not only the diversity of student that characterises UP, but in fact mirrored the very nature of this country- only in this way is this group "typical". I was not seeking commonalities – I was interested in finding out what was "out there". These six students, as I had hoped when I began, could not have been more different from each other. By observing them and interviewing them, I could catch a glimpse of who they are currently and who they might become as established professionals. I learnt about how they thought and what motivated them to enter the profession in the first place. And, most importantly, I saw how the "who I am" became

"how I teach". It is as a result of the methodology used in this study that the incongruence between perceived PMTI and actualised PMTI came to the fore.

6.4 Conclusions

Having analysed the data and having reflected on the study as a whole, I find that seven major conclusions can be drawn from this research.

1. **The PMTI's of these six students are substantially *different*, despite the fact that their tertiary training has essentially been the same.** They were indeed selected to form a maximum variation sample, but that selection was based entirely on their *personal* backgrounds. The common ground they shared was, in fact, their training to become mathematics education professionals. However, personality, influencers and perceptions remain unique to each individual and these are the filters through which information is sifted for assimilation purposes. For example, there is a direct correlation between the dominance of Mathematics Specialist in the individual's PMTI and Mathematics Expertise (which is the result of university training) in the actualisation of that PMTI. I posit that this correlation is evidence of the above-mentioned filtering. Below are the visual representations of all the PMTI's that were studied. None are identical. The uniqueness of personal histories and perceptions leads to different PMTI's and different retentions of what is taught at university.

Martie's PMTI

Influencers

Biography:
Father;
Teaching while a learner;
Prominence of love for and prowess in maths

Tertiary environment:
Non-education psychology modules

Teaching practice:
Relationships with learners

View of maths:
Something to be loved/hated;
Platonist/ problem-solving

Maths Specialist:
I like to be right

Teaching-and-learning Specialist:
Explainer/ Constructivist
Confident

Carer:
Encouraging

Actualisation

Mathematics expertise:
Superior ability; confidence; no mistakes

Evidence of understanding:
Questions, eyes, written work

Teacher/ learner centredness:
Learner receiver of CORRECT knowledge;
Learner must understand

Flexibility/ rigidity in teaching:
Structured lessons, but deviates easily to solve problems;
Lessons must be participatory

Evidence and purpose of nurturing:
Smiling, non-judgmental;
In order to improve maths performance

Ayesha's PMTI

Influencers

Biography:
Father;
Culture;
Teacher-centred schooling

Tertiary Environment:
Education theory

Teaching practice:
Real world as opposed to university

View of mathematics:
Set of rules which can be learnt through procedures.
Instrumental/ Platonist

Maths Specialist:
I think I am a Subject Specialist

Teaching-and-learning Specialist:
Instructor/ Explainer

Carer:
Moral preceptor

Actualisation

Mathematics expertise:
Knowledge of procedure

Evidence of understanding:
Chorus questions, eyes, written work

Teacher/ learner centredness:
Repetition of procedures-teaches, learners listen

Flexibility/ rigidity in teaching:
Structured lessons, planned in detail to avoid discipline problems

Evidence and purpose of nurturing:
Non-judgmental, encouraging to obviate learning problems

High | **Medium** | **Low**

Thandi's PMTI

Influencers

Biography:
As a teacher one is SOMEBODY in the community

Tertiary environment:
Educational psychology waste of time, positive influence of subject content and methodology modules

Teaching practice:
not positive

View of mathematics:
Love of challenge
Instrumentalist

Maths Specialist:
Most important;
I *should* be good

Teaching-and-learning Specialist:
Instructor, Theoretical

Carer:
Theory

Actualisation

Mathematics expertise:
Many mistakes,
Acknowledged inadequacy

Evidence of understanding:
Facial expressions, written work

Teacher/ learner centredness:
Letting learners teach

Flexibility/ rigidity in teaching:
Planning = finding out how to do the maths, preparing links to real life

Evidence and purpose of nurturing:
Friendly to encourage work, but no relationships, no involvement

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Thabo's PMTI

Influencers		Actualisation

Influencers

Biography: Teaching while a learner

Tertiary environment: All good and useful

Teaching practica: Learning experience – combined mentor teacher's style with university theory to develop own style

View of mathematics: Love of challenge; Problem-solving view

Thabo's PMTI

Maths Specialist: Knowing maths makes teaching it easy

Teaching-and-learning Specialist: Passionate Facilitator Explainer

Carer: Always available, approachable

Actualisation

Mathematics expertise: Very sound; precision orientated

Evidence of understanding: Body language, questions

Teacher/learner centredness: It's all about them; participation

Flexibility/rigidity in teaching: Planning for structure; helps in classroom management

Evidence and purpose of nurturing: Available beyond school hours for mathematical assistance

John's PMTI

Influencers

Biography: Good schooling

Tertiary environment: Maturing process

Teaching practica: Frightening; Learning opportunity; Useful skills from university training

View of mathematics: Something to be explored, linked to real world; Problem-solving

John's PMTI

Maths Specialist: Perceived as most important

Teaching-and-learning Specialist: Facilitator Creative

Carer: Pastoral role "main thing" Relationships

Actualisation

Mathematics expertise: Sound

Evidence of understanding: Question techniques, behaviour, body language, written work

Teacher/learner centeredness: Total learner involvement; open communication, humour

Flexibility/rigidity in teaching: Plan for flexibility

Evidence and purpose of nurturing: Relationships on sport field carried to class; Rapport, "help with life"

High	Medium	Low

Sipho's PMTI

Influencers		Actualisation

Influencers

Biography: Racially prejudiced schooling – all learners should be respected

Tertiary environment: Educational psychology modules most useful

Teaching practica: Too short to build relationships; exercising of own style; learning opportunity

View of mathematics: Problem-solving; Something to be explored, linked to real world

Sipho's PMTI

Maths Specialist: Perceived as most important

Teaching-and-learning Specialist: Facilitator Dramatic

Carer: Pastoral role "main thing" Relationships

Actualisation

Mathematics expertise: Acceptable

Evidence of understanding: Choir response questions, learners teaching

Teacher/learner centeredness: Teacher dramatic actor, learners active participants

Flexibility/rigidity in teaching: Planning to be organised, but adaptable to audience

Evidence and purpose of nurturing: No racial prejudice – all learners treated with equal respect.
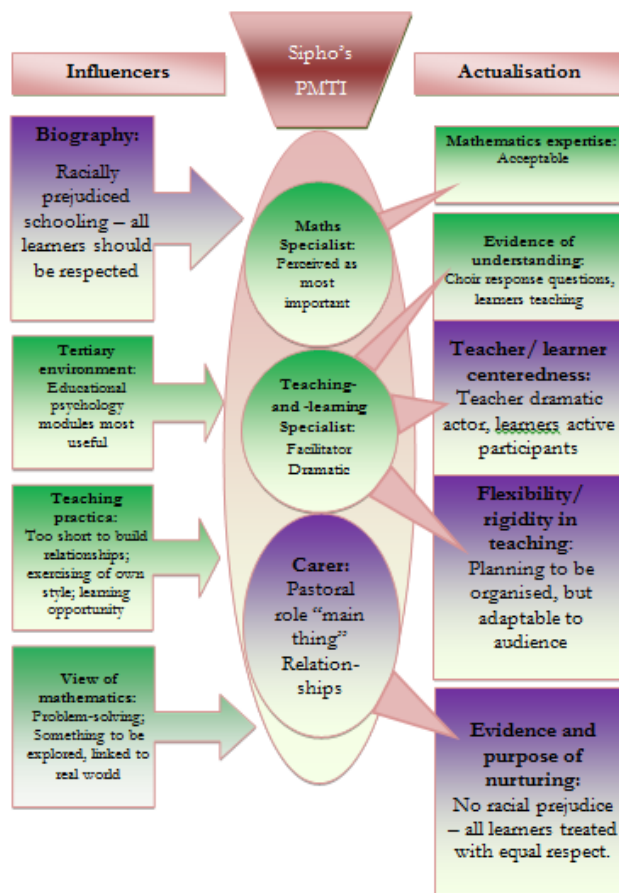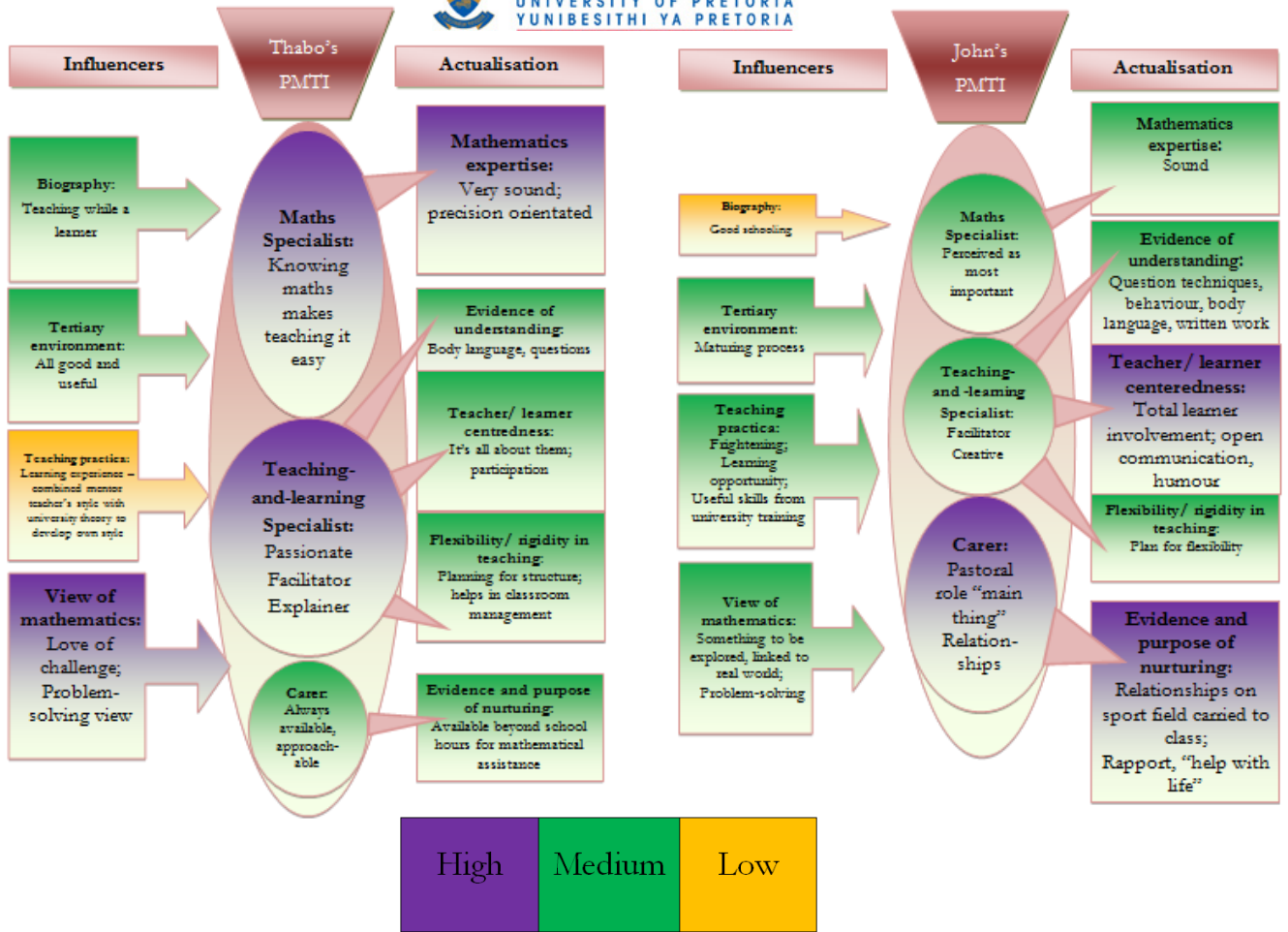
Figure 12. Visual representations of all six participants' PMTI's.

2. **PMTI is actualised in the classroom and is best observed through the individual's *interaction* with the learners.** It is through this interaction that mathematical expertise, evidence of understanding, learner-centeredness, flexibility and evidence of caring are seen. Literally, the actualisation of PMTI is the 'teacher-in-action' which is seen not in an empty classroom, but in the reciprocity of teacher-learner interplay. For instance, Martie ranks all three aspects as equal in her PMTI, yet in the classroom it is clearly observable that she is particularly concerned with the *subject* and making sure that the learners understand and are confident in her ability, as Mathematics Specialist, to teach them correctly. She focuses on mathematical 'correctness'.

3. **These students' perceptions of their own PMTI and the manifestation of that PMTI in the classroom are not congruent.** Using the terminology of Argyris and Schön (1974), their espoused theory and theory-in-use are not the same (see Section 6.1.2). It is certainly true that 'we teach who we are' but that is not necessarily 'who we say or think we are'. For example, Ayesha is critical of her teacher-centred high school teacher and speaks highly of the theory of learner-centred teaching in the mathematics classroom, but her own classroom practice is entirely teacher-centred; Thandi espouses a holistic understanding of learners who, she says, should be seen in terms of their whole world, yet she involves herself in no way with any part of the learners' world. Apparently these students are not yet capable of true reflection on themselves and their own practice; or that Beijaard et al.'s (2000) assumption that teachers' *perceptions* of their PMTI reflects *knowledge* of their PMTI does not apply to these student teachers. If this incongruence between espoused theory and theory-in-practice is to be addressed, 'reflective practice' needs to be more than another theory that is taught: students will need to be guided into practical means of reflection on their own practice.

4. **The most significant influencer of these students' PMTI's is a mathematics teacher or teachers they had as learners in high school.** Each one of the six mentioned the effect of their teachers in some way: Martie taught her classmates because their teacher was a poor explainer; Ayesha's teacher was a traditionalist who valued discipline and order – Ayesha emulates her despite her criticism of this teacher; Thandi's teacher omitted parts of the syllabus which she did not understand – Thandi works at sections she does not understand for *fear* of

emulating her teacher; Thabo's teacher was boring and frequently absent, during which time Thabo taught and acquired the taste for teaching; John's teacher was good, but did not particularly draw out the shy boy that John was – he wants to teach *as* well, but deliberately sets out to reach the withdrawn learners; Sipho's teacher was racist – Sipho is principally concerned with demonstrating his unprejudiced appreciation for each of his learners.

5. **Career choice is a key to understanding PMTI.** The motivation evinced by each of these students in selecting mathematics education speaks to who they are as educators. Martie came to teaching through trial and error, but found her niche in *explaining* the complexities of a subject she likes. Ayesha based her choice on traditional cultural considerations, and teaches in a traditional way. Thandi needed to be a professional with authority and interaction with children was not part of that need; Thabo and Sipho wanted to make a difference and to teach would allow them to do so at the level where they had experienced lack in their own lives. John enrolled for teaching by serendipitous accident, but found that teaching allowed him to combine his passion for sport with a need to involve all learners in the classroom, and so he did not return to engineering, his original career choice. His ultimate career choice thus resonated with his desire to make a difference to young people and to share his mathematical knowledge with them in such a way as to make their learning enjoyable. The question, "Why did you decide to become a teacher?" is one that elicits answers which may point to prominent aspects within the individual's PMTI.

6. **Beliefs are an intrinsic part of PMTI.** Core beliefs about the way mathematics should be taught and what makes a good mathematics teacher are developed early in the individual's professional thought processes and are not swayed by subsequent espoused or 'believed' theory. Beliefs regarding the subject mathematics, for example, were seen to follow the categorisations suggested by Ernest (1988) and were shown in this study to be significant in the individual's PMTI (see Table 17). Such beliefs, according to Ernest, also have implications for classroom practice. In linking beliefs to classroom practice (see Section 2.2), it follows that if classroom practice needs to change, beliefs need to be influenced first, as Stipek et al. (2001), Kagan (2002), and O' Connor (2008) suggest.

7. **The influence of the mathematics methodology modules is not as evident in these students' PMTI's as expected**. For instance, while the students have taken on board the notion that a slavish adherence to the textbook does not make for a dynamic classroom practice and they try to relate what they are teaching to the learners' reality, learner-centeredness and constructivism are interpreted according the individual's paradigm. Thus there is not a direct correlation between Teaching-and-learning Specialist and the actualisation of this aspect of PMTI in the classroom, despite the individuals' recognition of the validity of the teaching and learning theories they learnt about at university. Thandi, for example, believes she is practicing these teaching theories when she allows learners to do uncorrected sums on the board and to answer their classmates' questions. Ayesha and Martie believe their classroom is learner-centred if the learners are allowed to ask questions after the concept has been taught. Thabo confesses that he does not really know how to make the lesson learner-centred.

It has been important for me to investigate the PMTI of my students so that I could better understand the effect of my own practice as a teacher educator. Vloet and van Swet (2010) express this idea as follows: "Gaining insight into the rather new research domain of professional identity development is important, for it could provide effective tools to educational professionals to cope with changes in their practice, especially when stimulated to become change-agents themselves" (p. 150). This has led me to the following conclusion.

In final retrospection of this study particularly with a view to the major researchers and the literature in this field, the work of two academics comes to mind. Beijaard et al. (2000), in formulating a framework for PMTI with three aspects that I have interpreted as Mathematics Specialist, Teaching-and-learning Specialist and Carer, have provided the basis for study. I believe that these three aspects encompass what is meant when one speaks of a good teacher, with one reservation: the notion of passion - being driven to do something, the desire to make a difference - is not covered in these three aspects. The work of Ernest (1988) is fundamental to understanding how a mathematics teacher does the 'work of teaching' and how she views mathematics as a whole: in other words, how her PMTI is actualised. In this study the research done by both Beijaard and Ernest proved to be invaluable not only in the investigative process – looking at what is 'there' – but also in the theorising process – understanding what is seen. Thus: Beijaard I see as the major contributor in terms of the

constitution of PMTI; Ernest as the major contributor in terms of its actualisation. Influencers of PMTI, forming the left-hand 'column' of my literature framework, are also discussed by Beijaard et al. and Ernest, as many other academics do (see Section 2.5), but career choice as an important influencer is largely neglected. In this study I have found career choice motivators to be fundamental in providing insight into the individual's PMTI. My study contributes in this regard by positing that investigating PMTI necessitates study of both the constitution of this identity (what the individual's perceptions of it are) and its actualisation (what it looks like in the classroom). I also propose that the notion of passion must be accommodated in investigation of the constitution of PMTI and that the question, "Why did you decide to become a teacher?" be posed when researching the factors that influence PMTI.

6.5   Recommendations for policies, practice and research

The first three conclusions suggest that a 'one-size-fits-all' model of teacher training is in fact not effective – the students are unique individuals and their "entering perspectives" cause them to filter course content in a unique way. Mathematics teacher training should be 'tailor-made' to help *all* students, irrespective of their personal backgrounds, to become the kind of teachers that would make a difference to mathematics education in this country. The thought occurs that if the methodology modules were to become more "practical" as several of the participants suggested, it may be that their tertiary training would make more of a difference. To find a solution that would work in the context of South African mathematics education is a subject for possible further research, since such solutions do not appear to abound. "How should teacher preparation programs be designed to ensure the graduates become expert teachers? A recently released volume by the American Research Association indicates that the question is not even close to being answered empirically" (Hiebert, Morris, Berk and Jansen, 2007, p. 47). There is more to training pre-service mathematics teachers than just increasing their knowledge of mathematics and education theories (Da Pont, Oliveira & Varandas, 2002; Schepens et al., 2009). These students need to be guided into becoming good teachers, teachers who will make a difference to mathematics education in this country. In this regard, Beauchamp and Thomas (2009) recommend the following for teacher education:

We must then try to incorporate what we know about the contexts and communities and their influence on the shaping of teacher identities into our teacher education programmes to prepare new teachers for the challenges of developing strong professional identities in positive ways. (p. 186)

Such an 'incorporation' of the influencers in the individual's personal background will bear much further investigation – backgrounds in South Africa, as shown in this study, are truly diverse and taking them into consideration in the structuring of a methodology course will require the inclusion of practical modules in which students can share their beliefs about mathematics and its learning and teaching as well as their PMTI and what its influencers are. Research needs to be conducted into how the background diversity of students in South Africa can be specifically provided for in their tertiary training. This implies curriculum changes and time allocation modifications within the programme. However, if positive change can be wrought in the effectiveness of the tertiary training of pre-service mathematics teachers as a whole, then such policy and curriculum modifications are worth it. Three recommendations are thus to be made here: the diversity of personal background influences needs *further investigation*; *practical modules* need to be introduced in which students can share their perceptions about mathematics and how it should be taught; *curriculum changes* need to be made to accommodate these modules.

Conclusion 3 points to a need for tertiary training to involve more 'teaching sessions' in which students are given the opportunity to teach a lesson, observed by colleagues and recorded, so that they are given a different perspective on who they are in the classroom. Further research into this possibility will show whether the implementation of such an *'in-house' practicum module* will result in a closer congruence between theory and practice in these individuals' PMTI.

Conclusion 3 also has implications for future research. This study proves that incongruence between *perceptions* of PMTI and *actual* PMTI as manifested in classroom practice is a real possibility, in which case *research of professional teacher identity which does not include observation of the teacher-in-action is incomplete*. Researchers in this area need to be conscious of the fact that what is described in personal narratives regarding PMTI may be idealistic rather than real, unless the individual is a truly reflective practitioner.

Conclusion 4 implies that teachers are being 'born' in classrooms. It follows then, that if change in PMTI is desired by government or other authority holders, change will first have to be brought about in the school classroom, so that learners who become teachers of mathematics will have their PMTI's influenced differently. It is possible that if learners are regularly exposed to good teaching, this strong influencer, apart from improving overall mathematical performance, may help to *engender* good teachers. Ball, Hill and Bass (2005) describe a similar situation in the American context:

> Equally unsurprising is that many U.S. teachers lack sound mathematical understanding and skill. This is to be expected because most teachers—like most other adults in this country—are graduates of the very system that we seek to improve. Their own opportunities to learn mathematics have been uneven, and often inadequate, just like those of their non-teaching peers. (p. 14)

One way of remedying this is *professional development courses offered to teachers*, in which the focus is not only an improvement in content knowledge, but also a concerted effort to affect beliefs regarding the teaching and learning of mathematics. If there is a need to change a teacher's classroom practice, it is necessary to first influence her beliefs (Stipek et al., 2001, Kagan, 2002). Bringing about change in the mathematics classroom is not an easy task and thus a cycle exists in which unsuccessful classroom practices may give rise to the next generation of unsuccessful practitioners. Hiebert et al. (2003) describes just such a situation in the United States:

> If mathematics teaching showed signs of continuing improvement and if students were learning mathematics well, the concern about the effectiveness of teacher preparation programs would be less urgent. But the average classroom in the United States reveals the same methods of teaching mathematics today as in the past" (p. 202).

With regard to Conclusions 6 and 7, the fact that I have gained insight, have experienced the "in-seeing" of which Rilke wrote, means that I have a better understanding of the beliefs that underpin the nascent professional identities of my students. Fives and Buehl (2008) suggest that "[u]nderstanding these beliefs in the context of learning to teach and their relation to other important outcomes (e.g. classroom practices, student achievement) can inform the development of learning experiences tailored to the needs of future and practicing teachers (p. 135). However, how does one change beliefs? The literature confirms that beliefs are highly resistant to change. At the same time, it is possible that while students attest to the changes their beliefs have undergone during the course of

their training, such changes are not detectable in their classroom practice. Albion and Ertmer (2002) propose a solution: "if beliefs are formed and developed through personal experience then it seems logical that changes in beliefs should be effected through experience" (p. 35). However, he too realises that this is easier said than done: "beliefs appear to be static, resistant to change, and generally not affected by reading and applying research" (p. 35). Therefore the task of the methodology lecturer is not an easy one, and no facile solutions have been found to work.

PMTI merits further study as it may, in a longitudinal study, become a *predictor of the longevity in terms of career of a mathematics teacher in South Africa*, as well as of the effect of changes in the curriculum: pre-service teachers are more comfortable with concepts they learned and worked with at school than with those they dealt with at university. Therefore, if, when they return to school as teachers, only to teach new material not dealt with while they were still learners, uncertainty in the classroom can result, as Thandi demonstrates.

6.6 Limitations of this study

This research involved only six participants in an explanatory, interpretive case study. Interpretation by definition means that my own views and opinions came into play whether I purposed it so or not. According to Denzin and Lincoln (2003) this is part of being human: "To not make judgements is to lose sight of one's orientation in moral space, which is to lose one's grounding as a human being" (p. 445). Because of the smallness of the sample, generalisation of the findings is not viable. Also, the data may, to an unavoidable extent, be skewed because of my presence in the classroom – the Hawthorne effect. To minimise this, the camera was always stationed in the back of each classroom and I strove to film as unobtrusively as possible, being careful to be quiet and to remain immobile until the end of the lesson. A further limitation, which may also be seen as an advantage, lies in the fact that these students all knew me quite well. The impartiality of my conclusions may therefore be called into question; however, their familiarity with me also gave them the liberty to talk to me without reservations. In an effort to counteract a possible lack of impartiality, raw data and conclusions were discussed with fellow educational researchers.

The fact that only a limited number of lessons taught by these students was observed is a twofold limitation: firstly, by its very nature, teaching practice does not provide incontestable evidence of the student's PMTI because the student is operating in someone else's classroom, under someone else's practice requirements and with learners who are used to the ways of someone else. It is possible that under these circumstances impressions may be given which are not absolutely true in every respect. For this reason, the mentor teachers' opinions were also invited: they spent weeks with these students, observing them teach and holding discussions with them. Secondly, watching a student teach for just a few hours does not allow for a full spectrum of classroom behaviours to be observed – situations in which the learners demonstrated frustration or total incomprehension of a topic, such as do occur from time to time in the mathematics classroom and with which the teacher has to cope, were not observed.

Final Word

I believe it to be appropriate to end this study with the quotation from the poem of Rainer Maria Rilke (1987) in which is described a "*kind of in-seeing...seeing into the heart of things*": this research has afforded me the opportunity of *in-seeing*, not only into the thinking and practice of my students, but into my own practice and its effectiveness.