

**Professional mathematics teacher identity in the context of pre-service
training**

by

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Abstract

This study investigates the development and nature of Professional Mathematics Teacher Identity (PMTI) in pre-service teachers. It is an explanatory, interpretive case study in which six Fourth Year mathematics education students participated. PMTI is examined in terms of three aspects: Mathematics Specialisation; Teaching-and-Learning Specialisation and Caring, and the actualisation of these aspects is analysed in the context of the teaching practicum classroom. The effect of each student's personal history, their view of the subject mathematics as well as their experiences during tertiary training and teaching practica is probed. Of these, their experiences as learners in school were found to be the most influential factor, both on their initial career choice and who they are as mathematics teachers.

Main findings of this study are firstly that personal histories and perceptions lead to different PMTI's and different retentions of what is taught at university; that PMTI is observed in interaction with the learners, and that the students' self-perceptions are not congruent with those aspects as actualised in the classroom. For example, all six espouse the theory of learner-centred classrooms, but only two of them truly put this theory into practice in their own teaching, thus demonstrating that espoused theory and theory in action are not necessarily the same. It was also found that the mathematics methodology modules completed by these students were unable to shake entrenched beliefs with which the students enrolled at university. Factors determining career choice were key to understanding PMTI, as were the beliefs with which these students began their tertiary training.

Key Words: Professional Mathematics Teacher Identity; Pre-service; Influencers; Actualisation; Teaching Practica.

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List of abbreviations

BEd – Bachelor of Education, a degree course offered at the University of Pretoria

DoE – Department of Education

FET - Further Education and Training

JPS – Professional Studies: a module that is taught in the BEd programme

OPV – Education: a module that is taught in the BEd programme.

PMTI - Professional Mathematics Teacher Identity

PTI - Professional Teacher Identity

SMTE - Department of Science, Mathematics and Technology Education

UP - University of Pretoria

1. Introduction and contextualisation

“Who is the self that teaches?” is the question at the heart of my own vocation. I believe it is the most fundamental question we can ask about teaching and those who teach – for the sake of learning and those who learn. By addressing it openly and honestly, alone and together, we can serve our students more faithfully, enhance our own wellbeing, make common cause with colleagues, and help education bring more light and life to the world. (Palmer, 2007, p. 8)

This “self that teaches” is central to education and to the education of teachers.

Teacher professional identity then stands at the core of the teaching profession. It provides a framework for teachers to construct their own ideas of ‘how to be’, ‘how to act’ and ‘how to understand’ their work and their place in society. (Sachs, 2005, p. 15)

This study aims to investigate who the “self that teaches” is in pre-service mathematics teachers. The young South African education student who decides to teach mathematics is a person with the potential to make a difference to the mathematics classrooms in this country. So this research purports to gain insight into the professional identity of the pre-service mathematics teacher for “the sake of learning and those who learn”.

1.1 Problem Statement

The term “identity” comes from the Latin, *identitas*, literally meaning “sameness”, which seems ironic given the uniqueness of identity as an individual construct. However, to the casual observer on any

ordinary weekday on the campus of the University of Pretoria's (UP) Faculty of Education, there is a certain "sameness" to be seen: the students are all young, apparently focused as they file into the lecture halls, all apparently unified in their intention to become teachers, all interacting in the context of their tertiary training. There is thus a sociologically constructed 'group identity', such as is described by Wenger (2000) as a community of practice, of which such a casual observer might become conscious. According to Gee (2000), there are several terms in circulation which also refer to identity, like 'subjectivity' for example. However, to him the concept is best encapsulated as follows: "Being recognized as a certain 'kind of person', in a given context, is what I mean here by 'identity'. In this sense of the term, all people have multiple identities connected not to their 'internal states' but to their performances in society" (p. 99). He continues to say:

In today's fast changing and interconnected global world, researchers in a variety of areas have come to see identity as an important analytic tool for understanding schools and society. A focus on the contextually specific ways in which people act out and recognize identities allows a more dynamic approach than the sometimes overly general and static trio of "race, class, and gender." (p. 99)

In recent years there has been an increase in academic interest in the concept of identity, stretching across all fields of academic endeavour. Fearon (1999) actually traced this growth by monitoring the number of dissertation abstracts that were available on-line since 1981 and which contained the word 'identity'. He found that between 1981 and 1995, for example, that number rose from 709 to 1 911. Abdelal, Herrera, Johnston, and McDermott, writing seven years later, in 2006, confirm that the upward trend in academic awareness of the significance of identity as an "analytic tool" is a continuing trend: "As scholarly interest in the concept of identity continues to grow, social identities are proving to be crucially important for understanding contemporary life" (p. 695). However, Abdelal et al. (2006) have identified a danger in the plethora of research and interest in 'identity': "To the chagrin of the social scientific community, it is in large part this same ubiquitous sprawl of scholarship that has undermined the conceptual clarity of identity as a variable" (p. 695).

While there is a generally observable "community of practice" (Wenger, 2000) type of identity casually observable amongst the education students at UP, when the observer is not 'casual' and the focus of research narrows down beyond what can be noticed by just walking along the faculty's

corridors, the question of professional identity arises – who are these students as professionals in their field? In Gee’s words, what kind of person is this in this given context? Now the “clarity of identity as a variable” in terms of their *professional* identity as *pre-service* teachers of a specific subject (mathematics, in this case) is not evident and requires investigation. How does it begin? What does it look like? How is it “act[ed] out” (Gee, 2000, p. 99) in the classroom?

According to Borko and Putnam (1996), students come into tertiary training with “entering perspectives [that act] as a filter that determines how experiences within the teacher education program are interpreted” (p. 679). These filtering “perspectives” are recognised in this study as part of the professional mathematics teacher identity (PMTI) of such students, and is already in existence before they attend a single university module. These students are eventually sent out to schools for a practical teaching period after three years of training at UP. Ma and Singer-Gabella (2011) confirm that

Mathematics teacher education research concerned with questions of emerging teacher identities often focuses on the time period when teacher candidates begin to engage in practices of teaching: during their field placements. This is consistent with the definition of identity as constituted in practice. (p. 19)

Palmer (2007) declares that “we teach who we are” (p. 2). By implication then, “who we are” only becomes visible when “we teach”. So, the professional identity of these pre-service mathematics teachers needs to be observed in action in the classroom, so that we can gain insight into the kind of person that is to be released to teach in the South African mathematics classroom.

1.2 Context of the study

In South Africa, despite internationally recognised changes that have taken place in the country since 1994, there remains a serious concern about the state of mathematics education in this country. Ensor and Galant (2005) point out that a “considerable amount of educational research in South Africa points to a crisis in mathematics teaching and learning – many teachers are deemed to be failing to teach adequately, and learners are failing to perform” (p. 301). Arends and Phurutse (2009)

believe that a difference can be made to the state of mathematics education by “good teaching”: “The study of teachers and teaching deserves much more attention than it has been given, particularly in the light of growing empirical evidence that good teaching makes a huge difference to learning regardless of the socio-economic status of the learners” (p. 45). Ensor and Galant analyse the situation as follows: “While the pathology is widespread, and no doubt in many cases justified, we are concerned that research has thus far failed to ascribe to teachers and learners a positive subjectivity [identity]. We know what they don’t do, but we have not adequately grasped *why* they do what they do” (p. 301) (emphasis added).

Much of the research referred to above deals with teachers of mathematics in the classroom. However, answering Ensor and Galant’s question of “why they do what they do” requires investigation of those “subjectivities” *during their early stages*: i.e. while the person is yet a student studying to be a teacher, thus starting at the beginning, as it were. There is a need to investigate who the teacher of mathematics is before that career has even begun. Bullough (1997) confirms this:

Teacher identity – what beginning teachers believe about teaching and learning as self-as-teacher – is of vital concern to teacher education; it is the basis for meaning making and decision making. ...Teacher education must begin then by exploring the teaching self. (p. 21)

Students in mathematics teacher training have an identity which formed across their own experiences of mathematics education during their schooling and tertiary training and is fundamental to their teaching.

In South Africa, all learners take mathematics as a subject to the end of the ninth grade of their school career. After that, they may choose to do either *mathematical literacy* or *mathematics* to Grade 12 level. At UP, all students in the Faculty of Education who choose to train as teachers of mathematics have taken *mathematics* as a Grade 12 subject. Therefore these students have each been in a mathematics class for twelve years before commencing their tertiary studies. As students in the Department of Science, Mathematics and Technology Education, they are required to complete, amongst others, modules about mathematical content, the methodology of teaching mathematics, and teaching practica, then after four years they are released into the professional world of teaching.

It is against this backdrop that this study takes place: it investigates the ways in which students studying to be teachers of mathematics at UP “act out and recognise” (Gee, 2000, p. 99) the identity described by scholars as professional and related to the teaching of mathematics (see Beijaard, Meijer & Verloop, 2004; Boaler & Greeno, 2000; van Zoest & Bohl, 2005; Day, Kington, Stobart & Sammons, 2006; Graham & Phelps, 2003; Hodgen & Askew, 2007; Jita, 2004; Lasky, 2005; O’Connor, 2008; Walshaw, 2004; Zembylas, 2003). At the same time, this study strives to address the problem identified by Abdelal et al. (2006) that lies in the lack of “conceptual clarity of identity as a variable” (p. 695). Day, Kington, Stobart and Sammons (2006) confirm the importance of such research:

If identity is a key influencing factor on teachers’ sense of purpose, self-efficacy, motivation, commitment, job satisfaction and effectiveness, then investigation of those factors which influence positively and negatively, the contexts in which these occur and the consequences for practice, is essential. (p. 600)

1.3 Rationale for the study

Mathematics education in South Africa has received very poor reviews from such international studies as the TIMSS reports. With reference to the TIMSS ’99 results, Howie and Plomp (2002) found that

South African pupils performed poorly when compared to other participating countries. The average score of 275 points out of 800 points is well below the international average of 487 points. The result is significantly below the average scores of all other participating countries, including the two other African countries of Morocco and Tunisia, as well as that of other developing or newly developed countries such as Malaysia, the Philippines, Indonesia and Chile. (p. 608)

In the TIMSS 2003 report, South Africa fared no better. The score of Grade 8 learners in South Africa was again the lowest of all the scores, both internationally and of the six participating countries in Africa. These results suggest that mathematics education in South Africa requires serious investigation, and that, while there are large discrepancies in the range of mathematical performance, the overall conclusion is that mathematics education in South Africa is the worst in the world, in as much as the fifty participating countries can be said to represent the world.

This study makes the assumption that the low level of mathematics education in South Africa is at least partially the result of problems in the *quality* of teaching. Cross (2009) explains as follows: “Teachers organise and shape the learning context and therefore have enormous influence on what is being taught and learned” (p. 325). In fact, The National Policy Framework for Teacher Education and Development in South Africa (DoE, 2006) entrenches the seven roles of the teacher, referring to them as the “principles underlying the policy” (p. 5):

- a specialist in a particular learning area, subject or phase;
- a specialist in teaching and learning;
- a specialist in assessment;
- a curriculum developer;
- a leader, administrator and manager;
- a scholar and lifelong learner; and
- a professional who plays a community, citizenship, and pastoral role.

These principles are designed as pointers for improving teacher competency. Arends and Phurutse (2009) state that “[t]eacher competency is increasingly seen as critical if all learners are to derive benefit from the schooling system. It has been found in many developing countries, learners benefit less from education due to the poor quality and quantity of instruction” (p. 1).

Effective teaching of mathematics requires *more* than just sound subject knowledge. Therefore efforts to improve mathematics teachers’ subject knowledge *alone* will not succeed in bringing about positive change in the teaching of mathematics in South Africa. Palmer (2007) speaks of the “tangles of teaching”: “Those tangles have three important sources. The first two are commonplace, but the third, and most fundamental, is rarely given its due” (p. 2). The first two he denotes as the complexities of the *subject* taught, and the even greater complexities of the *learners* being taught. The third, and the one on which this research focuses in particular, he describes as follows:

If students and subjects accounted for all the complexities of teaching, our standard ways of coping would do – keep up with our fields as best we can and learn enough techniques to stay ahead of the student psyche. But there is another reason for these complexities: we teach who we are. (p. 2)

In this, Palmer echoes the words of Hamachek (1999) who said, “Consciously, we teach what we know; unconsciously, we teach who we are” (p. 209). Who then, is the pre-service mathematics teacher in the UP (a typical South African university) context? Why did this person choose to teach? Why did this person choose to teach mathematics, specifically? Is the tertiary training she is undergoing adding value to the “who we are” that is going to be taught once such training is completed? These are the questions which underpin the rationale on which this research is based. According to Adler (2005), “We need to continue to work to understand better and be able to work productively with the gap between conceptual and practical knowledge of teaching, between teacher educators and teachers as agents in the field of mathematics teaching, and between research and practice” (p. 169). This study proposes to do exactly that as it examines relationships within this gap. Thus, set against the background of poor mathematics education in South Africa as compared to international standards, this study will investigate one of the intrinsic elements of such education: what the identity is of the person who is training to teach in that context.

One of the outcomes of this research could be an improved understanding of the complex nature of mathematics teacher training in this country. There could also be implications for the nature and content of modules and courses whose effectiveness may be called into question as insight is gained into PMTI as manifested during tertiary training.

1.4 Research questions

In the interests of an in-depth investigation into pre-service PMTI, this identity is examined in terms of how it develops and what it looks like. The literature (van Zoest & Bohl, 2005; Varghese, Morgan, Johnston, Johnson, 2005; Boaler, Wiliam, & Zevenbergen, 2000; Beijaard, 1995; Kagan, 1992) indicates that teacher identity is not a simple, unitary construct, but has both social (in-the-community) and personal (in-the-mind) roots, and that its nature is complex (Beijaard, Meijer, & Verloop, 2004; Stronach, Corbin, McNamara, Stark & Warne, 2002; Zembylas, 2003; Cooper & Olson, 1996).

In the context in which my study takes place, this complexity is addressed by dividing the investigation into three main thrusts by looking at the influencers that affect PMTI, the students' perceptions of their PMTI and how that PMTI actually manifests in the classroom.

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?

This overarching question summarises the focus of this research, and as such requires further refinement. To this end three sub-questions have been formulated, the first of which examines the factors that influence this identity.

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

This sub-question relates to the finding of Beijaard, Meijer and Verloop (2004), echoing Gee (2000), that identity development “can best be characterised as an ongoing process, a process of interpreting oneself as a certain kind of person and being recognised as such in a given context” (p. 108). Therefore the factors which have a role to play in the development process need to be investigated as to how they bring about formative modification of this identity. These factors are both sociological and personal, and lie within the various contexts through which the student moves or has moved, like their schooling, cultural and family history, and the university experience itself. As students of mathematics education it is also conceivable that their view of the subject itself has played a part in the shaping of who they are as teachers.

The actual nature of PMTI is best accessed through the perceptions of the person whose PMTI is being investigated, because, as Beijaard et al. (2004) explain, “[t]he world of the self may appear to the outsider to be subjective and hypothetical, but to the individual experiencing it, it has the feeling of absolute reality” (p. 108). Therefore the second sub-question needs to be asked:

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

However, in order for that outsider, in this case the researcher, to gain access to the reality experienced by the person in question, that PMTI must be allowed to reveal itself in the classroom. According to Fearon (1999), identities should be seen “both as things to be explained and things that have explanatory force” (p. 2). Thus, while the student can be asked to explain the nature of her PMTI, the nature of her PMTI also explains what she does in the classroom. Only in seeing the identity in action can analysis take place of the perceptions which constitute it. This gives rise to the third sub-question which deals with the materialisation or manifestation of PMTI:

c) How is this identity actualised in the classroom?

Thus, by sub-dividing the task of evolving a description of the PMTI of mathematics education students at UP into these three confluent descriptive inquiries, a composite ‘picture’ can be created in which the development, nature and praxis of a particular PMTI is depicted.

1.5 Definition of terms

Learner : a young person who is still at school (in the South African context).

Student: someone who is receiving a tertiary education (while this is the case in South Africa, this term also applies to a school pupil in other countries).

Model C Schools: also called section 21 schools - were state-owned, but had a governing body and a degree of budget autonomy which allowed them to use school fees (often higher than other state – owned schools) to provide additional teachers, so that class sizes were reduced and equipment could be purchased, making these schools very similar to expensive private schools in terms of the education that was offered.

Teaching practicum: a period of between two weeks (second and third year of training) and six months (fourth year of training) in which an education student at the University of Pretoria spends time in a school, observing and teaching.

1.6 Structure of the thesis

In order to situate this study in a body of research, an in-depth literature study was done and reported in Chapter Two. Following on this, Chapter Three deals with the way in which this research was conducted, i.e. its design as well as the methodological norms that were applied. Chapter 4 is devoted to the presentation of the results of the study, and deals with the data gathered through six individual cases. Chapter Five concerns the cross-case analysis and includes insights derived from a group interview with the six participants in this study. Finally, Chapter Six presents the conclusions of this research, as well as its limitations.

1.7 Methodological considerations

After an extensive literature study was completed, in which the development and nature of professional identity was investigated (see Section 3.2), I decided that qualitative methodology was appropriate and that a case study would best facilitate the in-depth investigation of the PMTI of students at UP. The Fourth Year mathematics education students at UP were selected as the population for this study: they are in the final year of their degree and have completed all the academic modules that constitute the Bachelor of Education (BEd) programme. During the second and third terms of their fourth year in the BEd programme, they leave the campus to go to schools for their long practica. From this group, six students were selected as a maximum variation sub-sample for the case study. Three men (one English, one isiZulu and one Swazi) and three women (one Afrikaans, one Sesotho, and one Indian) were selected.

These six students were interviewed and observed as they were teaching at the school that they had selected for their practica. Both the transcribed interviews and observations were analysed using Atlas.ti and a cross-case analysis was done.

2. Literature review and conceptual framework

Abdelal et al. (2006) speak of the “ubiquity of identity-based scholarship” (p. 695). And indeed, much has been written about identity, although not quite as much about professional identity. However, about the professional identity that is particularly associated with the teaching of mathematics, there is no question of ubiquity. This chapter begins with an investigation into the ways people have defined identity. As Castanheira, Green, Dixon and Yeagerb (2007) found,

Any review of the literature of interdisciplinary or cross national studies of the concept of identity will show that there is no common conceptualization or framework guiding such work and that different perspectives focus on various angles of vision of the phenomenon called identity. (p. 173)

The concept of identity is refined in subsequent sections from core identity to professional identity, then Professional teacher Identity (PTI) to PMTI. The interrelationships between PTI, beliefs and instructional practice are highlighted, after which the chapter continues with a description of PTI in terms of its development and nature. Subsequent to that, there is an analysis of the literature around the factors which influence PMTI in particular. The chapter concludes with a description of the conceptual framework which guides this study.

2.1 Defining “identity”

Although much has been written about identity, the meaning of the term is often not clearly defined in terms of the context that is being written about. Abdelal et al. (2006) ascribe the problems associated with defining identity to “... this same ubiquitous sprawl of scholarship that has

undermined the conceptual clarity of identity as a variable” to the extent that “the current state of the field amounts to definitional anarchy” (ibid., p. 695). Fearon (1999) shares this sentiment:

Our present idea of “identity” is a fairly recent social construct, and a rather complicated one at that. Even though everyone knows how to use the word properly in everyday discourse, it proves quite difficult to give a short and adequate summary statement that captures the range of its present meanings. Given the centrality of the concept to so much recent research and especially in social science where scholars take identities both as things to be explained and things that have explanatory force, this amounts almost to a scandal. (p. 2)

Some academics use the term without defining what they take it to mean because they believe the readers understand the term (Fearon, 1999), while others provide a variety of definitions and interpretations of the concept. Still others declare that so nebulous a concept cannot be limited to a simple, singular definition; in fact, it is an “open concept” (Waterman, 1999, p. 592). Abdelal et al. (2006) found that, directly as a result of all the writing around the concept of identity and “the wide variety of conceptualisations and definitions” that are in use, some academics have concluded that “identity is so elusive, slippery and amorphous that it will never prove to be a useful variable for the social sciences” (p. 695). Gee (2000) believes the exact opposite: he declares that semantics are not important; what is important is the fact that identity can be used as “as an analytic tool for studying important issues of theory and practice in education” (p. 100). I subscribe to the notion that we teach who we are, which implies that investigating identity, or ‘who we are’ can give us insight into classroom practice - how we teach - and vice versa. So I agree with Gee, provided that definable aspects such as those referred to in the conceptual framework are used in such a study. Certainly, as my study will show, identity is a useful “tool” for investigating the link between theory and practice; I strive to gain insight into identity as it is influenced by theory, inter alia, and as it is actualised in classroom practice, by looking at certain aspects of the identity which come into play (see Conceptual Framework).

Beijaard et al. (2004) also refer to the plethora of meanings given to the concept of identity in the literature. They believe that Gee (2000) came closest to an acceptable definition when he said, “Being recognized as a certain ‘kind of person’, in a given context, is what I mean here by ‘identity’” (p. 99). They conclude that “identity can also be seen as an answer to the recurrent question ‘Who am I at this moment?’” (p. 108). While some researchers tie identity to context and time, others see it as a

never-finishing journey (Epstein, 1978; Wenger, 2000). Thus identity requires some sort of definition by the academic user of the concept in order to ensure that the reader understands what the term implies for that specific research endeavour.

In common parlance, 'identity' is simply 'who I am'. Each one of us has a 'core identity', a central 'me', which makes me different from my neighbour, my colleague, my family members; the 'me' that is present in every context in which I operate. This 'core identity' "holds more uniformly, for ourselves and others, across contexts" (Gee, 2000, p. 99); and "is experienced by individuals as 'core' or 'unique' to themselves in ways that group and role identities are not" (Hitlin, 2003, p. 118). "Core identity" can thus be seen as 'Who I am' at any time and in any context, as differentiated from 'Who I am in *this* context'. From these two definitions it is clear that core identity is an integral part of professional identity: I am still myself, with my values and beliefs, even though I may comport myself differently in different contexts in a manner appropriate to those contexts. Day, Elliot and Kington (2005) confirm this: "There is a general agreement among researchers that the 'self' is a crucial element in the way teachers construe and construct the nature of their work" (p. 566). In this study, core identity is seen as the individual's 'self' which is an inevitable part of whatever one does.

2.1.1 Professional identity

Professional identity maybe described from two points of view: the social and the personal. Abdelal et al. (2006) and Sachs (2001) espouse the social view and define professional identity as that which makes one group of professional people recognisably different from another. A basic definition of professional identity is provided by Sachs (2001):

A set of externally ascribed attributes that are used to differentiate one group from another. Professional identity thus is a set of attributes that are imposed upon the teaching profession either by outsiders or members of the teaching fraternity itself. It provides a shared set of attributes, values and so on that enable differentiation of one group from another. (p. 153)

Her definition deals with the identifiability of people in the profession. Ma and Singer-Gabella (2011) add the notion of this identifiability being in certain situations, emphasising "context and recognition [by self and others]" (p. 9). Professional identity can be seen, according to these academics, as a

collective identity that is recognisable because of certain defining aspects. The list of these aspects varies from one researcher to another, depending on their point of view.

For example, when looking at professional identity from the personal, or psychological viewpoint, Kelchtermans (1993) speaks of five interrelating parts rather than attributes: self-image; self-esteem; job motivation; task perception and future perspective (teachers' expectations of their careers). The list provided by Day et al. (2005) is slightly different – it includes professionalism, motivation, self-efficacy, job satisfaction and commitment. Ibarra (1999) speaks of a “constellation” of aspects in terms of which people define themselves as professionals and which includes “central and enduring preferences, talents and values” (p. 764). There seems to be very little consensus with regard to the ‘list’ of aspects that constitute professional identity.

Rather than provide a list of aspects which constitute professional identity, some authors prefer to see professional identity as an *interaction* between the individual and the professional environment. Van den Berg (2002) links experience and context: “Professional identity can be conceptualized as the result of an interaction between the personal experiences of teachers and the social, cultural, and institutional environment in which they function on a daily basis” (p. 579). In fact, van den Berg is linking professional identity to a personal interpretation of factors within the professional environment. Beijaard (personal communication, 2010) speaks of professional identity as an interaction between the personal and the professional. In such an interaction there is the possibility of the one influencing the other.

The focus of this study is professional identity, which relates the ‘self’ to a context and time (who I am at this moment in this context). While it makes the individual recognisable as part of a group of professionals, the individual’s singularity is not subsumed in the collective identity, because the individual professional identity also includes personal aspects which make each one unique. In fact there is an interaction between these personal aspects and aspects which relate to the profession, between that which is personal and that which is social.

2.1.2 Professional Teacher Identity

Professional Teacher Identity (PTI) or “self-in-practice” (Grootenboer, Smith & Lowrie, 2006, p. 614), is complex (Day, 2002; Chevrier, Gohier, Anadon, & Godbout, 2007; Vloet & van Swet, 2010) and composing a definition for it is a problematic exercise (Beauchamp & Thomas, 2009). However, several authors have attempted it, each looking at PTI through their own epistemological lens: the constitution of PTI, its development or its nature. Beijaard et al. (2004) provide an overview of the studies that have investigated professional teacher identity starting in 1995, up to and including those published in the year 2000. The definitions they identified are adapted and tabled below. Only three of the seven studies listed below were based on empirical research, and of those, two involved case studies.

Table 1

Overview of studies on professional teacher identity, adapted from Beijaard et al. (2004)

AUTHOR AND YEAR	DEFINITION OF PROFESSIONAL [TEACHER] IDENTITY (PTI): IT IS...	RESEARCH METHODOLOGY
Beijaard (1995)	Dynamic, changes over time through relevant others, events and experiences; and can be represented by relevant features of the profession	Case study
Sugrue (1997)	Part of a discourse which is open to continuous redefinition rather than a set of essential characteristics which are common to all teachers	Document analysis
Volkman & Anderson (1998)	A complex and dynamic equilibrium between personal self-image and teacher roles one feels obliged to play	Document analysis
Coldron & Smith (1999)	Not fixed or unitary; it is not a stable entity that people have, but a way to make sense of themselves in relation to other people and contexts	Theoretical analysis
Dillabough (1999)	Never fixed or pre-determined, but arises out of the relationship between those who interpret and ascribe meaning to action, language and everyday practice in varied social contexts and circumstances	Theoretical analysis
Samuel & Stephens (2000)	An understanding and acceptance of a series of competing and sometimes contradictory values, behaviours, and attitudes grounded in the life experiences of the self in formation	Case study
Beijaard, Verloop & Vermunt (2000)	Related to aspects of teaching common to all teachers at a general level, implying subject matter, didactic and pedagogical expertise	Survey questionnaire

These researchers thus found that PTI is not fixed (i.e. it is changeable)(Beijaard, 1995; Sugrue, 1997; Volkman & Anderson, 1998; Dillabough, 1999) or unitary (i.e. there are sub-identities) (Volkman & Anderson, 1998; Coldron & Smith, 1999), that it develops across different contexts and in relation to others (Beijaard, 1995; Coldron & Smith, 1999; Dillabough, 1999), and that it involves aspects of teaching like subject matter, didactic and pedagogical expertise (Beijaard, 1995; Beijaard, Verloop & Vermunt, 2000). Beijaard et al. (2004) identified four features of PTI:

- It is a process, not stable or fixed, but changeable
- It involves both person and context
- It consists of sub-identities which may co-exist harmoniously or not

- It implies action: “The way they explain and justify things in relation to other people and contexts expresses, as it were, their professional identity” (p. 123)

In the research around professional identity completed since the work Beijaard et al. (2004) did to summarise the findings in this field, several researchers have attempted new or slightly modified definitions of professional teacher identity. Korthagen (2004), writing four years after the publication of the last articles included in Beijaard’s list, made the following statement: “In the few publications devoted to this subject, we find no clear definition of the concept of teachers’ professional identity” (p. 82). However, subsequent to the work of Beijaard et al., Beauchamp and Thomas (2009) also carried out a summative exercise in professional teacher identity definitions. I combined their summary of the research done with a comparative literature study of my own. This selection process was based on the criteria that the source article had to be devoted to the subject of professional teacher identity, and was published in an accredited journal or a book dealing with the subject. These definitions are summarised in the Table 2.

Table 2

Overview of definitions of professional teacher identity formulated between 2001 and 2011

AUTHOR AND YEAR	DEFINITION OF PROFESSIONAL [TEACHER] IDENTITY (PTI): IT IS...	RESEARCH METHODOLOGY	PERSPECTIVE/FINDINGS	JOURNAL
Sachs (2001)	A set of common attributes and values that make teachers distinct from other professional groups	Discourse analysis: a literature study	Two discourses amongst Australian teachers: Managerial discourse leads to entrepreneurial identity; Democratic discourse leads to an activist identity	<i>Journal of Education Policy</i>
Jansen (2001)	The understandings that teachers hold of themselves in relation to official policy images	Literature study with a view to proposing a research programme	The discrepancy between policy images and personal identities of teachers	<i>South African Journal of Education</i>
Drake, Spillane & Hufferd-Ackles, (2001)	Teachers' sense of self as well as their knowledge and beliefs, dispositions, interests, and orientation towards work and change	Qualitative: Narrative discourse with ten elementary school teachers	Three categories of mathematics stories: 'turning point', 'failing' and 'roller-coaster'	<i>Journal of Curriculum Studies</i>
Danielewicz, (2001)	Malleable, subject to invention, created through self and others, flexible, and sensitive to contexts	Narrative discourse	Proposing a pedagogy for identity development	(Book) <i>Teaching Selves: Identity, pedagogy, and teacher education.</i>
Day (2002)	A dynamic combination of personal biography, culture, social influence, and institutional values	Literature study	Maintaining one's professional identity as a teacher in the face of school reform is difficult and little official attention is given to this	<i>Journal of Educational Research</i>
Zembylas (2003)	The repository of particular experiences in classrooms and schools, the site of thoughts, attitudes, emotions, beliefs, and values	Literary study on narrative research	The construction of PTI is based on emotion	<i>Educational Theory</i>
Korthagen (2004)	Self-concept: an organised summary of information including character traits, values, roles, characteristics and personal history	Theoretical study	Proposing a theoretical model framing the question: what is a good teacher?	<i>Teaching and Teacher Education</i>
Beijaard, Meijer & Verloop (2004)	Who I am at this moment – an ongoing process resulting in sub-identities and involving individual agency in different contexts	Literature review	Presenting an overview of research up to 2000 about PTI	<i>Teaching and Teacher Education</i>
Chanfrault-Duchet (2004)	The crossroads between the social and the personal self	Biographical approach: life stories	Demonstrating the use of life stories as a methodological tool	<i>Biographical Methods and Professional Practice: an International Perspective</i> (Book)
Lasky (2005)	How teachers define themselves; evolves over career stages; different from individual capacity which encompasses beliefs, identity values, subject area and pedagogic knowledge	Mixed methods: surveys and interviews in ten schools	The effectiveness of mediational techniques in dealing with the vulnerability of PTI in the face of reform	<i>Teaching and Teacher Education</i>
Walkington (2005)	Based on the core beliefs one has about teaching and being a teacher; beliefs that are continuously formed and reformed through experience	Qualitative: Narrative research with a group of first year pre-service teachers	The effectiveness of mentoring as opposed to supervision, and reflective practice in developing PTI	<i>Asia-Pacific Journal of Teacher Education</i>

Alsup (2006)	A weaving together of various subjectivities or understandings of self, expressed through discourses teachers are participants in and are creators of, and influenced by multiple life experiences	Qualitative: Two and a half year study of six pre-service teachers using narratives	A healthy PTI makes a good teacher and teacher educators are essential in guiding preservice teachers to examine their personal identities and build congruent professional ones	(Book) <i>Teacher Identity Discourses: Negotiating personal and professional spaces</i>
Flores & Day (2006)	Influenced by social, personal, cognitive and emotional responses	Qualitative: Longitudinal case study of fourteen new teachers through interviews and questionnaires	Three main PTI influences: teacher's personal history, teacher training & teaching practice; and teaching contexts ie school culture. Finding: powerful interplay between personal histories and contextual influences	<i>Teaching and Teacher Education</i>
Luehmann (2007)	Being recognised by self and others as a certain kind of teacher	Theoretical study	A purely cognitive approach in preparing reform minded teachers is ineffective: PTI development must be promoted	<i>Science Education</i>
Vähäsantanen, Hökkä, Eteläpelto, Rasku-Puttonen, & Littleton (2008)	The embodiment of individuals' perceptions of themselves as professional actors	Qualitative: Open-ended narrative interviews with twenty four teachers in Finland	Discussion of relationships between the socio-cultural context of work organisations and teachers' professional identity negotiations	<i>Vocations and Learning</i>
Schepens, Aelterman & Vlerick (2009)	Formed through interaction with others and with the environment; it is a relational phenomenon, socially and personally constituted	Quantitative: a questionnaire with 762 respondents	Examining PTI as formed through demographics, personality traits, experience and teacher training	<i>Educational Studies</i>
Chong & Low (2009)	Begins to be formed at school, and continues to develop; and is essential to teacher effectiveness	Quantitative: a questionnaire administered to 605 First Years in Singapore	Examination of motivations for joining teaching and how students feel towards teaching and the teaching profession at different points in their training	<i>Educational Research for Policy and Practice</i>
Cardelle-Elawar, Irwin, & de Acedo Lizarraga, (2010).	A psychological attachment that teachers have to the teaching profession; the selfhood they bring to the classroom	342 teachers: dialogic retrospection and interviews in pairs	Designing a model to help teachers understand what shapes their PTI	<i>Psicothema</i>
Shapiro (2010)	Based on affect – we feel that we have chosen this field and it has chosen us	Personal narrative	Exploration of the link between PTI and emotion	<i>Teaching and Teacher Education</i>
Timostuk & Ugaste (2010)	A continuous learning process involving reciprocal interactions between emotions and knowledge, in social and personal contexts	Qualitative: semi-structured interviews, both individual and group, with forty five student teachers	Suggesting improvements to teacher education in which closer links to the society in which the student will be required to work are established	<i>Teaching and Teacher Education</i>
Ma + Singer-Gabella (2011)	Dynamically constituted within particular contexts, malleable and intertwined	Qualitative: observations of a course with eleven students	Examination of teachers' changing conceptions of what it means to do, learn, and teach mathematics	<i>Journal of Teacher Education</i>
Lutovac & Kaasila (2011)	One component of multiple aspects of a person's identity and comes from a person's professional status or position within society, their interactions with others, and their interpretations of their experiences	Qualitative: A case study using narrative rehabilitation interactively	An interactive study in how to rehabilitate a negative view of mathematics continuing from learnerhood into pre-service identity	<i>Teaching in Higher Education</i>

More has been written about PTI from a theoretical point of view than from an empirical one (Rodgers & Scott, 2008). However the information in the table above indicates a changing tendency. Of the twenty two articles that were examined with a view to abstracting PTI from recent studies, nine may be considered to be purely theoretical. Of these, seven were written prior to 2005. Of the remaining thirteen, three are quantitative and ten qualitative, the latter mainly case studies. It appears then that a need has been identified in the academic community to use 'hands-on' techniques to investigate the concept of PTI.

From the table above it can be seen that earlier studies (Sachs, 2001; Jansen, 2001) tend to discuss PTI as a distinguishing element that separates teachers from other professionals or government policy-makers. A teacher is different from other professionals in terms of what she does – she teaches. PTI is therefore the professional identity which goes with being a teacher as opposed to that which is associated with being an engineer, for example. In this point of view, PTI is seen as a social construct.

From 2001 onwards, the notion of self with accompanying emotions, attitudes and beliefs as well as contextual role players are given centre stage in PTI definition discussions. The personal, intrinsic aspects of PTI are brought into the academic discussion. While several researchers (Drake et al., 2001; Zembylas, 2003; Lasky, 2005) link beliefs to professional teacher identity, Walkington (2005) introduces the notion of professional identity being *based* on beliefs concerning teaching. Others (Zembylas, 2003; Flores & Day, 2006; Shapiro, 2010) recognise that emotions are not only part of PTI, but are significant in effective teaching. Still others look at the nature of PTI with an emphasis on its dynamism and its tendency to be a process of continuous development (Danielewicz, 2001; Day, 2002; Beijaard et al., 2004; Lasky, 2005; Walkington, 2005; Chong & Low, 2009; Timostsuk & Ugaste, 2010; Ma & Singer-Gabella, 2011). This dynamism is linked to the effect of different contexts and the social interactions that are associated with them (Beijaard et al., 2004; Walkington, 2005; Ma & Singer-Gabella, 2011; Lutovac & Kaasila, 2011). Chanfrault-Duchet (2004) in fact speaks of PTI as the crossroads between the personal and the social self. Some authors, like Timostsuk and Ugaste (2010), bring together the notions of personal as well as socially derived aspects of PTI. I believe it is important to recognise that PTI is complex in that it is made up of personal as well as social aspects which come together in a construct that encompasses knowledge

and beliefs, emotions and relationships, contexts and experiences. This being said, the teacher should be recognised as a complex persona who is affected by societal and personal interactions which result in the “selfhood” (Cardelle-Elawar et al., 2010) that she brings into the classroom.

In the articles discussed in this sub-section, only two are specific in terms of categorising PTI. Beijaard et al. (2000) identify three categories that “cover” (p. 751) PTI: subject matter, pedagogical and didactical expertise; Flores and Day (2006) identify three categories of influence on PTI: personal history, teacher training and practica, and the school culture. It is my belief that these two studies contribute significantly to the elimination of the ‘wooliness’ surrounding PTI by identifying such distinct and clear categories of criteria which make PTI the “analytic tool” of which Gee (2000) spoke.

2.1.3 Professional Mathematics Teacher Identity

In this research a distinction is made between Professional Teacher Identity (PTI), Mathematics Teacher Identity and Professional Mathematics Teacher Identity (PMTI). The first of these is seen as a more general term which may be applicable to all individuals in the teaching profession. The teaching of mathematics should be in a category of its own, though. As Graven (2004) explains:

Around the world there tends to be far more concern about mathematics teacher knowledge and mathematical confidence (or math phobia/anxiety) than for other subjects. Thus... there are many aspects of the teachers’ learning experiences that are integrally connected to the particular nature of the subject ‘Mathematics’. (p 180)

The term Mathematics Teacher Identity, described by Bohl and van Zoest (2002) as a unit of analysis, is interpreted in this research as a category which includes those who, although they teach mathematics from time to time or for a period, are in fact not professional mathematics teachers – they may have been co-opted into teaching the subject because there is no one else to do so in a particular school, or some such circumstance. In South Africa this happens frequently. Graven (2004), for example, tells the story of some teachers that she worked with:

For example, Moses explained that it was not considered politically acceptable as a black student to study mathematics when he was at school and college. Rather, one had to study history and other subjects considered important for the struggle against apartheid... Moses had therefore studied to become a history teacher but became a teacher of mathematics due to the shortage of mathematics teachers. Another teacher, Barry, despite having taught mathematics and headed a mathematics department for many years, explained that he was not a mathematics teacher since he did not ‘even’ study mathematics at high school. He called himself an art teacher since this is what he had studied ... Similarly... Beatrice used to introduce herself as ‘the music teacher’ despite teaching predominantly mathematics classes. These examples illustrate an effect of South Africa’s apartheid history. (p. 189)

The term Professional Mathematics Teacher Identity however, is posited in this research as involving an individual who has studied the subject for the specific purpose of teaching it. Mastery in this profession, says Graven (2004), “involves becoming confident in relation to ... [inter alia] one’s identity as a professional mathematics teacher” (p. 185). Professional Teacher Identity is subsumed in Professional Mathematics Teacher Identity, and therefore shares its characteristics. In fact, they differ only with regard to beliefs about and views of the subject itself which plays a significant role in the professional identity of the mathematics teacher (see Section 2.5.4). Hodgen and Askew (2007) speak of a “strong disciplinary bond” (p. 484) which a teacher has with the subject she teaches. It is this bond with mathematics that is central to PMTI, a bond that includes a view of the subject and beliefs regarding the subject, and even emotions related to the subject. Ursula, the subject of Hodgen and Askew’s case study, identifies herself as a teacher of mathematics as follows: “I like being a specialist. I like having one subject. I like being a maths teacher” (p. 471).

In summary: there are many definitions of identity, so many that the concept has been described as amorphous. However, it is nevertheless an important tool for studying education issues (Gee, 2000), since ‘we teach who we are’. Core identity is the central ‘me’ which is unique and present in every context and role in which I operate. Professional identity, on the other hand, can be seen from a social point of view as what makes one group of professionals distinct from another, and from a personal point of view as, amongst other qualities, professional self-image, talents and values. Professional identity is also described as an interaction between the personal and the social. PTI, the particular identity associated with being a teacher, is described as neither fixed nor unitary, develops

across different contexts, and involves aspects of teaching like subject matter, didactic and pedagogical expertise. It is associated with beliefs and emotions, and seems to be in a process of continuous development. It is complex in nature, being made up of personal and socially derived aspects: the crossroads between the personal and the social self. PMTI differs from PTI in that PMTI includes the person's beliefs and views regarding mathematics – a bond between the teacher and mathematics. PTI is therefore included in PMTI.

2.2 The interrelationships between PTI, beliefs and instructional practice

Researchers do not dispute the link between *identity* and *instructional practice*. In fact, according to Day, Elliot and Kington, (2005), “There is general agreement among researchers that the ‘self’ is a crucial element in the way teachers construe and construct the nature of their work” (p. 566). Ezzy (2002) speaks not of ‘self’, but of “people’s pre-existing meanings and interpretive frameworks” which are “the dominant influences on what people do and observe” (p. 6). However, the robustness/tenuity of that link *is* the subject of debate. Mayer (1999), for example, makes a clear distinction between teacher identity and behaviour:

A teaching role encapsulates the things the teacher does in performing the functions required of her/him as a teacher, whereas a teaching identity is a more personal thing and indicates how one identifies with being a teacher and how one feels as a teacher. (p. 6)

On the other side of the argument is Walkington (2005) who asserts: “Whilst Mayer has defined function and identity as two different concepts, they are not mutually exclusive, but rather intertwined aspects of the developing professional” (p. 54). Hamachek (1999) and Palmer (2007) carry this notion further: we teach who we are. Thus professional identity (who we are) can be seen in our teaching. The properties of this ‘teacher-hood’ can be seen as what makes a good teacher.

Korthagen (2004), in an effort to provide a theoretical model for investigating ‘what is a good teacher’, describes his model as an onion and calls it “levels of change” (p. 87). He proposes six such levels. The two outermost levels are environment and behaviour – both of which can be directly observed by others. Environment refers to the school context, while behaviour is what can be seen

in that context and is heavily influenced by the next level, competencies. This ‘layer of the onion’ includes subject matter knowledge and skills. The remaining three inner levels are beliefs, identity and mission. A teacher’s competencies are determined by her beliefs, since “the beliefs teachers hold with regard to learning and teaching determine their actions” (p. 81). The teacher also holds beliefs about herself: “the level referring to how one defines oneself, in other words, to how a person sees his or her (*professional*) *identity*” (p. 81), which constitutes the next level. The deepest innermost level, mission, refers to “what it is deep inside of us that moves us to do what we do” (p. 85). While Korthagen’s model certainly provides categories or levels for studying what makes a good teacher, his model does not provide analysis points that the observer can use to describe how ‘who we are’ becomes ‘how we teach’. Also, the environment influences the teacher, but is not an intrinsic part of the teacher. The inner layers of his model correspond superficially with Gee’s notion of a core identity, in that beliefs, identity and mission may be thought to “hold[s] more uniformly, for ourselves and others, across contexts” (Gee, 2000, p. 99). Korthagen’s model does nevertheless serve to confirm the link between competencies or teaching-and-learning skills and subject expertise, and behaviour or that which is actualised in the classroom.

For Van Zoest and Bohl (2005), the link between ‘how we teach’ and ‘who we are’ is one that has both social and personal aspects. They offer a framework for examining PMTI based on Wenger’s theory that identity development is rooted in learning within communities. They describe their theory as follows: “We view forms of learning and knowing as lying on such a continuum, with in-the-brain on one end, social on the other, and every variation of combinations of the two stretched between them” (p. 332). They refer to “*Aspects of Self-in-Mind*” and “*Aspects of Self-in-Community*” (p. 332) to elucidate their thinking. With respect to individual cognition, they looked to Shulman (1987) who described important teachers’ knowledge as lying across seven categories:

- Content *knowledge*
 - Curricular *knowledge*
 - General pedagogical *knowledge*
 - Pedagogical content *knowledge*
 - *Knowledge* of learners
 - *Knowledge* of educational contexts
 - *Knowledge* of educational ends
- } Content and curriculum domain: what is to be taught
- } Pedagogy domain: who is taught and how they are taught
- } Professional participation domain: interaction with communities outside the classroom

Now, van Zoest and Bohl elected to collapse these categories into three broader domains: a) and b) they call the *content and curriculum domain* “since they deal with what is to be taught” (p. 333); c), d) and e) they call the *pedagogy domain* since “[they] all relate to who is to be taught and how they should be taught” (p. 333); f) and g) they call the *professional participation domain* which deal with interaction with communities outside of the classroom. The model suggested by van Zoest and Bohl resonates well with what Hill, Ball and Schilling (2008) call KCS – knowledge of content and students.

Beijaard et al. (2000) posit a model which resonates closely with the National Policy Framework for Teacher Education and Development in South Africa (DoE, 2006) (See Section 2.6.1). In their study of professional teacher identity, they were “inspired” (p. 751) by the work of Bromme, from which they developed the idea that teachers derive their professional identity from “the ways they see themselves as subject matter experts, pedagogical experts, and didactical experts” (p. 751). They specified that their framework applies to *the teachers’ perceptions of themselves*. Beijaard et al. are quick to note that, in Europe (they were based in Holland) these concepts are “relevant components of models and theories of teaching on the basis of which (student) teachers organise their work” and that there is “an overlap between the Anglo-Saxon concept of pedagogy and the European concept of teaching-and-learning... in European countries both concepts have different meanings” (p. 751). In fact, the way Beijaard uses the word “pedagogy” harks back to the most basic meaning of the word as defined by van Manen (1991):

So pedagogy is not just a word. By naming that which directs us and draws us caringly to children, the word *pedagogy* brings something into being. Pedagogy is found not in observational categories, but like love or friendship in the experience of its presence – that is, in concrete, real-life situations. It is here and here and here, where an adult does something right in the personal development of a child (p. 31).

Beijaard et al. work within a framework in which there are *three* domains which they define as follows: the subject matter (*subject* content knowledge and skills); didactics (the knowledge and skills related to the preparation, execution and evaluation of the *teaching and learning process*) and pedagogy (the knowledge and skills required to undergird and *support the socio-emotional and moral development of learners*, i.e., *caring* or *nurturing*). The difference between Beijaard’s understanding of the term *pedagogy* and Van Zoest and Bohl’s is clearly to be seen here: to the latter the term is a catch-all for teaching and learning, while Beijaard makes a distinction between pedagogy and didactics. So Beijaard’s

theoretical framework, while very similar to that of Van Zoest and Bohl, refines van Zoest's second domain (pedagogy) into two: pedagogy (caring) and didactics (teaching and learning).

The models discussed above provide frameworks for studying PTI (Korthagen) or PMTI (van Zoest & Bohl, and Beijaard et al.) as seen in classroom practice. Korthagen (2004) speaks of an 'onion' model, in which six aspects of what makes a good teacher can be investigated. Instead of a layered model, Van Zoest and Bohl (2005) speak of domains that can be studied, of which content and curriculum, and pedagogy can be seen as specifically relating to the teacher's expertise in terms of subject matter and teaching-and-learning skills that can be observed in her classroom practice. Beijaard et al. (2000) propose a model in which three aspects of PMTI can be identified: the teacher as subject specialist, teaching-and-learning specialist and caring specialist. The latter resonates more closely with the requirements of national education policy in South Africa.

While the models described above allow the investigation of PTI through looking at classroom practice, Pajares (1992) found in his research that, “[a] *nother perspective* is required from which better to understand teacher behaviours, a perspective focusing on the things and ways that teachers believe” (p. 307) (emphasis added). He was thus referring to the link between beliefs and instructional practice, about the robustness of which, since the publication of Pajares' article, agreement seems to have been achieved amongst the academic fraternity (Aguirre & Speer, 2000; Stipek, Givvin, Salmon, & MacGyvers, 2001). The *nature* of the beliefs that act as influencers of teacher behaviour is not as easily agreed upon, and, as Grootenboer (2006) suggests, careful consideration must be given to what one deems to be beliefs. He found that attitudes and emotions are also role players when instructional practice is being considered, but states categorically that separating beliefs from attitudes and emotions is not useful since these constructs are “notoriously difficult to clearly define and conceptualise due to their overlapping and interchangeable nature” (p. 271). He seems to see beliefs as a catch-all concept which includes both an affective and a cognitive dimension and which can be seen as “subjective, personal assumptions of truth which can strongly influence a person's behaviour or action” (p. 271).

The notion of beliefs as predictors of instructional practice is not new (Ernest, 1988; Stipek, et al., 2001; O' Connor, 2008). In fact, beliefs may be seen as the filter through which experience and

theory are transformed into instructional behaviour. In this regard, Stuart and Thurlow (2000) speak of a teacher's *belief system* as serving “an adaptive function” (p. 118), translating experience “and resulting beliefs” into practice. O'Connor (2008) also espouses the idea of a teacher's belief system and uses identity interchangeably with belief system both as a determinant of instructional practice and a mediator of an individual's “professional philosophy” (p. 118). The implication then is that 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).

So, in the literature there is general agreement concerning the significant connection between identity and practice as well as between beliefs and practice. ‘We teach who we are’ seems to be a truth that is universally accepted: the teacher's professional identity is an inevitable influencer of what happens in the classroom. Similarly, the constituents of the teacher's belief system are found to be profoundly influential in the operationalisation of the teacher's classroom practice. However, the nature of these connections is not investigated in terms of the interrelationships that exist between them: if both identity and beliefs influence practice, then the relationship between identity and beliefs will bear close investigation. Beijaard et al. (2000) investigated PTI by asking the teachers about their *perceptions* of their own PTI, operating on the assumption that no-one has better knowledge of their PTI than the individuals themselves. I contend that describing the individuals' *beliefs* about their PTI is a better indicator of “Who I am at this moment in this context”.

2.3 The development of PTI

According to Lasky (2005) who echoes Vygotsky, “Human development occurs on two planes, first on the social plane and then on the psychological. In short, that which is psychological is first social” (p. 900). This implies that we as human beings are, in measure, the product of our society (Smagorinsky, Cook, Moore, Jackson, & Fry, 2004; Varghese et al., 2005). Walshaw (2004) discusses these societal influences as described by Foucault:

For Foucault, politics [societal influences] enter into any discussion of subjectivity [identity]. Social institutions such as schools have particular *modes of operating*, particular forms of *knowledge*, and particular *positionings*. Particularities that relate to the school, the classroom, the associate/supervising

teacher, the university course, previous classroom experiences, personal biography, and so forth, all have their place in constituting the pre-service teacher as ‘teacher’. (p. 67)

These societal influences have an effect on that which is psychological. Teacher identity, according to Varghese et al., is a “profoundly individual and psychological matter because it concerns the self-image and other-image of particular teachers” (p. 39). The context (the social aspect) in which the individual reasons, makes decisions, acts and operationalises her PTI (the psychological aspect), plays a vital role in the development of PTI. The fact that PTI is responsive to social context implies participation in communities of practice (Lave & Wenger, 1991; Wenger, 2000). These communities cohere because of three defining properties: joint enterprise (they are doing something e.g. learning about teaching mathematics); mutual engagement (they are working together, e.g. as a group of Fourth year students) and a shared repertoire (shared resources which may be social, physical, historical and so on, for example, they may attend the same classes taught by the same lecturers). Participation in such a community of practice is identity-linked. In fact, Wenger sees identity as the “who we are” that is continually being developed in our own minds and in the minds of those with whom we interact in such a community. Professional teacher identity is developed in a particularly *specialised* society: schools and teacher training facilities. In order for the social environment, or community, to bring about identity development on a professional level, the individual has to be a *participant* in the activities of that community (Wenger, 2000, Smagorinsky et al., 2004). For the teacher, this community of practice may be seen as the school environment, colleagues teaching the same subject, and so on. For the pre-service teacher, the community of practice is the tertiary institute and its staff, and fellow students, particularly those who take the same subjects, as well as the schools in which they are placed for their teaching practica. It is this latter community which, according to Grootenboer (2006), is most influential: “While some pre-service teachers may be looking to be agents of school reform, the majority will identify with the dominant school culture and be tacitly and consciously seeking to reproduce the prevailing norms and practices” (p. 275).

However, van Zoest and Bohl (2005) point out the failing of Wenger’s theory to fully encompass the teaching environment because of its lack of ‘concrete reference of individual cognition’ (p. 332). Each individual is a sentient being with the power of decision-making in a context, and a person may in fact not allow a context to influence identity, for example, a pre-service teacher may not allow university training to influence who they are in the classroom, choosing instead to adhere to what

they have always thought to be right – the way their teachers were at school. Varghese et al. (2005) also point out a limitation in Wenger’s theory: “One of the issues is the focus on how individual identity develops within the structure of group practice rather than considering other ways in which identities are discursively created” (p. 30). However, they agree that professional identity is “a social matter because the formation, negotiation, and growth of teacher identity is a fundamentally social process taking place in institutional settings such as teacher education programs and schools” (p. 39). Nevertheless, it is so that identities are “discursively created” despite the commonalities which may lie in the social communities in which the individual operates. This uniqueness in individual PTI or PMTI can be ascribed to the individual core identity which is present across all contexts, as well as the formative influences which lie in the individual’s personal background, like family or cultural persuasions. Wenger (2000) emphasises the social aspect of identity formation, but negates a social-individual dichotomy:

Building an identity consists of negotiating the meanings of our experience of membership in social communities. The concept of identity serves as a pivot between the social and the individual, so that each can be talked about in terms of the other. It avoids a simplistic individual-social dichotomy without doing away with the distinction. The resulting perspective is neither individualistic nor abstractly institutional or societal. It does justice to the lived experience of identity while recognizing its social character - it is the social, the cultural, the historical with a human face. (p. 145)

Here Wenger is in fact bringing together the social and the personal dimensions of identity, speaking of the “lived experience” of identity. While there is a distinction between the two, there is a melding into what he describes as the “pivot” between the social and the personal. This echoes the words of Chanfrault-Duchet (2004) who describes PTI as the crossroads between the personal and the social self. That which is socially experienced is absorbed and internalised. Van Zoest and Bohl (2005) describe this process as a continuum: “We view forms of learning and knowing as lying on such a continuum, with in-the-brain on one end, social on the other, and every variation of combinations of the two stretched between them” (p. 332). They refer to “*Aspects of Self-in-Mind*” and “*Aspects of Self-in-Community*” (p. 332) to elucidate their thinking. PTI should be recognised, I believe, as the result of the formative influences of both the social and the personal or psychological dimensions of human endeavour, the “who I am as a teaching professional” being the meeting point of the contexts in which I operate and how I think in those contexts.

Ernest (1988), investigating the practice of teaching mathematics, also brings together the psychological and societal aspects of the teacher's teaching-self. He calls these key elements:

- the teacher's mental contents or schemas, particularly the system of beliefs concerning mathematics and its teaching and learning;
- the social context of the teaching situation, particularly the constraints and opportunities it provides; and
- the teacher's level of thought processes and reflection.

He specifies the personal aspects: beliefs concerning mathematics as a subject and its teaching and learning; and the individual's thought processes in terms of reflection; and emphasises the constraints and opportunities of the societal aspect.

Within this society individuals thus act as the “intentional human beings” (Varghese et al., 2005, p. 23). The development of PTI is not random, but a result of the agency of the individual. No teacher, pre-service or otherwise, is an automaton – all have the ability to think, make decisions and to accept or reject influences within their professional environment. This environment is not a singular, uniform and consistent context. It varies from class to class, from class to staffroom, from school to tertiary training facility. Each context comes with its own set of developmental and influencing factors, resulting in what can be described as different identity responses to different contexts. Roth and Lee (2007) discuss the notion of the salience of different identities in different contexts, the choice of which is dependent on human agency:

Whichever identities are salient for an individual during a particular context exist in a complex dance with one's sense of agency and position within the social world. Besides bringing about some change in the world, human agency also provides others and self with resources for making attributions about the kind of person one is. (p. 215)

Thus emphasizing the role of human agency within the different formative social contexts, they in effect bring together the social and psychological aspects of identity formation: human agency implies the action of the individual's will and intellect (i.e. that which is personal and psychological-which comes into play in different societal contexts).

Not only is the development of PTI dependent on the agency of the individual in different contexts, but it is an ongoing process of formation (Cooper & Olson, 1996; Borko and Putnam, 1996; Beijaard et al., 2004; Roth & Lee, 2007). This process has a double function – it develops PMTI, which at the same time affects the context in which it is developing (Cooper & Olsen, 1996). This idea of an inward development *and* an outward development can be extended into the notion that PMTI is something that can be *had* and *used* in order to establish oneself in the professional environment (Beijaard, Meijer, & Verloop, 2004). Zembylas (2003) calls this “self as a form of working *subjectivity*” (p. 107).

In summary: PTI develops on two planes: the social and the personal. The former is attributable to participation in communities of practice and acting in different contexts, which lead the individual to reason, make decisions and act in those contexts. Researchers emphasise the *agency* of the individual across different contexts in PTI development. This implies that the “who I am at this moment” is influenced by the decisions and choices I make as an individual. There are thus two distinct aspects to PTI development: the personal/psychological/internal and the societal/contextual/external. These two are mutually influential, since the individual’s PTI, while being influenced by factors within the context, also actively influences its context. PTI can be seen as the meeting point of the personal and the social. This development is a continuous process which does not necessarily contribute to a unitary identity – different PTI’s may be operationalised according to the different contexts in which the individual is acting. The complexity of which researchers write when discussing PTI is evident in investigating the construct. It is polysemic and unique to each individual; it is the continuously developing product of an ongoing process; it is shaped by the society in which it operates and simultaneously shapes that very society.

2.4 The nature of PTI

This section includes discussions regarding the various elements that are part of the nature of PTI and therefore also part of PMTI. The definitions which are found in the literature (see Section 2.1.2) indicate a general agreement regarding certain elements or characteristics which are consistently found by researchers to be present in PTI. Three categorisations of characteristics dominate the academic discussion: PTI is susceptible to context; PTI is not a unitary phenomenon, but seems to

consist of sub-identities; PTI is not fixed, but changes continuously and is influenced by various factors.

Susceptibility to context

Professional identity is sensitive to context (Peshkin, 1984; Lave & Wenger, 1991; Boaler et al., 2000; Beijaard, Meijer, & Verloop, 2004)). This implies firstly that certain aspects of identity are salient within certain contexts. For example, when in the classroom, the “teacher” aspect of PTI may be prominent, while, when dealing with a learner who is experiencing difficulties, the “carer” aspect may be more conspicuous. Stronach et al. (2002) call these “occasional identities” and speak of “a complex of occasional identities in response to shifting contexts” (p. 117). Fearon (1999) explains the same notion using practical examples:

One might answer the question “who are you?” entirely differently in different circumstances. For example, depending on the context, I might answer “an American,” “a professor,” “a son-in-law,” “a taxpayer,” “a Democrat.” In some situations I might even give my social security number. By this simple definition, then, it is trivial that one might have multiple identities, understood simply as answers to the question “who are you?” since how you answer the question will depend on the specific context. (p. 12)

Beijaard et al. (2004) define PTI as ‘who I am at this moment’. This implies that in a different moment, I may be different in terms of how I identify myself. Day and Leitch (2001) emphasise this point: “Yet what we believe, say and feel in one role may be quite different from what we believe, say and feel in another...Past and present contexts too are, therefore, important” (p. 407).

Multiplicity

Since PTI is not a singular, unitary phenomenon, but has multiple constituents which help to make it unique for each individual (Volkman & Anderson, 1998; Coldron & Smith, 1999), I believe that, rather than different *identities* coming to the fore in different contexts as Stronach et al. suggest, it is more accurate to say that different *aspects* of identity are more prominent in certain contexts. Beijaard et al. (2004) refer to these aspects as sub-identities et al. which arise through the variety of contexts and relationships in which a teacher might live and work. Peshkin (1984) refers to these sub-identities as “subjective selves” and explains that “[w]hich one comes to the fore depends on the situation in

which we find ourselves” (p. 34). Therefore, while academics are not in agreement regarding appellation of this phenomenon, they are unanimous about the sub-dividedness of PTI.

Beijaard et al. (2000) identify three specific aspects of the mathematics teacher which may be seen as sub-identities or clusters within her PMTI, since the “who I am at this moment” is different in each one of these aspects. Beijaard, Verloop and Vermunt (2000) in their study of professional teacher identity, were “inspired” (p. 751) by the work of Bromme (1991), from which they drew the idea that teachers derive their professional identity from “the ways they see themselves as subject matter experts, pedagogical experts, and didactical experts” (p. 751). Beijaard et al. explain that, in Europe (they were based in Holland) these concepts are “relevant components of models and theories of teaching on the basis of which (student) teachers organise their work” and that there is “an overlap between the Anglo-Saxon concept of pedagogy and the European concept of teaching-and-learning... in European countries both concepts have different meanings” (p. 751). Pedagogy, in the European context refers in particular to the socio-moral support of the learners, while didactics refer to teaching-and-learning skills.

Changeability

The third characteristic of PTI refers to its changeability. Apart from the salience of different aspects of PTI in different contexts, the literature also indicates that those aspects or sub-identities are subject to change. Some researchers have found that PTI changes constantly (Danielewicz, 2001; Day, 2002; Roth & Lee, 2007; Vloet & van Swet, 2010). Roth and Lee (2007) ascribe this changeability to social context: “instead of being an invariant attribute, the identities of subjects, who we are with respect to others (community), are co-constituted with and by the social and material resources at hand” (p. 216). This implies that, as the “social and material resources at hand” change, so does the constitution of the professional identity.

Others have found that there is a rigidity within PTI which bends with difficulty to receive change (Kagan, 1992; Ball, 1996; Cross, 2009). The literature is not clear concerning which constituents of identity are changeable and in a state of flux, and which are not. This demonstrated in the research conducted by Ball. At the time when large scale reforms were being imposed on the teaching of mathematics in the USA, Ball (1996), herself a teacher educator, examined the effects of such

definitive changes on the teaching and learning of mathematics, and in particular on the changes in teacher education. She found that a real rigidity existed which made adapting to reform extremely problematic:

Because the mathematics reforms challenge culturally embedded views of mathematics, of who can- or who needs to – learn math, and of what is entailed in teaching and learning it, we will find that realizing the reform visions will require profound and extensive societal and individual learning – and unlearning – not just by teachers, but also by players across the system. (p. 2)

Ball identifies one of the main problems in adapting to reforms in the fact that the teachers were required to teach in ways they had never seen or experienced: in terms of identity then, they were required to adopt into their professional identities ways of teaching which did not correspond with their knowledge and beliefs about effective teaching and learning. The element of rigidity in the system that was being reformed had impacted their personal ability to reform: “And so a paradox emerges. Elementary teachers are themselves the products of the very system they are now trying to reform” (ibid, p. 16). The resistance to change, Ball found, was not based on negative aspects of the reforms, which were generally accepted to be “attractive and inspiring in many ways. Yet there are also powerful disincentives to engage with this agenda, and some of these are deeply personal and at the heart of the identity one tries to create as a good teacher” (ibid. p. 19).

Kagan (1992) presents an entirely different notion: that a certain amount of rigidity within PTI is *essential* for professional growth:

Novices who enter the classroom without clear images of themselves as teachers are doomed to flounder. Bullough [the researcher in a case study with 15 prospective secondary school students] speculated that this may account for many cases where the effects of a teacher education program appear to be erased by classroom practice. ...when novices do not possess clear self-images with which to integrate program knowledge, program knowledge remains superficial and easily replaced. (p. 146)

In her opinion the strength or clarity of the self-image is a determinant of professional success for the new teacher. While clarity of self-image and rigidity within PTI may not be exactly congruent, it can be argued that clarity regarding who one is as a teacher provides rigidity to the structure of PTI

much as the skeletal framework provides rigidity to the human body. Thus an indiscriminately flexible and changeable PTI would certainly be a reason to “flounder” in the profession.

In summary: there appears to be some contradiction in the literature: while some researchers define the nature of identity as ever-changing and in a state of flux, others describe identity (particularly of the mathematics educator) as rigid and inflexible (Wilson & Goldenberg, 1998; Boaler, 2000). However, this contradiction is explained away when considering that the individual identity can be both rigid and flexible simultaneously, depending on the issue at hand. For example, in Ball’s study, mathematics teachers accepted changes in the theory of mathematics education as worthwhile and even inspirational, but were much less flexible when it came to changing their classroom practice. Thus there is a ‘good’ and a ‘bad’ rigidity and a ‘good’ and a ‘bad’ changeability. PTI that is unformed and amorphous seems to cause the individual to be unable to assess and assimilate valuable theoretical knowledge such as might be acquired at tertiary level. This also implies that the individual’s PTI is so changeable that success in the profession is unlikely. On the other hand, if PTI is so rigid that no change is possible, the individual’s practice becomes stagnant and new techniques in teaching and learning, for example, are not assimilated and put into practice. Therefore, a *strong* rather than a *rigid* PMTI seems to be ideal: one which is able to change when change is necessary and positive, and yet is able to offer a firm ‘operational platform’ from which decisions in practice can be made. In fact, if PMTI is to develop and grow, change is essential.

2.5 The influencers of PMTI

PTI is described by researchers as something which is continually changing, growing, developing, situated, not fixed but dynamic. Thus the tendency to *develop* is part of its nature; consequently PMTI is subject to influences which modify it. The literature indicates that the dynamics of environment and individual experience influence the formation of teacher identity in the learners who are being taught. For example, Ma and Singer-Gabella (2011) confirm that:

Recent research on the development of pre-service mathematics teacher identity is consistent with this conception, highlighting the relationships among prospective teachers’ identities as learners, doers, and teachers of mathematics and the contexts and practices in which they are situated. (p. 9)

Flores and Day (2006) refer to social, personal, cognitive and emotional responses as influencers of PTI; Alsup (2006) speaks of life experiences as influencers; Beijaard et al. (2000) identify three influencing factors on the mathematics teachers' professional identity: the teaching context, her teaching experience and her personal history. In identifying these three influencers, Beijaard is combining the social and the personal by examining the teacher's past and present contexts (life experiences) which have influenced her PTI. Where Beijaard was studying the professional identity of experienced secondary school teachers, this study concerns pre-service teachers in their final year of study. Beijaard's three influencers may in this context thus be seen as the teaching practica, the tertiary environment, and the student's individual background, including schooling and personal history. However, another influencer is discussed by researchers like Thompson (2009), Ernest (1988), Cooney (2003) and Cross (2009) who have found that the teacher's view of the subject mathematics also has an effect on their practice.

2.5.1 The influence of personal background

No student arrives on Registration Day at university without having lived through various experiences both inside and outside of school as she was growing up. Each person comes from a particular background, family, culture, personal environment. Anderson (2007) explains the link between the individual's social relationships and mathematics as follows: "Through relationships and experiences with their peers, teachers, family, and community, students [learners] come to know who they are relative to mathematics" (p. 7). The wording used here is significant: "who they are" by definition refers to identity; and "relative to mathematics" indicates a positioning of this identity with regard to the subject. According to Anderson, then, this positioning is established through social interactions contained in the student's personal history. MacGregor (2009) echoing the words of Day and Leitch (2001), speaks of "influences of the past" which are contained in narratives:

When pre-service teachers commence their University study they bring with them varied narratives about who they believe they will become as teachers... The narratives of professional identity that they hold have been shaped by a range of social, political and educational constructs. (p. 3)

Thus PMTI is developed under the influence of external elements which may (like teachers) or may not (like parents and family) be directly related to the subject mathematics. Nevertheless, these

influencers are acknowledged in the literature as meaningful and important (Knowles, 1992; Kelchtermans, 1993; Sugrue, 1997; Beijaard et al., 2004). Sugrue (1997) in fact found that pre-service teachers' lay theories around teaching are rooted in their own personalities, but are heavily influenced by family and experiences. Knowles (1992) includes early teacher role models. Beijaard et al. (2004) refer to all these aspects as “biography”:

A (student) teacher's biography, then, is important in the process of identity formation... early childhood experiences, early teacher role models, previous teaching experiences, and significant or important people and significant prior experiences as relevant biographical categories. (p. 115)

It would seem that the image of self-as-teacher is very closely linked to the image of self-as-learner. Learners come to know what it means to be in a mathematics classroom (Anderson, 2007). Boaler, William and Zevenbergen (2000), contend that “students who develop a sense of identity which resonates with the discourse of mathematics are more likely to continue with their studies than their peers who do not develop such a sense of identity” (p. 1). They found that this ‘resonance’ with what happens in the mathematics classroom is characterised by three things: a sense of belonging to a community; a sense of achievement within the community; and particular behaviours associated with the community. As learners are therefore participants in the community in the mathematics classroom, they are influenced by the dynamics of that community in terms of who they are with regard to mathematics teaching and learning. Lave and Wenger (1991) explain quite simply that learning is in fact “a social practice through which we come to know who we are” (p. 2). Within the social practice of being a learner in a classroom, there is a variety of identity-influencing factors, including the teacher, the rules of the classroom and the exigencies of the content of the subject itself. Op't Eynde, De Corte and Verschaffel (2006) found that learners come to an understanding of the dynamics of the mathematics classroom: “their understanding of and behaviour in the mathematics classroom is a function of the interplay between who they are (their identity), and the specific classroom context” (2006, p. 194). Boaler, William and Zevenbergen (2000) explain that the learners “learn how to be a mathematics student” (p. 3). It is quite conceivable that the learner also learns how to be a *mathematics teacher* in this social practice. According to Boaler the teachers “through their actions and talk convey a sense of what it is to be a member of this community of practice” (p. 4).

Not only do the student's memories of being in a classroom as a learner play a central role in their own performance as teachers, but it also affects their perception of the learners in front of them. Kagan (1992) found that, "in constructing images of teachers, novices may extrapolate (albeit unconsciously) from their own experiences as learners, in essence, assuming that their pupils will possess learning styles, aptitudes, interests and problems similar to their own" (p. 145). Thus deeply entrenched personal perceptions not only affect how the student teacher sees herself, but also how she sees others, depending on the context in which she finds herself.

The literature indicates that teachers have strong images of what it means to teach mathematics that were formed while they were still learners (Ball, 1988; Beijaard, 1995; Liljedahl, 2002). For example, Liljedahl unequivocally states that "...the formation of teachers' beliefs about mathematics teaching and learning come from their own experiences as a learner of mathematics" (2002, p. 2). However, these images do not just concern the teaching and learning of the subject, but also the context, the school, and the subject itself (Ball, 1988). Ball describes these learner images or beliefs as "a web of interconnected ideas" (p. 40) which were developed while the individual was still at school. The significance in these school-born images lies in the fact that they constitute the basis of the individual's PMTI:

These ideas are more than just feelings or fleeting notions about mathematics and mathematics teaching. During their time as students of mathematics they first formulated, then concretized, deep seated beliefs about mathematics and what it means to learn and teach mathematics. It is these beliefs that often form the foundation on which they eventually build their own practice as teachers of mathematics. (Liljedahl, 2007)

This being the case, South African learners, for the most part receiving their schooling in teacher-centred classrooms, have therefore firmly embedded a "web of interconnected ideas" concerning the mathematics classroom. These ideas form the foundation for the PMTI of those who enter the mathematics teaching profession.

In South Africa, as in many countries all over the world, classrooms are still mainly teacher-centred (Nkhoma, 2002; Hiebert, Morris & Glass, 2003; Jacobs, Hiebert, Givvin, Hollingsworth, Garnier, & Wearne, 2006; Staples, 2007). It is therefore in a teacher-centred environment that "professional

identities” may have been engendered: both in the mathematics teacher and in the mathematics learner. Learners and teachers are aware, consciously or otherwise, of what it means to be in a mathematics classroom either to learn or to teach. Between the two poles of learner and teacher lies the mathematics student teacher who, for four years, is in a phase where she is no longer a learner, nor is she yet a teacher. At this time identity-influencing factors from “learner-hood” (which may be teacher-centred) are interacting with identity-influencing factors inherent in tertiary training, which, at the UP, focuses on learner-centeredness. Teachers of mathematics were traditionally accustomed to teaching clearly defined sets of rules (what Boaler and Greeno refer to as “the lack of variety... in mathematics lessons” (2000, p. 176)) which generally remain constant and immutable. Boaler also refers to “figured worlds”, of which the mathematics classroom is described as a particularly “narrow and ritualistic” (ibid. p. 171). In fact, Ball (1993) speaks of the “curriculum of the dead” in which learners had no role to play other than being passive receptors of remote facts. However, the National Curriculum Statement introduced in 2006 entrenches a learner-centred approach to education in South Africa. Therefore, pre-service mathematics teachers at UP are subject to conflicting influencers: their own schooling was mainly teacher-centred, yet their professional training requires learner-centeredness.

2.5.2 How tertiary education shapes PMTI

Teacher educators, according to Spalding, Klecka, Lin, Wang and Odell (2011) are “well aware of the widespread public perception that teacher education is an archaic enterprise, out of touch with teachers’ real-world needs, stubbornly and self-servingly refusing to teach teachers the simple, finite set of skills they need to survive” (p. 3). Thus there is a perceived general intransigence of teacher training programmes when it comes to adapting to, or even acknowledging the changing requirements of the reality of the school environment despite inquiries and reviews in this area. Graham and Phelps(2003), teacher trainers in Australia, speak of the changes within teaching as a profession and the evolving demands placed on teachers by the community, all of which had been the subject of reports for twenty years prior to the introduction of change in teacher training programmes in Australia: “Irrespective of the plethora of recommendations that typically result from such reviews and inquiries, a significant concern that emerges is the lack of understanding or agreement about what is the best approach to the initial and ongoing formation of teachers”

(Graham & Phelps, 2003, p. 2). This begs the question, “why those with responsibility to transform teacher education and the quality of teaching did not meet the challenges and why, when so many issues were highlighted, so few were addressed.” (p. 2) One reason for this may be the gap between theory and practice (Brouwer & Korthagen, 2005; Schepens, Aelterman & Vlerick, 2009).

Challenges: the gap between theory and practice

Students are required to integrate theory and practice in a way that makes sense to them, but they then move into schools for their teaching practicum where they are frequently confronted with practice that resonates with what they experienced themselves as learners. Smagorinsky et al. (2004) speak of the different belief systems of the two environments which the student is required to reconcile in order to function successfully in both. A student teacher they worked with expressed her concerns about practicum as follows: “What I am concerned about I think throughout this semester, being with my [cooperating] teacher as opposed to being at [the university], I just hope that I don’t totally switch to her side” (Smagorinsky et al., 2004, p. 8). In this young woman’s mind the school and the university were not only dissimilar in teaching philosophy, they were on entirely opposing sides. Worse still, the researchers working with her found that “her effort to reconcile the different belief systems affected the development of her identity as teacher” (p. 9). She had in fact fallen into what Feiman-Nemser and Buchmann had identified as the “two-worlds” pitfall, as early as 1985. The basis of this dichotomy, according to Smagorinsky is the university’s concerns with ideals, and the school’s concern with “their gritty application” (p. 9). Walshaw (2010) explains as follows:

The university course work, on the one hand, imposed specific strategies of being, acting, and thinking about what effective mathematics teaching is like. Supervising teachers in schools, on the other hand, invest in their own particular discursive codes of mathematics pedagogy which foreground particular processes and practices of planning and enacting practices in the classroom. (p. 119)

One of the problems associated with the distance between theory and practice is the fact that often, while learner-centeredness is taught at university, it is not practiced. Walczyk, Ramsey and Zha (2007) found that “[n]umerous studies have documented the infrequent use of learner-centred instruction in college science and mathematics classrooms and its negative effects on undergraduate learning and motivation” (p. 85).

Challenges: entering perspectives

Learners have spent years observing teachers as well as the general dynamic of the mathematics classroom, resulting in what Borko and Putnam (1996) call “entering perspectives” (p. 679). These “entering perspectives” of pre-service teachers are entrenched through what Borko and Putnam calculate to be more than 10 000 hours of apprenticeship in observing their teachers while they themselves were learners. However, one or two hours per week out of possibly twenty eight weeks in the tertiary academic calendar for maybe three years make a generous estimate of pedagogical training: more than likely less than 170 hours in total during the course of a teacher training programme. Sheer numbers make it obvious that the training programme would have to outweigh the “entering perspectives” in intensity in order for the training to make a difference. The likelihood of this happening, according to Borko and Putnam, is not strong.

Researchers agree that these perspectives are of paramount importance as critical sieves through which tertiary training is filtered (Kagan, 1992; Borko & Putnam, 1996; Chuene & Lubben, 1999; Stuart & Thurlow, 2000, Wilson, Cooney & Stinson, 2005). The concern is that the basis used for judgement and filtering is not sound: “From years of teacher watching in school, pre-service teachers have long developed theoretically uninformed, underdeveloped and pedagogically naive views or conceptions about teaching” (Chuene & Lubben, 1999, p. 24). Since they frequently do not challenge these naive beliefs, which are then in fact confirmed in teaching practice, “the tertiary course experience can be seen as an anomaly and in time, dismissed” (Grootenboer, 2006, p. 275). The question therefore remains – how must the in-service university courses be structured or presented so that new learner centred knowledge and beliefs not only take pre-eminence over the old teacher centred knowledge and beliefs, but actually supplant them?

Challenges: redundancy of training

Tertiary training may also be dismissed if the student feels that it is redundant – she believes that she already knows how to teach because of her years of experience with teachers and teaching during her own schooling. Feiman-Nemser et al. (1987) found that prospective elementary teachers began their tertiary training *already* feeling prepared to teach. This may well have a wider application than just prospective elementary school teachers, meaning that pre-service teachers feel that they already know how to teach, thus giving an element of superfluity to their teacher training. Liljedahl (2002) speaks

of the effectiveness of mathematics education as being dependent on “a complex coordination of specific knowledge and specific beliefs” (p. 1). He is critical of teacher education programmes:

Too often, however, the emphasis... is placed on the infusion of content knowledge, pedagogy, and pedagogical content knowledge, with only a cursory treatment of the beliefs that, for better or for worse, will govern the eventual application of what has been acquired within these programs. (p. 1)

In fact, according to the research done by Walkington (2005), students actually have a very limited expectation of what their tertiary training should teach them: “When asked what they expect to learn at university, the majority of respondents clearly focused on subject knowledge, how to teach that subject knowledge, how to gain the respect of children and how to ‘control’ children” (p. 58).

Challenges: experiential disparity

Another consequence of the “apprenticeship of observation” (Stuart & Thurlow, 2000, p. 114) lies in the possibility of the student’s experience as a learner being so different from what is taught at university that assimilation of the latter becomes too difficult. Wenger (2000) explains: “Communities of practice cannot be romanticized. They are born of learning, but they can also learn not to learn” (p. 229). There are two possible situations in which little learning takes place, he postulates. In one, “competence and experience are too close” and in the other, “experience and competence are too disconnected” (p. 233). It is possible that teacher training is so dissociated from the students’ own school experiences that school and university are polarised. Wenger (2000) uses a hypothetical situation to illustrate this point – an ordinary person is in conversation with a group of serious scientists:

Sitting by that group of high-energy particle physicists, you might not learn much because the distance between your own experience and the competence you are confronting is just too great. Mostly what you are learning is that you do not belong. (p. 233)

If the student finds that what is taught in teacher training is not something which she can easily assimilate because of the distance between her experience and her competence, it may well result in the pre-service teacher abandoning what she has been taught in favour of traditional school praxis (Smagorinsky et al., 2004).

Challenges: lecturer/student gap

This “distance” may be one of the reasons for which Kagan’s research of 40 case studies revealed a common factor: the inadequacy of teacher training. “Teacher education is not speaking to teachers where they are. Feelings of anger and frustration about teacher education are typical among teachers” (1992, p. 162). Tertiary training of pre-service teachers is designed by educationists who themselves have certain knowledge and beliefs, gained through their own experience or through their observation of others, which influence what they teach. According to Liljedahl (2007),

Our understanding of what knowledge and beliefs are needed for the teaching of mathematics is informed by the knowledge and beliefs possessed by teachers who are effectively (or not effectively) teaching that concept. This emerging understanding, in turn, informs our work in pre-service and inservice teacher education as we work to develop the necessary knowledge and beliefs within teachers.

Therefore teacher trainers operate from the framework of their own belief system within the modules they present, while trainee teachers work within the framework of *their* own system of beliefs and knowledge. Research by Borko and Putnam (1996) reveals that often these two systems are in conflict with each other: “the beliefs about learners and learning promoted in many teacher education programs and reform agendas differ, sometimes markedly, from those prevalent in schools and characteristic of many entering teachers” (p. 679). Each of these role players (teacher trainer and trainee teacher) have their own concept of what should constitute teaching and learning, and each has an understanding of his/her own professional identity. According to Ball (1988), teacher training seldom takes serious cognisance of the beliefs and conceptions of student teachers:

Instead of taking what they already know and believe into account, teacher educators tend to view prospective teachers as simply *lacking* particular knowledge and skills. This lack of attention to what prospective teachers bring with them to learning to teach mathematics may help to account for why teacher education is often such a weak intervention – why teachers, in spite of courses and workshops, are most likely to teach math just as they were taught. (p. 40)

Adler, Ball, Krainer, Lin and Novotna (2005) found that the ‘gap’ between teacher educators and pre-service students is increasing: “a significant note about who is (re)learning to teach mathematics is that differences are increasing between teacher educators and their ‘learners’ – i.e., prospective and practicing teachers” (p. 361).

Opportunities for solutions: training for reflection

A possible means of resolving the problems regarding the effect or lack thereof of tertiary training is discussed by Graham and Phelps (2003), who were the designated designers of a new module in teacher training at Southern Cross University in New South Wales. Their concern was that the module should cause student teachers to “engage with what it *means* to be a teacher” (p. 4); that the question of ‘Who am I?’ be operationalised into ‘What do I have to do?’ According to their experience and research, what was needed was a move from a “competency approach” (p. 8) to a reflective one. Acquiring the habit of reflection would help pre-service teachers to grasp the need for continuous learning and give them agency in the development of their own professional identities: “Reflection, used well, can potentially position the developing teacher to be able to continually reconstruct his/her professional knowledge in response to the changing imperatives, demands and expectations of ‘being a teacher.’” Stronge (n.d) corroborates this: “Reflective teachers portray themselves as students of learning.” The new module developed by Graham and Phelps was designed to facilitate the process in which student teachers could begin “to construct themselves as ‘expert learners’” (p. 10). Once this notion of continuous learning by “expert learners” is established, Graham and Phelps theorise that these neophyte teachers will be aware of what they do not know, what they are currently unable to do successfully and where their attitudes need adjustment, and they will then be able to use appropriate strategies to change the status quo.

From these principles it follows that amending teacher training courses to form a more constructivist environment challenging students’ knowledge and beliefs and helping them to be more reflective could create generations of teachers who are able to adapt to change and can accommodate new ideas in their professional identities (Nolan, 2006). Skott (2001) espouses this idea: “Teachers’ reflections on practices, then, may turn the classroom into a learning environment for teachers as well as students” (p. 4). While this appears to be a viable solution to the problem of inflexibility in terms of professional teacher identity, a reflective practice requires time, as the experienced teachers interviewed by Wilson et al. (2005) pointed out: while they recognised the value of reflection, “they claimed that a teacher needs to think about her or his practice but noted that there was not always time to reflect” (p. 100). Therefore the inculcation of reflection as a property of good teaching may, in fact, increase stress in the workplace because of the conflicting time demands of teaching and

reflecting. In Kagan's research, some novices, although encouraged to be reflective in their teaching practice, were so overwhelmed by the classroom and its exigencies, that they "fell back on the culture of their respective schools, in some cases adopting pedagogical orientations *contrary* to those encouraged by the university program (1992, p. 144) (emphasis added). It has not however, been established whether a limited number of hours spent in teacher training lectures can even effectively bring about the habit of reflection and the facility to use that reflection to make methodological decisions in an environment far removed from the lecture hall, taking into account what Kerkham calls "the spatial dimension of identity" (p. 5) in which context is closely related to place.

Opportunities for solutions: hands-on training

Besides encouraging reflectivity, tertiary training could also be positively amended through making the programme more interactive. The students would then be more involved in a 'hands-on' type of training which would consistently be linking theory to practice. This notion is founded in the theory of Lave and Wenger (1991), who describe learning as an "evolving form of membership" (p. 53), which makes the depth of learning proportional to the involvement of the learner in the activity. Mathematics teacher education may well neglect this aspect of learning in its traditional emphasis on the cognitive, lacking in what Varghese et al. call "coparticipation" (p. 29).

This cognitive emphasis should nevertheless encompass two outcomes: students must be taught to teach, *and* they must be taught mathematics. Adler et al. describe this as a twofold task involving identity formation:

An enduring problem in mathematics teacher education is its task to build both mathematics and teaching identities. While we have learned a great deal about some of the specialty of teacher's knowledge, we need to understand better what it means to teach both *mathematics* and *teaching* in the same program. We do not understand well enough how mathematics and teaching, as inter-related objects, come to produce and constitute each other in teacher education practice. ...The field needs to understand better how mathematics and teaching combine in teachers' development and identities. (p. 378)

While much criticism can and has been levelled against teacher training programmes as a whole, the teaching profession is a complex one and preparing someone to enter it is a daunting task. In point of fact,

It should not be assumed that initial teacher preparation will enable the teacher trainee to smoothly adjust and adapt to the teaching conditions at a real school. The shift from being a university student to being a classroom teacher in most cases is a dramatic one. (Arends & Phurutse, 2009, p. 6)

Kagan (1992) comes to the same conclusion:

Classroom teaching appears to be a peculiar form of self-expression in which the artist, the subject and the medium are one. Whether any academic program of study can truly prepare someone to practice it is perhaps a question that one dares not ask. (p. 164)

2.5.3 The effect of teaching practica on PMTI

Most teacher training programmes do not consist only of lectures far removed from a school classroom - a significant percentage of the training includes practical in-service periods or practica in which students are required to work at a school as student teachers. Leatham and Peterson (2009) describe the practicum as “the capstone course of most teacher preparation programmes” (p. 99). In theory, teaching practica provide the student with an opportunity to put into practice new knowledge and skills; it allows the lecturers to assess the student as professional teacher; and it permits the student to test the character and robustness of his/her professional teacher identity and associated beliefs, against reality. Which beliefs will be dominant – the “entering perspectives”, or those imparted during teacher training? As Fives and Buehl (2008) explain, “Beliefs are at play in any learning experience. In teacher preparation, there is a spectrum of deeply held, often unexamined, beliefs that influence how future and practicing teachers approach the task of learning to teach and the knowledge they construct from experience” (p. 135). Teaching practica or field placements provide the first opportunity for observing fledgling PMTI’s in action, and are therefore important in any study on pre-service professional identity (Hiebert et al., 2003; Walkington, 2005; Cattley, 2007). They show the student doing the “work of teaching” (Ball & Forzani, 2009, p. 497).

Inexperienced students, insecure in the application of the theory taught at university, often enter school classrooms where traditional forms of teaching are practiced (Borko & Putnam, 1996). This further entrenches the properties of identity as formed *prior* to tertiary training. It is not unusual that the school's ways take precedence over the university's in the student teacher's mind during teaching practicum because two things have changed: the student is now the teacher and the person in authority over her is her mentor teacher, not a university lecturer (Borko & Putnam, 1996). A further contributing factor may well be their lack of confidence in their mastery of the subject. Ball (1988) found that teacher education students were *surprised* to find that subject knowledge was actually essential. Borko and Putnam suggest that "their knowledge of mathematics is not sufficiently connected to enable them to break away from the common approach" (p. 686). They are lacking in what Hiebert, Morris, Berk and Jansen (2007) call competences. Consequently, student teachers look to the voice of experts i.e. the in-service teacher and the textbook (Borko & Putnam, 1996) for guidance. Neither of these resources may encourage adaptability – on the contrary, both traditional teachers and textbooks tend to follow a prescriptive style. Instead of speaking of a "prescriptive style", Walshaw (2010) speaks of a "tight script":

To the supervising teacher, however, teaching constitutes a tight script that establishes how the teacher's work is to be enacted in the classroom. Not only are the pre-service teachers, then, working at embodying the technicalities of practice and behaviour in their supervisor's classroom, they are also, among other things, exploring their positioning in relation to histories of standards and value systems of the supervising teacher. (p. 121)

The literature reveals that it is possible that a teacher, pre-service or otherwise, may not in fact put into practice what she professes (Newstead, 1999; Freese, 2006). The verbalised beliefs may be those acquired through tertiary training, but these have not become so entrenched that they are translated into classroom practice (Hiebert et al., 2003). Although such theory apparently makes sense to the student since she professes her belief in the theory, it would seem that there is little connection between what is sincerely believed and what is equally sincerely practiced. The pre-service teacher probably does not know that she is not practicing what she learnt.

However, there is also the potential for problems to occur. In her investigation of the effect of extended practica on the student's nascent professional identity, Kagan (1992), found that the

university's misperception of the student teacher's abilities actually *forces* the student to adopt the school's culture even though this may conflict with what has been taught at the university:

[There is a] sharp gap between the expectations of their skills held by university faculty and their actual skills. Novices were expected to function as advanced beginners when, in fact, they did not even possess minimal survival skills. Because the faculty appeared to be insensitive or nonresponsive to the developmental needs of candidates and failed to provide them with procedural knowledge, candidates were forced to rely on prevalent school cultures. (p. 144)

When confronted with the realities of the classroom for which they are unprepared, the students revert to what they know best - the teaching methods their own teachers demonstrated when they were at school (Hiebert et al., 2003).

Thus teaching practica, intended to fortify and support the theory taught at university, may achieve the exact opposite: they may confirm the 'correctness' of teaching and learning practices last observed while the students were still learners themselves. However, these field experiences *do* allow the pre-service teacher to test 'who they are' as professionals under the aegis of an experienced mentor teacher. Metaphorically speaking, the fledgling PMTI has the opportunity to try its wings.

2.5.4 The influence of the view of the subject mathematics and its teaching and learning

This particular identity influencer is the essence of the difference between PTI and PMTI. Researchers like Thompson (2009), Ernest (1988), Cooney (2003) and Cross (2009) have found that the teacher's view of the subject mathematics has an effect on the way they teach and in fact on who they are as mathematics teachers. The way teachers of mathematics view the subject is not necessarily the same as the way engineers or scientists view it. Adler and Davis (2006) call this a "specificity to the way that teachers need to hold and use mathematics in order to teach mathematics – and [that] this way of knowing and using mathematics differs from the way mathematicians hold and use mathematics" (p. 272). The teacher's view of mathematics is based on what she believes with regard to mathematics as a cognitive construct, and how it should be taught, and so if any changes need to be made in her classroom practice, these beliefs will have to be addressed first (Cooney, 2003).

Those in whom the desire to teach has been triggered form what Borko and Putnam (1996) call an “overarching conception of teaching a subject” (p. 690). It is also possible that they may have in association with this, an overarching conception of the subject itself. Gess-Newsome (1999) speaks of a “content-specific orientation” (p. 78) which affects the teacher’s classroom practice. There is a traditional perception of the mathematics classroom as a place of rigidity and fixed rules. In their research around the fixedness of certain practices and beliefs in the teaching of mathematics, Wilson and Goldenberg (1998) conducted a case study in which a Mr Burt, a middle school mathematics teacher wanted to change the way he taught, but experienced difficulty in moving away from his traditional approach: “Mr Burt’s approach generally portrayed mathematics as a rigid subject to be mastered and correctly applied, rather than a way of thinking or as a subject to be explored” (p. 287). This man, therefore, remained rigid in his practice because of the perceived rigidity within his field. Hodgen and Askew (2007) investigating in particular the links between emotion and identity, found that there was a general tendency in the schools they worked with to teach mathematics “as a set of dull and decontextualised procedures” (p. 469). In their work with primary school teachers, Hodgen and Askew found a possible reason for this:

One common belief they [teachers] have is that a teacher’s difficulties with mathematics enables her better to empathise with and understand children’s difficulties. This can lead to teachers protecting pupils from – or defending them against – mathematics. Often such ‘protection’ focuses on making mathematics ‘simple’ and ‘easy’ by emphasising step-by-step and procedural techniques. (p. 482)

Such knowledge and beliefs derived from the various mathematics learning/teaching contexts to which the individual has been exposed, may then well be that which is so embedded in the professional identity that change becomes anathematic. It follows that this would bring about the rigidity for which mathematics teaching is often known. Skott (2001) calls these beliefs “school mathematics images” and describes them comprehensively as “expressions of unique personal interpretations of and priorities in relation to mathematics, mathematics as a school subject, and the teaching and learning of mathematics in schools” (p. 6). These act as “filters” through which learning takes place, according to Borko and Putnam (1996), and, echoing the findings of Ball, become paradoxically both “the *targets* of change and important *influences* on change” (p. 675).

Boaler and Greeno (2000), interviewing high school learners in both the United States and the United Kingdom, found that learners “seemed to accept the lack of variety they reported in mathematics lessons, not because they enjoyed the lessons, but because they thought that was the way mathematics *had to be*.” (p. 176). The problem they encountered was that this very rigidity seemed linked to what they call “received knowledge” (p. 173), a non-constructivist way of imparting information. This, in turn, resulted in some learners being repulsed by mathematics education: “many students develop identities that give negative value to the passive reception of abstract knowledge” (p. 188). The question that arises then is, the learners who become teachers of mathematics themselves, do they espouse passive reception as a viable way of knowing mathematics and does it become part of the professional identity they are developing? In other words, does this rigidity become part of who they eventually will be as mathematics educators? Or do they recognise that there are other ways of teaching and learning mathematics which they can adopt into their own professional methodology one day and does this presage flexibility within their nascent identities?

Boaler and Greeno found that such learners of mathematics have absorbed into their identities elements of style that not only are inflexible by their very nature, but are so thoroughly fixed in their understanding of teaching and learning mathematics that they perpetuate those styles in their own teaching. Boaler and Greeno call this “a cycle of received knowers, teaching received forms of knowing” (p. 196). By implication then, the teacher training which these students would have undergone was not able to affect change on that which was impressed onto their identities while they were learners at school. Borko and Putnam (1996) explain this phenomenon as follows: “Although learning can be heavily influenced by instruction, how and what individuals learn is always shaped and filtered by their existing knowledge and beliefs. It can therefore never be completely determined by instruction” (p. 674). However, Borko and Putnam (1996) use their findings to make a significant recommendation in this regard:

Because teachers’ knowledge and beliefs – about teaching, about subject matter, about learners – are major determinants of what they do in the classroom, any efforts to help teachers make significant changes in their teaching practices must help them to acquire *new* knowledge and beliefs” (p. 675) (emphasis added).

As Cross (2009) points out, “Beliefs are central to the way teachers conceptualise and actualise their role in the mathematics classroom” (p. 328). Central to this then, are the beliefs that are held regarding the subject itself. Leatham and Hill call this “mathematical identity” (p. 226) which they define as “an individual’s relationship with mathematics”. They clarify their definition as follows: “That is, the ways a person learns, does, thinks about, retains, or chooses to associate with the subject”(p. 226). Researchers like Thompson (2009), Ernest (1988), Cooney (2003) and Cross (2009) have found that beliefs in this regard range from seeing mathematics as “a static, procedure-driven body of facts and formulas, to a dynamic domain of knowledge based on sense-making and pattern-seeking” (Cross, 2009, p. 328). Ernest (1988), distinguishes between three “philosophies” regarding the subject:

First of all, there is the instrumentalist view that mathematics is an accumulation of facts, rules and skills to be used in the pursuance of some external end. Thus mathematics is a set of unrelated but utilitarian rules and facts.

Secondly, there is the Platonist view of mathematics as a static but unified body of certain knowledge. Mathematics is discovered, not created.

Thirdly, there is the problem solving view of mathematics as a dynamic, continually expanding field of human creation and invention, a cultural product. Mathematics is a process of enquiry and coming to know, not a finished product, for its results remain open to revision.

Cross (2009) refers to these three views as traditional, formalist and constructivist perspectives, respectively. She explains that these three perspectives can be further clarified as content-focused with emphasis on performance (learners follow rules and procedures), content-focused with emphasis on understanding (dual focus: content and understanding) and learner-focused (learner inquiry and sense-making), respectively. Ernest (1988) also postulates three instruction modes which teachers may follow:

1. Instructor: Skills mastery with correct performance
2. Explainer: Conceptual understanding with unified knowledge
3. Facilitator: Confident problem posing and solving

He then proceeds to link a specific view of mathematics with a specific style of teaching and a specific way of learning. Likely associations may thus be represented as follows:

- 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

In his investigation of how pre-service mathematics teacher identity may be modified, Liljedahl (2002) confirms that the deeper the beliefs the more resistant they are to change: “Unfortunately, these deep seated beliefs often run counter to contemporary research on what constitutes good practice” (p. 1). He suggests two ways in which such beliefs may be changed: one advocated by Feiman-Nemser et al. (1987) in which the beliefs of pre-service teachers are challenged, forcing them to make “explicit” that which was “implicitly constructed”, making them transform their beliefs from “non-evidential to evidential” (p. 2); the second way involves “being submersed in a constructivist environment” (p. 2). Liljedahl’s application of a combination of these techniques, in what he calls “mathematical discovery” and which forces students to make explicit their beliefs in confrontation with mathematical problem solving, “has shown that pre-service teachers’ experiences with mathematical discovery has a profound, and immediate, transformative effect on the beliefs regarding the nature of mathematics as well as their beliefs regarding the teaching and learning of mathematics” (p. 2). In fact, Liljedahl’s students almost uniformly moved away from the stance that mathematics is something to be *learnt* to one in which they understood that mathematics is something one *does*. They also realised that passive reception is anathematic to *doing*, and that doing mathematics requires talking and thinking. Liljedahl thus proved that radical change in the beliefs within a teacher identity is possible, albeit under highly controlled circumstances. Liljedahl’s findings point to the importance of the person’s beliefs regarding the subject mathematics, if change is to be brought about through tertiary modules. Ernest (1988) confirms this:

It depends fundamentally on the teacher's system of beliefs, and in particular, on the teacher's conception of the nature of mathematics and mental models of teaching and learning mathematics. Teaching reforms cannot take place unless teachers' deeply held beliefs about mathematics and its teaching and learning change.

It is thus worthwhile for researchers of PMTI to inquire as to how the teacher, or in the case of this study, the pre-service teacher, views mathematics. In this view, according to Ernest (1988), lie significant predictors of the classroom practice of the person in question.

In summary: the individual's background is a strong influencer upon her professional identity. She has images fixed in her understanding of what it means to be a teacher of mathematics placed there during her years of being a learner in mathematics classrooms. There is a certain inflexibility associated with the teaching of mathematics based on perceptions that a mathematics classroom is a place where a narrow application of rules is dominant. It is also generally a place where teacher-centeredness is still the order of the day, despite the learner-centred requirements of the national curriculum in South Africa. Pre-service teachers in this country are therefore *taught* in one way, while being expected to *teach* in another. According to the literature, the influence of schooling is very often dominant.

A second influencer of PTI is tertiary training, which is variously described as ineffectual and out-of-touch. It appears that mathematics teacher education generally does not have the positive impact on teacher identity that it aims to have, other than in the increase of subject matter knowledge. Various problems or challenges are highlighted in the literature. There is too wide a gap between the students' experiences as student teachers in schools and the theory they are taught at university; learner-centeredness, while taught and required in tertiary training, is not modelled at university. The students have deeply established viewpoints and beliefs, or entry perspectives, with which they come to tertiary training and through which they filter all they are taught at university. The result is that the tertiary programme is seen as an anomaly which has nothing to do with reality. Many students, having spent years in an internship as learners, believe they already know how to teach before their tertiary training, which thus is believed to be superfluous. It is also possible that tertiary training appears to be beyond the reach of the student, totally disconnected from her competence, so that she learns not to learn. Also, teacher trainers have their own belief systems about education, which may be in conflict with the belief systems of trainee teachers. Possible solutions for some of these challenging issues are training students to be reflective practitioners so that they are brought to thinking about their beliefs and actions, and making the training more hands-on and practical to avoid a polarisation of the university and the school as influencers.

Teaching practica, a third influencer of PTI, provide an opportunity for the neophyte teacher to practice new knowledge and skills in the classroom under the aegis of a seasoned teacher. One of the problems that arise, however, is that the theoretical training of the university is often brought into direct confrontation with a classroom environment where traditional teaching methods are employed. Lacking in competences and experience, the pre-service teacher then turns to the experts at hand – the supervising teacher and the textbook for guidance. Unless the precepts and educational theory taught at university have become embedded into the student's PTI, it is likely that they will revert to what they know best in the classroom – the way they were taught at school. This is even more likely if the school in which they are doing their practicum subscribes to an ethos which does not correspond with their teacher training.

The way the mathematics teacher views the subject has an influence on her PMTI and hence on the way she teaches and views her learners. Traditionally, mathematics classrooms are recognised for their rigidity and rule-adherence, with an emphasis on procedural techniques. A student may enter teacher training with such firmly fixed ideas about mathematics and how it should be taught, that what is taught at university, if it does not seem congruent to these ideas and beliefs, is not allowed to influence their PMTI. Three main views of mathematics are identified: Instrumental (traditional – teachers teach and learners listen); Platonist (teacher explains and learners receive knowledge) and Problem-solving (constructivist: teacher facilitates learners' construction of their own understanding).

Summary of the literature study

The literature links PTI to instructional practice in the sense of 'we teach who we are'. For the purpose of this research, identity is narrowed down from the general concept of core identity (the individual's 'self' which is ever-present), to professional identity (relating to who the person is in a specific context at a specific time, making the person part of a group of similar professionals), to PTI (where the group of professionals consists of teachers) and finally is pared down to PMTI (where the group of professionals consists of *mathematics* teachers). PTI and PMTI are intrinsically congruent, except for the distinguishing aspect of mathematics as a subject and the accompanying knowledge, skills and beliefs. Many definitions for PTI are postulated in the literature, most of which refer to the properties and development of PTI (see Tables 1 and 2). Some researchers recognise the significance

of beliefs and emotions in PTI, others emphasise its tendency to be dynamic and related to context. Beijaard et al. (2004) define PTI as ‘who I am at this moment’, linking the personal to time and context. PTI relates to both the personal and the social: self-in-the-mind and self-in-the-community (van Zoest and Bohl, 2005). Beijaard et al. (2000) associate PTI with specific aspects of teaching which are common to all teachers: subject matter, didactic and pedagogical expertise.

PTI is made manifest in the classroom – we teach who we are (Palmer, 2007). In order to study the self-who-teaches, Korthagen (2004) describes an ‘onion’ model in which six layers are discussed, ranging from the environment (the outer layer) to mission or calling (the innermost layer). Van Zoest and Bohl (2005) describe a three-domain model, in which *what* is to be taught, *who* is to be taught, and interaction with communities outside the classroom are considered. Beijaard et al. (2000) also describe a three-domain model, in which subject specialisation (similar to van Zoest and Bohl’s first domain), didactics specialisation (similar to van Zoest and Bohl’s second domain) and Caring are to be investigated. The latter model most closely fits the principles laid out in the National Policy Framework for Teacher Education and Development in South Africa (DoE, 2006).

PTI develops on two planes - the social and the personal - across different contexts and in relation to other people. Chanfrault-Duchet (2004) describes PTI as the crossroads between the personal and the social self. It is adapted and modified throughout the life of the professional in question and is a significant role player both in her efficiency as a teacher, and her ability to adapt to and be adapted by changes in the teaching environment. The literature links PTI to beliefs and emotions as well as to personal histories, changing contexts and cultures. The literature also suggests a distinct link between PTI, beliefs and instructional practice: if the latter is to change, beliefs need to be influenced so that PTI, which is based upon beliefs (Bullough, 1997; Walkington, 2005), can develop and adapt to change.

The literature reveals that PTI is not a fixed, unitary concept. It is complex in that it is made up of different sub-identities, each developed in different contexts and influences (Volkman & Anderson, 1998; Beijaard et al., 2004). The characteristic of professional identity mentioned by most of the researchers, is its propensity to change and be in a state of continuous development, particularly in relation to different contexts. While some researchers describe PTI as in a constant state of flux,

never fixed, others, like Ball (1996) refer to the rigidity which characterises mathematics teachers. This apparent contradiction can be explained by consideration of different issues – in some (like changes in theory about mathematics education) change is not anathematic, while in others (like changes required in an individual’s classroom practice) flexibility is often absent.

PTI is influenced by a number of factors, the social leading to the personal (Lasky, 2005). These factors can be categorised as biography (Knowles, 1992; Kelchtermans, 1993; Sugrue, 1997; Beijaard et al., 2000), teacher training (Kagan, 1992, Borko & Putnam, 1996; Adler et al., 2005), the school context (Beijaard et al., 2000; Flores & Day, 2006) and the individual’s view of mathematics (Ernest, 1988; Cooney, 2003; Thompson, 2009; Cross, 2009). While the individual’s own schooling experiences are deemed to be a very strong influencer of PMTI, teacher training, according to the literature, is not as effective as it purports or aims to be. Various theories are put forward: the pre-service teacher’s beliefs and knowledge gained from school experiences outweigh the precepts of teacher training simply because of the ratio of time spent in either institution; teaching practicum reinforces the pre-service teacher’s own school experiences, not what is taught at university; pre-service mathematics teachers’ subject knowledge is insufficient to allow them to break away from the old methodologies within which they feel safe; the person’s view of the subject itself affects how she teaches it. Promoting a reflective practice as part of teacher training is suggested as a way around the intransigence of methodologically unsound practices, but the practicalities of instilling such practice in such a way as to alter or even replace these practices remain unclear.

PMTI is thus described in the literature as complex in both its nature and its development. It is multi-faceted, sub-divided and subject to change; it is affected by context. It can be investigated through the individual’s perceptions of who they are as a teacher of mathematics, and how that identity is made manifest, or actualised, in the classroom.

2.6 Conceptual Framework

Since PMTI has a complex nature, any conceptual framework used to study this construct needs to address this complexity. For this reason, it was deemed necessary to combine aspects of frameworks regarding investigation of teacher identity as found in the literature, particularly in the work of Beijaard et al. (2000), Ernest (1988) and Thompson (2009). Figure 1 below represents the conceptual framework that has been constructed for this study.

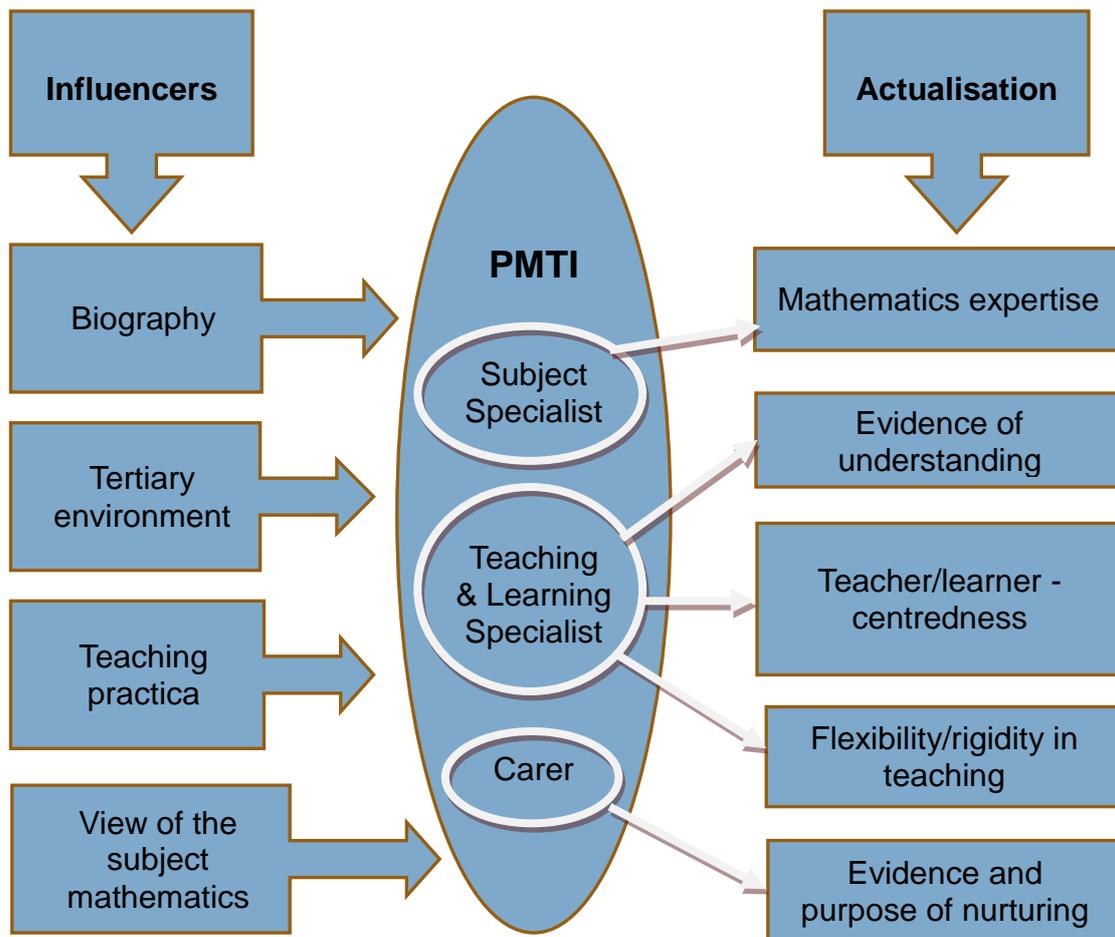


Figure 1. Conceptual framework for PMTI

2.6.1 PMTI

For the purpose of this study, the work of Beijaard et al. (2000) is used as the principle structure for the conceptual framework. It matches the requirements of the national education policy in South Africa. According to the National Policy Framework for Teacher Education and Development in South Africa (DoE, 2006) the following aspects are what should be seen in a good teacher. She must reveal herself to be

- a specialist in a particular learning area, subject or phase;
- a scholar and lifelong learner; and
- a curriculum developer;
- a specialist in teaching and learning;
- a specialist in assessment;
- a leader, administrator and manager;
- a professional who plays a community, citizenship, and pastoral role

The first three aspects can be linked to subject specialisation and being an expert in terms of what is required in terms of a particular subject; the next two deal with expertise in the skills necessary for teaching and learning; and the last two refer to the importance of the caring, guiding and leading aspects of being a teacher. The National Council of Teachers of Mathematics (NCTM) says much the same thing: a good mathematics teacher must know mathematics well and must have the skills and strategies to guide learners' understanding and learning (2008). However, while these aspects encapsulate important properties of 'teacher-hood', the complexity of what is implied in the 'self-that-teaches' goes beyond these aspects. In the words of Alsup (2006):

They [teachers] know that the profession is often perceived, both by “insiders” and “outsiders”, as being *more* than a job – instead as a way of life or a “calling”. A teacher is defined as an individual who should go above and beyond the call of duty for the benefit of the young people with whom he or she works, with no expectation of extra reward, much less even adequate compensation. (p. 20)

Therefore, when considering the actualisation or manifestation of PMTI as 'the teacher' in action, it must be born in mind that while certain aspects can be looked at specifically in order to make this

actualisation describable, there is more to it than can be captured by the examination of a finite number of aspects. This said, study of the actualisation of PMTI is *facilitated* by examining a limited number of aspects. In the Beijaard framework three aspects of PMTI are considered, which they define as follows: the teachers as a specialist in terms of: subject matter (*subject content knowledge and skills*); didactics (the knowledge and skills related to the preparation, execution and evaluation of the *teaching and learning process*) and pedagogy (the knowledge and skills required to *undergird and support the socio-emotional and moral development of learners*, in a word, *caring*). Van Manen (1991) in fact defines pedagogy as “all those affairs where adults are living with children for the sake of those children’s well-being, growth, maturity, and development” (p. 28). In this study, PMTI, as ‘self put into practice’ (Joseph & Heading, 2010), will be analysed in terms of these three aspects: Mathematics Specialisation, Teaching-and-learning Specialisation, and Caring.

2.6.1.1. Mathematics specialisation

In this study, this aspect of PMTI deals with the individual’s perception of her knowledge and understanding of the subject mathematics, what it entails and how it relates to the real world. Leatham and Hill (2010) call this “mathematical identity” (p. 226) which they define as “an individual’s relationship with mathematics”. The literature indicates that there is a strong correlation between the teacher’s knowledge of mathematics and successful classroom practice (Hill, Rowan & Ball, 2005; Ball, Thames & Phelps, 2008; Krauss, Brunner, Kunter, Baumert, Blum, Neubrand & Jordan, 2008, Wilkins, 2008; Pang, 2009). Therefore subject expertise is an important aspect of the PMTI of a good mathematics teacher. Ernest (1988) and Thompson (2009) found a distinct link between the individual’s beliefs and understanding of mathematics and the way that person teaches. As part of successful classroom practice, the importance of the teacher’s responses to learner questions is agreed upon by academics (Chin, 2006; Ainley & Luntley, 2007; Darling-Hammond & Richardson, 2009).

Since the actualisation of this aspect of PMTI is studied in terms of classroom observation, the student’s ability to deal with the actual mathematics in the classroom – both in terms of what she was teaching, and in terms of her answers to questions that arise, is analysed. Specifically, the accuracy and comfort with which she handles the mathematical concepts is studied. This facility with the subject is called “mathematical knowledge for teaching,” by Hill, Rowan and Ball (2005):

[W]e mean the mathematical knowledge used to carry out the *work of teaching mathematics*. Examples of this “work of teaching” include explaining terms and concepts to students, interpreting students’ statements and solutions, judging and correcting textbook treatments of particular topics, using representations accurately in the classroom, and providing students with examples of mathematical concepts, algorithms, or proofs. (p. 373)

2.6.1.2. Teaching-and-learning specialisation

In this aspect of PMTI the person’s perception of her skills and knowledge relating to the actual teaching of mathematics as well as her understanding of the learning of mathematics are considered. These skills are what make a teacher able to teach effectively: “sophisticated teaching” is required by society’s demands for complex and analytical skills (Darling-Hammond & Richardson, 2009). It is part of the function of tertiary training to inculcate such teaching skills into fledgling teachers, yet some believe that these skills are instinctive and that one becomes a teacher because one *can* teach. In effect, that the field has chosen us (Shapiro, 2010). This study investigates the individual’s perceptions in this regard – does she see herself as having been taught to teach or as having been born with the ability to teach?

With regard to the actualisation of the individual’s conceptions of teaching-and-learning, Thompson (2009) examined the locus of control, which she saw as where the control of the activities in the classroom lay, seen in this study as learner/teacher-centeredness; what is recognised as evidence of understanding; and how flexible the participant was in her teaching. This flexibility she related to planning. While planning is an important task (So & Watkins, 2005), a good mathematics teacher should be able to change her instruction based on the way the lesson unfolds as learners raise concerns and put forward ideas (NCTM, 2000). This adaptability signifies the ability to notice and interpret what is happening in the classroom in order to promote learning (van Es & Sherin, 2008). What is perceived by teachers as evidence that the learners have understood what is being taught is a significant aspect of effective classroom practice (Fisher & Frey, 2007). One of the skills a good mathematics teacher should have, is the ability to determine whether learners have understood while the lesson is in progress, so that immediate measures can be taken where misunderstanding is evident. In this study, these three aspects of effective classroom practice are seen as observable aspects of PMTI in terms of teaching-and-learning expertise.

2.6.1.3. Caring

In considering this aspect of PMTI, the individual's perception of herself as Carer in terms of her interaction with learners is investigated. Caring is associated with the affective aspects of classroom practice. Authors like Zembylas, 2003; Flores & Day, 2006 and Shapiro, 2010, recognise that this aspect is not only part of PTI, but is significant in effective teaching. Caring lies at the base of the relationship the teacher has with the learners and vice versa, which leads to the support of learners in their non-cognitive development. Kunter and Baumert (2006) refer to such caring as “personal learning support” (p. 235) and describe it as a quality dimension in teaching.

This ‘quality dimension’ can be observed in the way the teacher relates to the learners as individuals and what the nature of their interaction is. In her dealings with the learners, the teacher's belief regarding the purpose of caring is made manifest through her actions – does she relate to the learner on an academic level in order to promote learning, or is her concern with ‘the socio-emotional and moral development of learners’ her motivation? Answering these questions provides a description of the actualisation of PMTI, specifically in terms of both the evidence of care and its purpose.

2.6.2 Influencers

Beijaard et al. (2000) identify the dominant factors which influence the formation of teacher identity. They isolate three significant influencers: what they call *context*: the ecology of the classroom and culture of the school; teaching *experience*: “well-organised knowledge bases that enable [experienced teachers] to draw readily on their past experiences; and the *biography* of the teacher: “a... perspective which emphasizes the transformation of identity, the adaptation of personal understandings and ideals to institutional realities...” (p. 753). However, since Beijaard et al. were specifically working with experienced teachers, while this is a case study concerning student teachers, it was necessary to adapt their influencing framework to the context of pre-service teachers. To this end, *context* now becomes the teaching practicum, teaching *experience* now relates specifically to tertiary education environment, and *biography*, or personal history, looks specifically at identity formation through the influence of high school teachers, family and friends and other personal factors. From the work of

Thompson (2009) and Ernest (1988) a fourth influencer is drawn: the individual's view of the subject mathematics.

Therefore, in this study, the following primary influencers of the development of PMTI will be investigated: the pre-service teacher's personal history, her tertiary training and accompanying teaching practica, and her view of mathematics (see Section 2.5.4). Personal and social contexts from the individual's past are accessed in terms of how they influenced the person's PMTI. Schooling as well as cultural and family influences are included. These influences are particularly relevant to the individual's choice of career – why they decided to become a mathematics teacher. According to the literature (see Section 2.5.1), such influences are significant (Knowles, 1992; Kelchtermans, 1993; Sugrue, 1997; Beijaard et al., 2004). The effectiveness of the experiences undergone by the individual in tertiary training comes under scrutiny. It is widely reported that tertiary training of pre-service teachers is not effective (see Section 2.5.2) and Ball (1988) in fact 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). In investigating the effect of teaching practica on PMTI, what is in effect being scrutinised is what Feiman-Nemser and Buchmann identified as the “two-worlds” pitfall in which the more theoretical aspects of teacher training appear to be in conflict with “real world” of the classroom (see Section 2.6.3). Now the student is back in the classroom, far removed from the halls of academe – does this experience reinforce educational theory taught at university, or is it in conflict with such theory? Researchers like Thompson (2009), Ernest (1988), Cooney (2003) and Cross (2009) have also found that the teacher's view of the subject mathematics has an effect on the way they teach and in fact on their professional identity (see Section 2.5.4). Ernest describes three instruction modes used by mathematics teachers:

1. Instructor: Skills mastery with correct performance
2. Explainer: Conceptual understanding with unified knowledge
3. Facilitator: Confident problem posing and solving

He links a specific view of mathematics with a specific style of teaching and a specific way of learning. Likely associations may thus be represented as follows:

- 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

Ernest's research informs this study in providing a framework for the analysis of the influence of the individual's view of mathematics on her classroom practice.

3. Design of the study

In this study my aim is to gain insight into the PMTT's of the mathematics education students who are about to complete their academic studies, in effect what poet Rainer Maria Rilke (1987) describes as:

kind of in-seeing,

in the indescribably swift, deep, timeless moments

of this divine seeing into the heart of things.

Although, as Heidegger (2000) points out, research may not be classifiable in terms of its practical applicability and usefulness “according to everyday standards that one would otherwise employ to judge the utility of bicycles or the effectiveness of mineral baths” (p. 13), there is nevertheless merit in “in-seeing”. It has an effect on the ‘in-see-er’. Says Heidegger, “even if we can't do anything with it, may not philosophy [or in this case, this investigation] in the end do something with us, provided that we engage ourselves with it?” (p. 13). I investigate PMTI not only to “see into it”, but also to allow that investigation to affect my practice.

In this chapter there is a description of the worldview and philosophy which underpins this research as well as the design of this study and the methods that were followed. This is an explanatory, interpretive case study in a single case embedded design (see Section 3.2) in which I investigate the PTMI of a small group of pre-service teachers at UP. The participants in this study are described, and the data collection strategies and instruments are discussed: a biographical questionnaire, interviews (both individual and group) as well as classroom observations. This is followed by a description of the data analysis procedures that were used and the methodological norms that were implemented. Finally, ethical considerations are discussed.

3.1 Researcher epistemology and ontology

Silverman and Marvasti (2008), reflecting on thinking critically about one's approach, declare that "your prior experience usually has an important bearing on how you approach your data" (p. 96). I have taught mathematics for twenty eight years, the latter nine of which have been at university level. While I believe that mathematics is to be explored and investigated within the paradigm of its own rules and regulations, and I value its logic and consistency, I am primarily concerned with *how* it is taught. I prioritise the encouragement of my students to reason and to grasp concepts in a way that they can hold and assimilate. I believe that I am a social constructivist, one of those who "hold assumptions that individuals seek understanding of the world in which they live and work" (Creswell, 2009, p. 8). This means that I recognise that individuals develop their own subjective interpretations or sense-making of their experiences and that these interpretations are constructed both socially and personally – in relationship with others and in certain contexts, as well as intrinsically according to their own personalities. According to Creswell, there are four major elements that characterise social constructivism: understanding, multiple participant meanings, social and historical construction and theory generation. All of these form part of my research paradigm: I have interviewed and observed the participants in order to understand the meaning of their social and historical roots; I have observed them in the classroom so that I may literally understand how *their* understanding is actualised, and ultimately I theorise about my findings.

I also believe that there is a place in the mathematics classroom for simply "teaching". I espouse the notion that the learner is the 'end user' of what happens in the classroom, and that therefore every consideration should be given to making learning and teaching as efficient as possible. So, as a mathematics educator, I have my own PMTI, and, inasmuch as "we teach who we are" (Palmer, 2007, p. 2), I have, consciously or not, impressed upon my students my beliefs either in what I have done or how I have done it. Knowing this, I have with conscious effort tried to keep my own opinions of good teaching out of the analysis of these data. According to Creswell (2009), social constructivist researchers "recognise that their own backgrounds shape their interpretation, and they position themselves in the research to acknowledge how their interpretation flows from their personal, cultural, and historical experiences" (p. 8). The shadow of my own PMTI is unavoidable in

my interpretation of the data collected in this study; I have tried however to allow the participants to speak for themselves so that my interpretation of what they say and do is open to scrutiny.

According to Nieuwenhuis (2007), if I am to describe my ontology, I should provide an answer to the question ‘What is reality?’ He contends that a subjective view of the world assumes that “while the social world is perceived as external to individual cognition... it is made up of... human-constructed entities” (p. 54). Then I, as a qualitative researcher and constructivist, answer the question about reality by saying that reality is a social construction and that I understand that I cannot be separated from my research – I am part of the social construction I am investigating. “Truth is therefore not an objective phenomenon that exists independently of the researcher” (ibid., p. 54). I also understand that my findings are “*created* rather than *discovered*” (p. 54) because I am constructing a description of what I believe to be the truth about how and why people interact with each other in the context I am studying. Nieuwenhuis also states that:

Qualitative researchers...believe that the world is made up of people with their own assumptions, intentions, attitudes, beliefs and values, and that the way of knowing reality is by exploring the experiences of others regarding a specific phenomenon – an attempt to see how others have constructed reality by asking about it. (p. 54)

Similarly, in order to answer the question ‘How can I know?’ I refer to my understanding of truth in my research: the personal experiences, beliefs and interactions I have observed and described I accept as true for the six students who lived through them. They ‘know’ their own truths, and believe that what they believe is true and correct. “Human beings, after all, have beliefs about everything” (Pajares, 1992). Investigating beliefs in the context of educational research brings to light a plethora of perspectives and conflicting opinions (Nespor, 1987; Peterson, Fennema and Carpenter, 1991; Fives and Buehl, 2008). Academic opinion can be diametrically opposed on this issue: Rokeach (1968) found that knowledge was part of beliefs; Nisbett and Ross (1980) found that beliefs were part of knowledge. Pajares (1992) speaks of a “messy construct” in which empirical investigation is problematic, and separating beliefs and knowledge is a daunting task. Rather than define beliefs and prescribe an investigation methodology, Pajares suggests that beliefs should be inferred, and studied as *beliefs about*... In the context of education, these beliefs would be about “schooling, teaching, learning and students” (Pajares, 1992, p. 36) Rokeach (1968) referred to these beliefs as attitudes. In

the case of mathematics education in particular, there are beliefs regarding the subject itself which influence the way it is taught and learnt (Ernest, 1988; Thompson, 1992, Cross, 2009).

Espousing the notion of a beliefs being held in a system as propounded by Rokeach (1968), Liljedahl (2007) suggests that teacher knowledge i.e. knowledge of teaching, knowledge of teaching mathematics and knowledge of mathematics, is in fact part of such a belief system. He agrees with the notion postulated by Leatham (2006) that beliefs are “things that we just believe” and that knowledge is “what we more than believe – we know” (p. 92). Plato defines knowledge as *justified true belief*. The difference between knowledge and beliefs parallels the way Ezzy (2002) sees the difference between fact and theory: “That is to say, an epistemology that makes a radical separation between fact and theory does not deal adequately with the theory-dependent nature of data” (p. 6). In other words, the process through which one arrives at what one might call “fact” or “knowledge” is driven by “belief” or “theory”. Pajares (1992) in fact found that it was “difficult to pinpoint where knowledge ended and beliefs began” (p. 309). Thompson (1992) brings the argument back to practical issues: whether we speak of beliefs or of knowledge, the important concern is, what is its effect on classroom practice?

In summary, then, knowledge and beliefs, according to many researchers, are separated with difficulty, and many resort to Plato’s understanding of knowledge as justified true belief. By implication then, knowledge is a subset of belief. Individuals (for the most part) operate based on knowledge as an individual construct. That is, their actions are guided by what they believe to be true and of value for their practice. Mathematics teachers (pre-service or in-service) are no different – their actions (i.e. teaching) are guided by what they believe to be true about mathematics and about the teaching and learning of mathematics. Kagan (1992) found that all the cases she documented “testified to the stability and inflexibility of prior beliefs and images” and that these beliefs and images played a central role “in filtering the content of education course work” (p. 140).

My epistemological perspective in this regard is that knowledge forms a subset of beliefs, based on the notion postulated by Leatham (2006) that beliefs are “things that we just believe” and that knowledge is “what we more than believe – we know” (p. 92). I also espouse the Liljedahl (2007) postulation that teacher knowledge i.e. knowledge of teaching and knowledge of teaching

mathematics, is in fact part of a belief system. Beijaard et al. (2000) investigated teacher identity in terms of “teachers’ perceptions” which he defines as “representations of their understandings of their own professional identity” (p. 750). These representations they categorised as subject matter expert, didactical expert and pedagogical expert. I contend that it is possible to investigate PMTI through an examination of these three constructs.

Nevertheless, I accept that “precise, systematic and theoretical answers to complex human problems are not possible” (Nieuwenhuis, 2007, p. 55), and that the knowledge I have gained has emerged from what the participants view as knowledge. It was therefore important for me to observe from the point of view of an ‘insider’: I know the students and they know me; I am familiar with the mathematics methodologies they have done and with which I know they should be familiar. However, to gain real insight into who these students are, I have needed to find out how they ‘make meaning’ of their own PMTI. As Walkington (2005) explains, “A view through the eyes of the pre-service teacher is essential for all clearly to understand the personalized and contextualized journey of learning” (p. 56). To this end I decided to use a case study design.

3.2 Research design

Of the twenty nine studies tabled in Section 2.1 concerning professional teacher identity, sixteen were based on empirical research. Of those, eleven were case studies. Case study therefore seems to be the method of choice for the majority of researchers whose investigations were not only theoretical. A reason for this is given by Bromley (1986):

[Case studies] get as close to the subject of interest as they possibly can, partly by means of direct observation in natural settings, partly by their access to subjective factors (thoughts, feelings and desires), whereas experiments and surveys often use convenient derivative data, e.g. test results, official records. (p. 23)

This is an explanatory, interpretive case study in a single case, embedded design since it involves what Yin (1994, p. 39) calls multiple units of analysis. As Yin (2006) explains, “The case study method is pertinent when your research addresses either a descriptive question (*what* happened?), or

an explanatory question (*how* or *why* did something happen?)” (p. 112). In this particular case, the research deals with PMTI in terms of how the students perceive its development and how it is operationalised in the classroom during fieldwork or teaching practica, focused through the following questions:

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?

The goal is to interpret the data so as to explain what the students’ PMTI’s ‘look like’ in the classroom. Merriam (1988) describes an interpretive study as one in which the researcher “gathers as much information about the problem as possible with the intent of interpreting or theorizing about the phenomenon” (p. 28). This notion is corroborated by such academics as Goetz and LeCompte (1984) who speak of researchers hoping “to find a theory that explains their data” (p. 4), Creswell (2007) who refers to the “final interpretive phase” in which the researcher “... reports about the meaning of the case” (p. 75) and Lincoln and Guba (1985) who speak of lessons learned from the case. In my research I strive to do exactly that – to draw from my data the meaning of what I find – to explain what I have learned. Creswell confirms that the type of problem best suited for case study design is “Providing an in-depth understanding of a case or cases” (p. 78), such as this study attempts to do.

Since this is a study investigating the PMTI of pre-service students in their final year of training at the University of Pretoria by placing the PMTI of six such students under close scrutiny, Yin’s (1994) description applies: “Within the single case may still be incorporated subunits of analyses, so that a more complex – or embedded – design is developed” (p. 44). Guba and Lincoln (1981) declare that: “Any case study is a construction itself, a product of the interaction between respondents, site and researcher” (p. 207). In this particular instance, the interaction occurs between six students, the researcher and two sites: the university and the school. The interaction spoken of by Guba and Lincoln may also be seen as a functional system: “The case is an integrated system. The parts do not have to be functioning well, the purposes may be irrational, but it is a system. Thus people and programs are clearly prospective cases” (Stake, 1995, p. 2).

The research in this study, qualitative in nature and exploring such a deep-seated construct as professional mathematics teacher identity, was designed in such a way that depth was the focus. Patton (2002) states that,

In some ways, the differences between quantitative and qualitative methods involve trade-offs between breadth and depth. Qualitative methods permit inquiry into selected issues in great depth with careful attention to detail, context, and nuance; that data collection need not be constrained by predetermined analytical categories contributes to the potential breadth of qualitative inquiry. (p. 227)

Identifying four essential properties of a qualitative case study, Merriam (1988) describes them as follows: particularistic – problem-centred, small scale, focused on a particular situation or phenomenon; descriptive - the end product is a rich, thick description of the phenomenon; heuristic – illuminates understanding of the phenomenon; and inductive – “builds abstractions, concepts, hypotheses, or theories, rather than testing existing theory” (p. 20). Jita (2004), in his research into the professional identities of science teachers set against the background of the changing educational and social system in South Africa, found that “the case study method allows for a context-specific inquiry into teaching and teacher change. It is from such in-depth context-rich case studies that other researchers working in similar contexts can draw lessons and extend their findings” (p. 14). The significance of context in this regard is emphasised by Golafshani (2003) who explains that qualitative research “uses a naturalistic approach that seeks to understand phenomena in context-specific settings” (p. 600) in which “the researcher does not attempt to manipulate the phenomenon of interest” (Patton, 2001, p. 39). Golafshani explains the process of this kind of research as follows: “Unlike quantitative researchers who seek causal determination, prediction and generalization of findings, qualitative researchers seek instead illumination, understanding, and extrapolation to similar situations” (p. 600). However, “Our actions in the world, including actions we take as inquirers, cannot occur without reference to those paradigms: ‘as we think, so do we act’” (Lincoln & Guba, 1985, p. 15)

Case study research is not intended to yield generalisable findings, and it was not the purpose of this study to generalise, as Yin (1994) puts it, “from one case to another” (p. 37). Instead, the aim was to “see-in” and to “generalise findings to theory, analogous to the way a scientist generalises from experimental results to theory” (p. 37). Cresswell (2007) explains that qualitative research must in

fact “elucidate the particular, the specific” (p. 126). According to Myers (2000) “small qualitative studies are not generalizable in the traditional sense, yet have redeeming qualities that set them above that requirement.” Such redeeming qualities are described by Merriam (1988) who explains that an interpretive study contains

“rich, thick description. These descriptive data, however, are used to develop conceptual categories to illustrate, support or challenge theoretical assumptions held prior to data gathering...If there is a lack of theory, or if existing theory does not adequately explain the phenomenon, hypotheses cannot be developed to structure a research investigation. A case study researcher gathers as much information about the problem as possible with the intent of interpreting or theorizing about the phenomenon. (p. 28)

In fact, generalizability “holds little meaning for most qualitative researchers” (Creswell, 2007, p. 76), other than naturalistic generalisations through which the reader might be able to recognise patterns or applicability of the study which resonates in their personal experience (Stake, 1995).

Table 3 shows the design of this research: the objectives of the study are summarised so that the coherence of the research may be seen, and particular constructs of the conceptual framework are juxtaposed to the research questions and sub-questions. The methodology is linked by arrows to the relevant constructs. According to Creswell (2007), “Qualitative research questions are open-ended, evolving, and nondirectional; restate the purpose of the study in more specific terms; start with a word such as “what” or “how” rather than “why”; and are few in number” (p. 107). He recommends that a broad, single overarching question be used with several subquestions which introduce the procedural steps in the research process, and this is what has been done in this study. The following overarching question has been formulated:

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?

This question is broad, as Creswell suggests, and addresses the two main issues that are under scrutiny: the student’s perceptions of her PMTI, specifically in terms of its development; and how that PMTI actually manifests in the classroom. The sub-questions that follow advance the procedural steps of the research in that they break down the main question into process pointers:

In what way do the influencers of PMTI shape its development? This question is addressed by the literature review and by interviews with the trainee teachers. The literature points out that PTI (or PMTI) is influenced by factors which may be personal or social (Thompson, 1984; Beijaard et al., 2000; Flores & Day, 2006). This question gives access to the development of PMTI by allowing identification of such role players in this process. At the same time, it enquires after the *way* that these role players have influenced PMTI. As indicated by the arrow in Table 3, this question is addressed through interviews with the participants.

What are this student's perceptions of her PMTI? This question is addressed by means of the biographical questionnaire and interviews with the participants. According to Beijaard et al. (2000), the participant is the person best able to discuss their perceptions and beliefs regarding their PMTI. This question provides access to the characteristics of the individual's PMTI and allows insight into what the individual's PMTI 'looks like'.

How is this identity actualised in the classroom? This question is inspired by the words of Palmer (2007): "We teach who we are" (p. 2). Through observation of PMTI-in-action in the classroom, finding the answers to this question completes the 'picture' by allowing comparison between the individual's perceptions of their PMTI and the practical outworking thereof.

Table 3

Research design

AIM	OBJECTIVES	RESEARCH QUESTIONS	SUB-QUESTIONS	CONCEPTS FROM CONCEPTUAL FRAMEWORK	DATA SOURCES	METHODOLOGY		
To investigate the nature of the PMTI of the pre-service teacher against the background of education in South Africa, as well as the factors which influence this identity	To explore the nature of this identity in terms of its influencers and nature.	Who are the pre-service students at the University of Pretoria in terms of their Professional Mathematics Teacher Identity, and how is this identity actualised in the classroom?	In what way do the influencers of PMTI shape its development?	Influencers	Literature Students	Questionnaire	Interviews	Observations
			What are these students' perceptions of their PMTI?	Mathematics Specialist Teaching-and-learning specialist Carer	Mentor teachers Classroom observations			
			How is this identity actualised in the classroom?	Mathematical expertise Teaching-and-learning skills Evidence and purpose of caring				

3.3 Research methods

Given the qualitative nature of the data to be collected and the fact that this is a case study dealing with identity, a biographical questionnaire, interviews and classroom observations were used to access the information required to answer the research questions. Kvale (1994) speaks of this method as follows: “The qualitative interview based on conversation and interaction here appears as a privileged access to a linguistically constituted social world” (p. 147). It is precisely that “privileged access” upon which this research is dependant. Prior to the commencement of the Fourth Year teaching practica, the questionnaire was administered to the whole group of Fourth Year pre-service mathematics teachers, after which a sub-sample of six students was selected for closer study. Two sets of individual interviews were conducted with these six students, one before and one after the teaching practicum, as well as a single group interview, also after the practicum. Classroom observation was done with them during their teaching practicum in the second term of the school year to strengthen the data collected verbally in the interviews. An interview was also conducted with the mentor teachers of these students, in which questions were asked regarding the characteristics of the PMTI they were able to observe in their student.

In this section, the sample and participants in the study are discussed with particular reference to the site of the research and the selection process that was used. This is followed by a discussion of the data collection strategies and instruments that were used, after which methodological norms and ethical issues are dealt with.

3.3.1 Sample and participants in the study

At the University of Pretoria, the BEd (Bachelor of Education), a four-year degree, is currently constructed in such a way that the subject methodologies constitute a year-long module which is offered in their third year of study. The elective subjects, like mathematics, are taken alongside of education modules (dealing with education theories and the complexities of teaching in the twenty first century), and other professional studies like educational psychology across the first three years of study. For three weeks at the beginning of each of the second and third years the students are sent

out to schools on a short teaching practicum exercise, in which observation is their main task. During their fourth year the students undergo further academic training for the first quarter, where after they spend the second and third quarters at schools doing their “internship” or teaching practicum. In the fourth quarter they return to campus for short remaining modules and the finalisation of their studies. The academic subjects like, in this case, mathematics, are taught during the first three years of study only.

It is within the context of this programme that this research was conducted. Having completed the academic part of their training, the Fourth Year students, who are all poised for launching into the professional world of teaching, were selected to form the sample of participants in this case study. I chose to do this study with the Fourth Years because they have come to the end of the academic programme and all that remains for them to do before qualifying for their degrees is the teaching practicum. At this point these individuals find themselves between the two poles of being a student and being a professional- they are no longer actually students, nor are they yet professionals. No further influencing from theoretical part of their tertiary training can take place, because it is done. Therefore my research looks at the ‘end product’ of tertiary training as an influencer.

Purposive maximum variation sampling is the strategy that was used to determine the participants in this study. According to Merriam (1988), “purposive sampling is based on the assumption that one wants to discover, understand, gain insight; therefore one needs to select a sample from which one can learn the most” (p. 48). A maximum variation sample was chosen since the aim of this study was to find out ‘what’s out there’ in terms of PMTI, not to generalise from a ‘typical’ sample. Chein, who first coined the term ‘purposive sampling’ in 1981, explains the principle as follows:

The situation is analogous to one in which a number of expert consultants are called in on a difficult medical case. These consultants – also a purposive sample – are not called in to get an average opinion that would correspond to the average opinion of the entire medical profession. They are called in precisely because of their special experience and competence. (p. 440)

Patton (2002), discussing the apparent weakness of maximum variation sampling, declares that,

For small samples, a great deal of heterogeneity can be a problem because individual cases are so different from each other. The maximum variation strategy turns that apparent weakness into a

strength by applying the following logic: any common patterns that emerge from great variation are of particular interest and value in capturing core experiences and central, shared dimensions of a setting or phenomenon. (p. 235)

Therefore this sampling strategy is particularly suited to my research: emergent “common patterns” as well as the divergences deriving from students with the disparate backgrounds which characterise education in South Africa (see Section 3.3.1.1) provide significant answers to the research questions in this study. The target population for this case study was the mathematics education students of 2010 in the Department of Science, Mathematics and Technology Education of the Faculty of Education at the University of Pretoria. This population was chosen for two reasons: convenience and the demographic diversity for which the university is known. The University of Pretoria accommodates a large demographic diversity and a range of backgrounds in terms of the schools from which the students have matriculated. According to Paterson and Arends (2009), UP is the second most popular tertiary institution in South Africa for prospective educators, and thus is particularly characterised by the diversity of its students.

The population in question is divided into two: those students who are preparing to teach in the FET phase of high school (Grades 10 to 12) and those students who will eventually teach the Senior Phase (Grades 6 to 9). The latter group, while majoring in mathematics, amongst other subjects, are not necessarily subject specialists – in fact those grades tend to require generalists in terms of their fields of expertise. However, the group of students who want to teach in the FET phase are trained to be Mathematics Specialists and are therefore those who, in theory, are not only *able* but who also *desire* to teach mathematics to learners who have chosen to continue with the subject to Grade 12 level. It is this group of students who form the sample for this study.

3.3.1.1 Selection criteria

Purposive sampling is also known as criterion-based sampling and “means that the inquirer selects individuals and sites for study because they can purposefully inform an understanding of the research problem and central phenomenon in the study” (Creswell, 2007, p. 125). In this section, the criteria for selecting participants are discussed. The Fourth Year class consisted of sixty five students, of which thirty one were studying to teach in the FET phase. Twenty five of these students consented to be available for selection as participants in the study. A questionnaire was administered to these

students providing biographical information regarding the type and environment of high school attended, matric results and gender of the participant, as well as their insights regarding the three aspects of PMTI: Mathematics Specialist, Teaching-and-learning Specialist and Carer.

In order to achieve a maximum variation sample, the following criteria were used. Firstly, the school attended by the student was considered -whether it was a rural or city school and whether it was a former Model C, private or formerly disadvantaged school. Prior to the political changes which came about in South Africa in 1994, education was generally segregated and there were “white” schools, the better of which were designated as Model C schools, and “black” schools, later usually referred to as “formerly disadvantaged” schools, a term which referred to not only facilities and logistics, but also quality of education. Despite the changes of 1994, the general constitution and character of many of these schools have remained constant. Data about the school attended by the participant therefore provides insight into their PMTI in terms of early role models and classroom practices which differ widely between these three types of schools. Next, the students were asked to indicate which symbol they achieved in mathematics in Grade 12 and whether this was on the Higher or Standard Grade. This choice of grades represents the level of difficulty of the mathematics course the student did at school. The choice could be made at the end of Grade 9 and meant that from Grades 10 to 12 the student was taught mathematics on a more advanced level, or not. Information drawn from these two criteria therefore is indicative of the participant’s mathematical prowess as assessed by the school system and provides background information to their perception of themselves in the area of subject matter expertise (See Conceptual Framework). The students were also asked to indicate whether they were intending to teach mathematics specifically upon qualification (they have three majors any one of which they are qualified to teach at FET level, depending upon their preference). This criterion informs this research in that PMTI is an intrinsic part of the individual who sees herself as a mathematics teacher – the student who does not want to teach mathematics is not relevant to this particular study. The students were also asked to give their age: this is an indication of whether they began teacher education directly upon leaving school or did something else first, possibly meaning that teaching mathematics was not their first choice. The following table shows the distribution of these students across these criteria according to gender and race.

Table 4

Distribution according to gender, race and high school they attended of students in sample group

SCHOOL ENVIRONMENT: CITY/ RURAL	TYPE OF SCHOOL: FORMERLY MODEL C/ FORMERLY DISADVANTAGED/ PRIVATE	MATRIC MATHS SYMBOL	MATRIC MATHS LEVEL HG/SG	INTENTION TO TEACH MATHS: YES/ NO	AGE
Female-white					
CITY	C	A	HG	Yes	23
CITY	C	C	HG	Yes	22
CITY	PVT	C	HG	Yes	23
RURAL	C	D	HG	Yes	22
RURAL	C	A	HG	Yes	23
CITY	C	B	HG	Yes	22
CITY	C	B	HG	Yes	21
CITY	C	A	HG	Yes	22
CITY	C	A	HG	Yes	25
Female-Black					
CITY	DISAD	E	HG	Yes	23
CITY	PVT	E	HG	Yes	21
RURAL	DISAD	E	HG	Yes	21
CITY	DISAD	D	HG	No	23
Female- Indian					
RURAL	DISAD	B	HG	Yes	20
Male-white					
CITY	C	A	HG	No	22
CITY	PVT	D	HG	Yes	21
CITY	C	A	HG	No	22
Male-black					
RURAL	DISAD	C	HG	Yes	26
RURAL	DISAD	A	SG	Yes	26
RURAL	DISAD	D	HG	Yes	24
RURAL	DISAD	C	HG	Yes	32
RURAL	DISAD	B	HG	Yes	24
RURAL	PVT	A	HG	Yes	27
CITY	DISAD	D	HG	Yes	22
CITY	C	B	HG	Yes	22

Fourteen of the participants in the sample were female, and eleven male. From this table it can be calculated that 36% of this sample were taught in rural high schools (of which 66% were formerly disadvantaged). Generally speaking, the students in this sample who attended formerly disadvantaged schools achieved lower symbols in matric than the others. All but three of these students indicated that they intended teaching mathematics upon completing their studies. Students aged over twenty four either pursued some other career directly after matriculating and prior to beginning their teacher training, or they studied a course other than teaching after leaving school.

Working with Patton's principle that "if researchers assume that a variable may influence the data they should implement variations" (2002, p. 109), the process for identification of a maximum variation subsample began with the placement of the participants into categories based on the two most obvious variables: gender and race. This subdivision resulted in five fairly homogeneous groupings, three of which were female, and the smallest of which were Female-Indian and Male-white containing one and three participants respectively. These two categories were where the selection process began since they offered little choice in terms of who would be selected. Since there were three female categories and only two male, I decided that two participants would need to be selected from the Male-black category so that the number of female and male participants remained equal.

The single participant in the Female-Indian category qualified for selection into the subsample automatically by virtue of being unique in her category. Since two of the participants in the category Male-white indicated that they had no intention of teaching mathematics upon completion of their studies, they were automatically disqualified from selection into the subsample. That left just one participant in that particular category. The category next in size was Female-black. Here there were four candidates, of which only three were intending to actually teach mathematics. Of these three, one stood out: she had matriculated in a private school in the city. She thus became the third member of the subsample. The remaining two categories were the largest. Of the nine candidates in the Female-white category, all but one were educated in former Model C schools, whether in the city or rural. Since no single participant stood out, random sampling was done in this category. "A purposeful sampling strategy does not automatically eliminate any possibility for random selection of cases...A small, purposeful random sample aims to reduce suspicion about why certain cases were

selected for study...” (Patton, 2002, p. 241). Selection from this category was therefore random, and so the fourth participant was identified. The final category, Male-black, presented near uniformity in terms of the first two selection criteria- almost all were from disadvantaged rural schools. There were two anomalies: one candidate from a private rural school, and the other from a former Model C school in the city. Since the participant in the Female-black category was from a private school, the second anomaly in the Male-black category presented the better option for variation purposes. Also, the private rural school candidate from the Male-black category had not passed several of the academic modules, including the third year mathematics methodology module, and was therefore not a suitable candidate for the sub-sample: his academic training was incomplete. The sixth candidate was then randomly selected from the conformity of the Male-black rural disadvantaged school group. Table 5 summarises the constitution of the subsample.

Table 5

Distribution according to gender, race, and high school of students in subsample

CODE NAME	SCHOOL ENVIRONMENT: CITY/ RURAL	TYPE OF SCHOOL: FORMERLY MODEL C/ FORMERLY DISADVANTAGED/ PRIVATE	MATRIC MATHEMATICS SYMBOL	INTENTION TO TEACH MATHEMATICS: YES/ NO
Female-white				
MARTIE	CITY	C	A	Yes
Female-black				
THANDI	CITY	PVT	E	Yes
Female- Indian				
AYESHA	CITY	DISAD	B	Yes
Male-white				
JOHN	CITY	PVT	D	Yes
Male-black				
THABO	RURAL	DISAD	C	Yes
SIHO	CITY	C	B	Yes

Kvale (1994), in answer to the question of how many subjects are needed, replies: “a paradoxical answer is that if the aim of a study is to obtain general knowledge, then focus on a few intensive case studies” (p. 165). A choice exists: “we could look at a narrow range of experiences for a larger number of people or a broader range of experiences for a smaller number of people” (Patton, 2002, p. 227). It was the latter choice that seemed most suitable to the requirements of this inquiry. Patton assures researchers that this choice is one that can only be made by the researcher according to the exigencies of a particular inquiry:

No rule of thumb exists to tell a researcher precisely how to focus a study. The extent to which a research or evaluation study is broad or narrow depends on purpose, the resources available, the time available, and the interests of those involved. (p. 228)

Patton describes the benefits of studying a small sample; the two kinds of findings described by him closely approximate the type of findings this research aims to lead to:

Thus, when selecting a small sample of great diversity, the data collection and analysis will yield two kinds of findings: 1) high-quality, detailed descriptions of each case, which are useful for documenting uniquenesses, and 2) important shared patterns that cut across cases and derive their significance from having emerged out of heterogeneity. Both are important findings in qualitative inquiry. (p. 235)

In fact, the criterion for sample selection is that the size and constitution of the sample is consistent with the information needed to answer the questions (Creswell, 2007). The questions in this study require a ‘close-up’ view to yield, in the words of Patton, “high-quality detailed descriptions” which highlight “uniquenesses”. The research questions also require diversity in the small sample so that any “shared patterns” become significant.

3.3.2 Data collection: strategies and instruments

According to case study dogma, it is advisable for there to be more than one source of evidence. “In fact, good case studies benefit from having multiple sources of evidence...The main concern is not that any particular source be used...the main idea is to ‘triangulate’ or establish converging lines of evidence to make your findings as robust as possible” (Yin, 2006, p. 115). In this study, the questionnaire data and the individual interviews (data provided by students) were supported with

classroom observations, and information garnered from the students' mentor teachers through an interview and an abridged form of the questionnaire. According to Golafshani (2003), "The methods chosen in triangulation to test the validity and reliability of a study depend on the criterion of the research" (p. 604). The conceptual framework of this study provides for three investigatory thrusts: influencers of PMTI, perceptions of PMTI and actualisation of PMTI. The first two are informed by data provided by the student, while the third relies on data provided by the observer and the mentor teacher. There are thus three sources of evidence: the student, the observer and the mentor teacher.

3.3.2.1 Questionnaire

Student questionnaire

A questionnaire (see Addendum A) was administered to the entire class of Fourth Year mathematics education students at the commencement of their methodology module. The questionnaire was a translated and adapted version of a questionnaire created by Prof. Douwe Beijaard in his investigation of "experienced secondary school teachers' current and prior perceptions of their professional identity" (Beijaard, Verloop & Vermunt, 2000, p. 749). This adapted questionnaire had a two-fold purpose. Yin (2006) recommends a "formal case study screening procedure" (p. 115) in a situation where a selection must take place amongst several candidates. Since the first section of the questionnaire supplied biographical data like sex, race (by virtue of surnames) and type of high school, this allowed a spreadsheet to be created, giving insight into the constitution of the sample and providing the basis for the selection of the subsample (see Section 3.2.1 above). The second purpose of the questionnaire and one for which the questionnaire was designed by Beijaard et al., was to "explore the way teachers see (and saw) themselves as subject matter specialists, didactical specialists and pedagogical specialists" (ibid., p. 749), and thus provided a base for discussion in the initial interviews, as well as a basis of comparison between the students' PMTI beliefs and their practical outworking in the classroom.

Section 1 of the questionnaire accessed only biographical details. The second section of the questionnaire was divided into two parts: the first required the students to indicate their prioritisation of the three aspects professional mathematics teaching, using Beijaard's original terminology: Subject Specialist (a teacher that focuses on *subject knowledge and skills*), Didactics Specialist (a teacher that

focuses on knowledge and skills regarding the preparation, implementation and evaluation of *teaching and learning processes*) and Pedagogics Specialist (a teacher that focuses on knowledge and skills concerning the *socio-emotional and moral development of the learners*). The meanings of these terms were clearly set out in accordance with the conceptual framework of this study and were also verbally explained to the class prior to administration of the questionnaire. This sub-section therefore specifically delved into the way the students saw themselves as teaching professionals. The second part of Section 2 was also adapted to suit this study – it consisted of elucidatory open-ended questions in which the students explained both the reasons for their ranking, and how their tertiary education (not, as in the original questionnaire, the school environment) contributed to those three aspects of their teaching identity, “allowing them to share their views relatively unconstrained by the researcher’s perspectives” (Creswell, 2005, p. 197). Here the students were to look at their professional identity through the filter of tertiary training.

Mentor teacher questionnaire

This questionnaire contained only the ranking exercise in which the mentor teacher was required to prioritise the three categories of PMTI (Subject, Teaching-and-learning skills and Caring specialist) in terms of what they observed as dominant in the student’s classroom practice (see Addendum E). They were also asked to explain their choices.

3.3.2.2 Interviews

Exploring PMTI by only doing classroom observations would have been to miss the crux of this investigation: PMTI is about the professional self and so requires more than recording behaviour. “We cannot observe feelings, thoughts, and intentions...[nor] how people have organised the world and the meanings they attach to what goes on in the world. We have to ask people questions about those things” (Patton, 2002, p. 341). All the interviews were transcribed, coded in Atlas.ti and analysed.

Individual student interviews

Prior to the commencement of the practicum, individual interviews were conducted with each of the sub-sample members. These interviews were semi-structured, and the questions were designed to further clarify and provide depth and insight into the beliefs expressed and explanations given in the

questionnaire (see Interview Protocol, Addendum B). The interview questions were created by taking into account the exigencies of the conceptual framework (see Table 6 below). Since this interview was held prior to the long teaching practicum, the questions concentrated on the aspects of the conceptual framework dealing with influencers and perceptions of PMTI. The design of the questions was loosely based on suggestions by Patton (2002) in his discussion on interviews which “aim to capture the perspectives of program participants” (p. 341). In fact, a combination of strategies was used to acquire the richest possible descriptions: while seven standardised questions were pre-determined “to be sure that each interviewee gets asked the same questions – the same stimuli – in the same way and in the same order...” (Patton, 2002, p. 344), yet the interviewer was also free to pursue any subjects of interest that arose during the course of the interview.

Table 6

First individual interview: questions related to conceptual framework

QUESTION	PURPOSE – TO ACCESS:	CONCEPT FROM CONCEPTUAL FRAMEWORK
1. How would you describe a good mathematics teacher?	Overall understanding of what it means to be a good mathematics teacher	PMTI
2. Why did you choose to study to become a mathematics teacher? What influenced your choice most heavily and why?	Influences from personal background	Biography as influencer
3. In the questionnaire you indicated that you attach great value to the Mathematics Specialist/Carer/teaching-and-learning specialist role of the teacher. Describe yourself as a mathematics teacher.	Perceptions of own PMTI	PMTI
4. How did you implement these roles in your previous teaching pracs?	Perceptions of PMTI in action – previous teaching practica	Actualisation of PMTI
5. When you enrolled for your teaching studies, what were your expectations of the training to become a mathematics teacher?	Perceptions of tertiary training	Tertiary training as an influencer
6. What changes do you perceive in yourself as a result of your tertiary training?	Perceptions of own PMTI	Tertiary training as an influencer
7. What aspects of your training would you change if you could?	Perceptions of tertiary training	Tertiary training as an influencer

At the end of the third school term, which brings to an end the long practicum in which the Fourth Year students participate, the sub-sample was again interviewed individually. Observations were not conducted during this term, since it is the university's policy that all its final year students are observed only by the schools during this time, and students are at liberty to go to any school of their choice in the country. The semi-structured interviews held at this point therefore yielded data regarding the overall practicum experience, as well as insights into tendencies and behaviours observed in the videoed lessons.

The interview questions were designed to provide information about the participant's beliefs concerning the subject mathematics, how it should be taught and learnt and the extent of their involvement as Carers of their learners (see table 7 below). The first four questions dealt with beliefs regarding mathematics as a subject, as well as the attitude of the student regarding the subject. After Question 4 was answered, each student was shown the video clip of themselves teaching. Questions 5-7 were intended to access their perception of their own PMTI with reference to what they had just observed in the video. Questions 8 and 9 dealt with the aspect of teaching-and-learning expertise in investigating what the student believes about evidence of learner understanding and rigid adherence to lesson preparation. The next three questions were designed to find out whether the student is confident of their own expertise, whether in fact they believed their teaching to be congruent with what they thought was good mathematics teaching. The final question investigated their beliefs concerning their role as Carer.

Table 7

Second individual interview: questions related to conceptual framework

QUESTION	PURPOSE – TO ACCESS:	CONCEPT FROM CONCEPTUAL FRAMEWORK
1. How do you see the subject mathematics? Describe “mathematics”.	Overall perception of the subject	Beliefs about the subject mathematics
2. What is the purpose of the subject?	Beliefs regarding what their teaching is meant to achieve	
3. How do you feel about the subject?	Attitude toward the subject	
4. Do you believe that there is scope for creativity in the teaching and learning of maths? (Flexibility)	Beliefs regarding the rigidity/flexibility in the teaching of mathematics	
5. What stands out for you in this video clip?	Perceptions of PMTI	Actualisation of PMTI: Teaching-and-learning
6. How would you describe your own teaching style? Eg: a) Negotiation of meaning – teach by questioning? b) Emphasis on relationships? c) Relevance to real life?	Perceptions of PMTI: teacher/learner-centeredness	
7. As a maths teacher, what are your personal goals in the classroom? What do you try to achieve?	Perceptions of PMTI	
8. What do you see as evidence that learners are understanding?	Beliefs regarding teaching-and-learning	Evidence of understanding
9. What do you believe is the purpose of planning a lesson? (Preparation)	Beliefs regarding teaching-and-learning	Flexibility/rigidity in teaching
10. What, in terms of teaching maths, are you unsure of?	Perception of self as an expert	Mathematics expertise/ teaching-and-learning expertise/ caring expertise
11. What, in terms of teaching maths, are you sure of?	Perception of self as an expert	
12. Do you look back on a lesson you have taught with a view to finding strengths and weaknesses? Describe an example.	Perception of self as an expert: ability to reflect	
13. Do you believe that a maths teacher should be available to learners after class? What about during class?	Beliefs regarding self as Carer	Evidence and purpose of caring

Group student interview

A group interview was conducted during the school holiday between the second and third school terms, specifically to discuss the reality of the classroom situation in relation to the “theoretical practice” discussed prior to the practicum. The group interview was selected as a good method of collecting data after the practicum because it allowed me “to observe interaction on a topic” (Morgan, 1997, p 10). The advantage of group interviews as described by Morgan (1997) that they “provide direct evidence about similarities and differences in the participants’ opinions and experiences as opposed to reaching such conclusions from post hoc analyses of separate statements from each interviewee” (p. 10), in practical terms, meant that one student’s opinion or experience triggered a similar or opposing response from others in the group. This yielded rich data since the interviewees had all just gone through the same sort of practical experience: “Focus groups are advantageous when the interaction among interviewees will likely yield the best information and when interviewees are similar to and cooperative with each other” (Creswell, 2005, p. 215).

This interview was semi-structured in that there were five set questions, but the animated interaction amongst the participants led to a somewhat unstructured format, which Patton calls the “informal conversational interview” (2002, p. 342). However, as Patton points out, “Being unstructured does not mean that conversational interviews are unfocused” (p. 343). In view of the fact that this interview was conducted in the middle of a six-month long teaching practicum, the questions were focused on the actualisation of their PMTI’s and tertiary training as well as the practicum experience itself as influencers. For these students, the previous experience of teaching in a classroom was in a brief two-week practicum that took place eighteen months prior to this interview. During this time they had completed a year-long mathematics methodology module and other education modules at the university. It was therefore germane to this study to find out whether those modules had made a difference to their perceptions of their PMTI. Question 4 (see table below) was designed to access the difference made by the total university experience. Questions 1, 2 and 5 were concerned with the influences of the academic part of teacher training as well as the practica, while Question 3 gave the students the opportunity to describe themselves in terms of their PMTI and its actualisation.

Table 8

Interview questions for group interview

QUESTION	PURPOSE – TO ACCESS:	CONCEPT FROM CONCEPTUAL FRAMEWORK
1. Was this teaching prac different from your other teaching pracs? Why? If yes, why; if no, why not?	Whether the tertiary training which has taken place since the two week teaching prac in the beginning of the third year has made a difference.	Tertiary training as influencer Teaching practicum as influencer
2. Has anything changed in your ideas of what it means to be a teacher?	Whether the teaching prac has made a difference to the PMTI that developed during the third year	Teaching practicum as influencer
3. How do you see yourself in the future in the classroom? Describe 'you' in a classroom next year.	Perceptions of own PMTI	Actualisation of PMTI
4. Did you teach as you were taught at school or did you teach differently?	Changes in PMTI since schooling	Teacher training as an influencer
5. Now that you know what it's like out there, how would you make the methodology more relevant? More worthwhile?	Perceptions of tertiary training	Tertiary training as an influencer

Mentor teacher interview

In interviewing the mentor teacher, the purpose was to gain insight into another perspective of the student's classroom practice. These teachers were witnesses to the student's lessons and teaching-and-learning skills in action over a period of nearly two months and would provide a longer term viewpoint than the limited observations I would conduct. Unfortunately, only four of the six mentor teachers were available for interviewing and then only briefly and largely informally. Three questions were asked: how they would describe a good mathematics teacher; what their opinion was of the student's classroom practice in terms of what was most striking, and where she could improve.

3.3.2.3 Classroom observation

Two lessons taught by the students were “non-participatively” (Creswell, 2005, p. 200) observed and digitally recorded. The lessons were part of the ordinary teaching day of each of the students and the video camera was stationed at the back of the classroom on each occasion, so as to be as unobtrusive as possible. No observation schedule was used. The recording included not just the teaching part of

the lesson, with the student standing in front of the class, but also interaction with the learners as the student moved around the class. Care was taken not to film learners' faces for ethical reasons.

In observing the students at work in their classrooms, it was the intention to see how they carry out the various roles that teaching mathematics requires of a teacher. Grier and Johnston (2009) speak of an overlapping between identity and function: "Although some researchers call for a distinction between teacher identity and teachers' functional roles, the two concepts are not mutually exclusive and overlap considerably" (p. 59). However, I argue that identity is *actualised* in the classroom through the functional roles that are played. Although the students had quite clearly expressed their ideas about how they teach and who they are as mathematics teachers in the initial interviews, the classroom observations were designed to give insight into what Maxwell (1996) calls "theory-in-use" (p. 76). He found that participants' perspectives are sometimes not all shared openly in interviews, but that such perspectives become clear when watching the participant in action in the classroom. According to Patton (2002),

Interviews present the understanding of the people being interviewed...interviewees are always reporting perceptions – selective perceptions...By making their being own perceptions part of the data – a matter of training, discipline, and self-awareness – observers can arrive at a more comprehensive view of the setting being studied... (p. 264)

3.3.3 Data analysis procedures

According to Patton (2002), "Qualitative analysis transforms data into findings. No formula exists for that transformation. Guidance, yes. But no direction." (p. 432). The process, he says, "involves reducing the volume of raw information, sifting trivia from significance, identifying significant patterns, and constructing a framework for communicating the essence of what the data reveal" (p. 432). The sifting and pattern-identifying procedures to which Patton refers were carried out in this study by using the data analysis programme, Atlas.ti. The guiding principle in using the programme was what Silverman and Marvasti (2008) speak of as "methodological awareness" whose purpose is, amongst others, to show as much as possible to the research study audience of the evidence that has led to particular conclusions. In an effort to do so, the interviews were digitally recorded and classroom observations were video-taped. All the data were coded in Atlas.ti using open coding, or

what Gibbs (2007) calls data-driven coding. According to Denzin and Lincoln (2003), coding serves two purposes: “First, codes act as *tags* to mark off text in a corpus for later retrieval or indexing...Second, codes act as *values* assigned to fixed units” (p. 277). Both purposes were used in this study, which is why the data were ‘code-saturated’.

Questionnaire data

The biographical data in Section 1 of the questionnaire was tabulated in Excel and used in the sample selection process as described in Section 3.3.1.1. In Section 2 of the questionnaire the respondents were required first of all to complete a ranking exercise in which they were to indicate the relative importance given in their PMTI to Subject Specialisation, Teaching-and-learning Specialisation and Caring. This information was tabled alongside of the biographical data in Excel and used as a point of discussion during the initial interviews. The written responses in the questionnaire were copied into Atlas.ti and coded, using Open Coding. Twenty codes were generated inductively, bearing in mind the exigencies of the research questions (see Section 1.4) and the conceptual framework. The table below presents the inclusion criteria from which the codes were generated.

Table 9

Inclusion criteria for coding questionnaire data

INCLUSION CRITERIA	CODES
Mathematics Specialist	Better discipline Learners cannot learn what teacher does not understand Linking maths to real world Makes it possible to be flexible Respected because of knowledge So that learners can achieve outcomes Sound subject knowledge makes teaching easy
Teaching-and-Learning Specialist	Knowing learning styles in order to adapt teaching style Strategies to deal with diversity Strategies to link to real life Strategies to promote understanding Subject knowledge cannot be conveyed without skills
Carer	Allowing learners to communicate Be a role model Care in order to access maths blockages Dealing with classroom diversity Learners are multifaceted Patience with slow learners Preparing learners for life with moral values Preparing learners for real life challenges

Mentor teacher questionnaire

The data from the mentor teachers' questionnaires were transcribed, but not coded because each questionnaire contained only the ranking exercise and an explanation thereof. Instead, this information was incorporated in the analysis of the data provided by the students.

Interview data

These recordings were professionally transcribed, without grammatical corrections or exclusion of ums and other verbal eccentricities. According to Gibbs (2007), coding is easiest when working from a transcript. The transcriptions were then coded in Atlas.ti, using data-driven coding derived from "reading the text and trying to tease out what is happening" (ibid, p. 45), thus a thematic content analysis. Gibbs also explains that "[h]ow you develop these thematic codes and which of them you focus on will depend on the aim of the research" (p. 44). In this study the aim of the research is

captured in the conceptual framework, so the content was analysed with the conceptual framework in mind. The coding remains open, but coding began with some ideas of what to look for. Gibbs explains as follows:

If your project has been defined in the context of a clear theoretical framework, then it is likely that you will have some good ideas about what potential codes you will need. That is not to say that they will be preserved intact throughout the project, but at least it gives you a starting point for the kinds of phenomena you want to look for when reading the text. The trick here is not to become too tied to the initial codes you construct. (p. 46)

In the analysis of the data, in an effort to follow Gibbs' advice, the codes were used as a guide for searching the text and quotes used in the presentation of the results include the context of the coded quote and not just the coded quote itself.

For the initial interviews (prior to the teaching practica) fifty seven codes were generated, for the second interview set, seventy four, and for the group interview, nineteen. The number of codes created was a function of the desire to code even nuances of meaning. Asked how many codes should be used for thorough coding of qualitative data, Patton (2002) replies: "The answer depends on the nature of your data, which particular coding method you select for analysis, and how detailed you want or need to be – in other words, more filters to consider" (p. 19).

Table 10

Inclusion criteria for coding initial set of individual student interviews

INCLUSION CRITERIA	CODES
PMTI	Aha moment Nurturing and showing care Subject specialist Priorities in teaching identity: balanced Self as maths teacher: not a specialist Description of good maths teacher: discipline Description of good maths teacher: can relate maths to real life Description of good maths teacher: teach effectively Description of good maths teacher: cares about learners Description of good maths teacher: passion for maths Description of good maths teacher: superior subject knowledge Description of good maths teacher: professional, subject specialist Description of good maths teacher: teaching process specialist
Biography as influencer	Memory affects teaching Negative Opportunity to teach Not wanted to teach from the beginning Reason for becoming a teacher: calling Reason for becoming a teacher: cultural requirement Reason for becoming a teacher: family Reason for becoming a teacher: love for children Reason for becoming a teacher: love for maths Reason for becoming a teacher: making a difference Reason for becoming a teacher: part of personality Reason for becoming a teacher: society negative Reason for becoming teacher: by accident Reason to become a teacher: becoming someone
Tertiary training as influencer	Change in perceptions Increased subject knowledge Learner-centeredness Learning about children Maturation, discipline Methodology Effect of teacher training: very little Effect of teacher training: amalgam of academic, peer, school experiences Change required in training: make it more difficult Change required in training: make it more practical Change required in training: none Change required in training: repetition removed

Practica as influencer	Abbreviated relationships Applying varsity and mentor knowledge Fear countered with relationship Learning from mentor teacher Satisfaction of enlightenment Mathematics Specialist Carer Thrill of teaching Awareness of inadequacies Teaching strategy: based on relationship Teaching strategy: different approaches Teaching strategy: focus on content Teaching strategy: psychology - use other learners Teaching strategy: research and prep Teaching strategy: structured, process orientated Teaching strategy: focus on understanding Teaching strategy: perception of body language Teaching Style: as taught at school - stereotypical
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The second set of individual interviews with the students generated a different set of codes because the questions accessed other parts of the conceptual framework. Since these interviews were conducted at the end of the long teaching practicum, extensive questioning could take place regarding the student's view of the subject and their experiences in the field.

Table 11

Inclusion criteria for coding second set of individual student interviews

INCLUSION CRITERIA	CODES
Beliefs about the subject mathematics	Attitude towards maths: passion Attitude: challenging Reason for attitude: understanding, wanting to share Reason for attitude: belief in creativity Purpose of maths: learning to think Purpose of maths: mental development Purpose of maths: real life practicalities View of mathematics: uncertain, theoretically dynamic View of maths – creativity View of maths: procedural View of maths: real world use View of maths: way of thinking View of maths: problem solving , reasoning View of maths: source of belief - varsity
Actualisation of PMTI	Perception of self: dramatic Perception of self: practical Own description of style Goal: fun Goal: marks + understanding Goal: Reasoning skills and understanding Perception of video Weight of beliefs: content versus caring Weight of beliefs: independence of motivation Weight of beliefs: understanding versus speed Weighting: varsity versus school
Evidence of understanding	Choir response Visual; questions; books Asking questions Make learners explain
Flexibility/rigidity in teaching	Flexibility: answering learners Flexibility: depart from plan Planning: gives flexibility Planning: keep learners busy all the time Planning: staying ahead of sharp kids Planning: structure Planning: time management Planning: to get content right

Expertise in mathematics/ teaching-&- learning/ caring	Love of being right Creativity: linking to real world Creativity: manipulatives Creativity: only certain topics Creativity: reason - interest and functionality Certainty: content Certainties: knowledge, care Certainty: atmosphere of comfort Certainty: teaching for understanding Uncertainty: content Uncertainty: learners understanding Uncertainty: not taught as learner Uncertainty: running out of ways to explain Uncertainty: technical Locus of control: discipline Didactics: challenges Didactics: different methods Didactics: reason for questioning Didactics: use technology Didactics: asking why? Source of belief - didactic strategy Source of belief: understanding - varsity Reason for nurturing: improve attitude Reason for nurturing: research Source of nurturing attitude: school Reflection: on errors Reflectivity: not Reflectivity Teaching style problems
Evidence & purpose of caring	Availability Conflict Encouragement Encouraging responses Personal care Positive dealing with wrong answer Re-explaining Understanding: faces

The group interview, positioned as it was in the middle of the long teaching practicum, particularly involved discussion about the influence of tertiary training and teaching practica, as well as the actualisation of PMTI. The data from this interview was analysed in terms of nineteen codes.

Table 12

Inclusion criteria for coding group interview

INCLUSION CRITERIA	CODES
Tertiary training as influencer	Methodology changes: compress content Methodology changes: curriculum knowledge Methodology changes: phase appropriate Methodology changes: practical Methodology changes: thinkers
Teaching practicum as influencer	Extended prac: experiences challenges Extended prac: interaction Extended prac: theory replaced
Actualisation of PMTI	All three categories equal Being a teacher: integration of roles Being a teacher: discerning evidence of learning Being a teacher: flexibility Being a teacher: parental role Carer Subject specialist Vision of self: flexible Vision of self: integration of roles Vision of self: involved Vision of self: role model

Mentor teacher interviews

Of the six mentor teachers, only four were available for interviewing, and that informally, since they were busy and hurried. Three of the four interviews were recorded. The fourth interview, conducted with Thandi's mentor teacher, could not be recorded because it took place in the classroom where learners were making a great deal of noise and he did not have the time to relocate for the interview. Field notes were taken during this interview. Two questions were asked: whether the mentor teacher considered the student to be a good teacher, and in which areas improvement was required. The three recordings were transcribed, but not coded, since the information was concisely delivered because of time and logistical constraints on the part of the teachers, and was organised around the two questions that were asked.

Observation data

The videos were also imported into Atlas.ti. Both deductive and inductive coding was used initially as Open Coding, and then as Code by List: the elements in the conceptual framework were used as broad code subjects, like “Evidence of Understanding” – hence the deductive aspect of the coding; then a variety of sub-codes were created, drawn from what was said – hence the inductive aspect. Twenty three codes were generated in total.

In the analysis of the data, the context of the coded quote is generally included so that, when discussed, the quote is not taken out of context and thus subjected to misinterpretation. However, “because qualitative inquiry depends, at every stage, on the skills, training, insights, and capabilities of the inquirer, qualitative analysis ultimately depends on the analytical intellect and style of the analyst” (Patton, 2002, p. 433). Therefore, while every effort has been made to be transparent about the data collection and its analysis, that analysis has included interpretation, which, by definition, is subjective. Denzin and Lincoln (2003) explain as follows: “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).

Chronology of research activities

This research began with the administration of the biographical questionnaire to the entire Fourth Year class, after they had signed letters of consent for participation in this research. Using the information provided by this questionnaire, the participant selection was made for the case study. Shortly after that, the first individual interviews were conducted. The students then left the campus to commence the teaching practicum in the schools of their choice. At the end of that school term, approximately two months later, the students returned to campus for the group interview. They then continued with second half of their teaching practicum, after which they once again returned to campus, at which time the second individual interviews were conducted.

3.4 Methodological norms

Qualitative studies have long been criticised by quantitative researchers regarding validity and reliability issues. The reason for this may lie in Sadler’s statement regarding qualitative data

processing: “Whatever its strengths, the mind is apt to make errors of judgement and inference” (2002, p. 123). Patton (2002) speaks of credibility, instead of validity and reliability:

The credibility of qualitative inquiry depends on three distinct but related inquiry elements:

- rigorous methods for doing fieldwork that yield high-quality data that are systematically analyzed with attention to issues of credibility;
- the credibility of the researcher, which is dependent on training, experience, track record, status, and presentation of self;
- philosophical belief in the value of qualitative inquiry, that is, a fundamental appreciation of naturalistic inquiry, qualitative methods, inductive analysis, purposeful sampling and holistic thinking. (p. 552)

These three criteria are relevant to this particular research in that I believe that the phenomenon of PMTI can only be effectively investigated using a qualitative design; every effort was made to maintain rigorous standards in careful data collection and detailed analysis; I have tried to handle the data as honestly as possible. It is this latter aspect, involving the person of the researcher, that Maxwell (1996), describes in the context of qualitative research:

The validity of your results is not guaranteed by following some prescribed procedure...Instead, it depends on the relationship of *your* conclusions to the real world, and there are no methods that can assure you that *you* have adequately grasped those aspects of the world that *you* are studying. (p. 86)(emphasis added)

From this statement of Maxwell’s, it is clear that the role played by the researcher is fundamental to the credibility of the study. Patton (2001) declares that, in qualitative research, “the researcher is the instrument” (p. 14). Therefore, “the credibility of qualitative research depends on the ability and effort of the researcher” (Golafshani, 2003, p. 600), since interpretation of qualitative data is particularly subjective. In fact, Guba and Lincoln (1981) say that in a case study the researcher needs to “make clear that objectivity, being unachievable in any event, is not an aim” (p. 207). When considering the credibility of qualitative research, the concern therefore is not so much the data itself as the inferences drawn from the data and the interpretation thereof (Creswell & Miller, 2000). For this reason the researcher “has an obligation to be self-examining, self-questioning, self-challenging,

self-critical, and self-correcting. Any case study should reflect these intensely personal processes on the part of the researcher” (Guba & Lincoln, 1981, p. 207).

The types of understanding at which the qualitative researcher arrives can be categorised as follows, according to Maxwell (1996): description, interpretation, and theory. He recommends, instead of trying to prove the validity of each of those understandings, that validity *threats* be identified and that strategies be developed to nullify those threats (p. 88). In the case of this study, all the data came from three sources: a questionnaire, interviews, and classroom observations. Therefore, threats to validity, where validity is seen as ‘truth’, in terms of each of these needed to be investigated.

3.4.1 Trustworthiness of the data

While quantitative researchers use statistics to demonstrate reliability and validity, qualitative researchers

are not usually concerned with reliability, since they recognise that much of what they do is, in the last analysis, not truly replicable. There is, in other words, no expectation that one researcher observing a community at one time will exactly duplicate the findings of a different researcher observing the same community at a different time. (Angrosino, 2007, p. 58)

In qualitative enquiry the researcher can therefore only hope to convince the reader of the trustworthiness of her interpretation: “no amount of member checking, triangulation, persistent observation, auditing, or whatever can ever compel; it can at best persuade” (Lincoln & Guba, 1985, p. 329).

3.4.1.1 Interviews and observations

The main threat to valid description, in the sense of describing what you saw and heard, is the inaccuracy or incompleteness of the data. The audio or video recording of observations and interviews, and verbatim transcriptions of these recordings, largely solves this problem. (Maxwell, 1996, p. 89)

The recorded and transcribed interviews and class observations were member-checked to ensure that no misrepresentation took place. According to Creswell and Miller (2000) *rich* description is another

way of dealing with the threat to valid description. In this case, the readers can judge the faithfulness of the narrative through the vivid detail that is provided, allowing them to feel as if they experienced the events themselves, in a word, verisimilitude (Angrosino, 2007, p. 60). According to Creswell and Miller (2000),

Thus, credibility is established through the lens of the readers who read a narrative account and are transported into a setting or situation. To use this procedure for establishing credibility, researchers employ a constructivist perspective to contextualize the people or sites studied. (p. 129)

The next threat to the trustworthiness of the data lay in the interpretation thereof (Maxwell, 1996, p. 89). This less easily nullified threat had to be taken into consideration *during* the data collection process. This implied not filtering the meanings and perspectives of the participants through the framework of my own perspectives, but allowing the participants to reveal and justify their viewpoints without the restriction of what Maxwell calls “leading, closed, and short answer questions” (p. 90). Creswell and Miller (2000) define validity in this sort of context as: “how accurately the account represents participants’ realities of the social phenomena and is credible to *them*” (p. 124) (emphasis added). Golafshani also states that,

Therefore, reliability, validity and triangulation, if they are to be relevant research concepts, particularly from a qualitative point of view, have to be redefined ... in order to reflect multiple ways of establishing truth. (p. 604)

Kvale (1994) puts it differently: “Validation becomes investigation, continually checking, questioning, and theoretically interpreting the findings” (p. 167). In terms of qualitative research interviews, he found that, “Validation is here not some final product control or verification; verification is built into the research process with continual checks of the credibility, plausibility, and trustworthiness of the findings” (p. 168). Member checking, recognised by Lincoln and Guba (1985) as “the most crucial technique for establishing credibility” (p. 314), should therefore involve not only a confirmation of the credibility of the raw data, but should allow participants to “react both to the data and the final narrative’ (Creswell & Miller, 2000, p. 127). This ensures dependability, which is the qualitative equivalent of reliability in quantitative research (Golafshani, 2003, p. 601). In this study, the participants were invited not only to check the accuracy of the transcriptions, but also to comment on the authenticity and confirmability of the overall account.

Inevitably in this kind of research, researcher bias is a factor to be considered. In fact, “an unethical case writer could so select from among available data that virtually anything he wished could be illustrated” (Guba & Lincoln, 1981, p. 378). Maxwell (1996) pins bias down to “selection of data that fit the researcher’s existing theory or preconceptions and the selection of data that ‘stand out’ to the researcher” (p. 90). Qualitative research by its very definition implies *human* involvement in a very personal way. The researcher is *there*; “Interviewer neutrality is a chimera” (Cohen, Manion & Morrison, 2000, p. 121). The researcher records and observes. In fact, says Merriam (1988), “the world is not an objective thing out there but a function of personal interaction and perception” (p. 17). The researcher’s judgment allows the data to be interpreted. Maxwell acknowledges: “it is clearly impossible to deal with these problems by eliminating the researcher’s theories, preconceptions, or values” (p. 91). Disinterest is not an option, since the initiating factor for the research, in fact its very basis, is *interest*. So, “validity in qualitative research is not the result of indifference, but of integrity” (Maxwell, 1996, p. 91). In recognition of the issue of bias, I had to make it my standard practice in collecting and interpreting the data to examine my own thinking so as to make the descriptions and interpretations as honest as possible, making every effort to use the participants’ perspectives as a filter.

With regard particularly to the classroom observations, *reactivity* (Maxwell, 1996, p. 91) was a very real concern. However, eliminating the effect of the researcher’s presence is as impossible as eliminating the researcher’s values and theories. This being the case, and following Maxwell’s advice in this regard, what needed to be considered was not *whether* my presence had an effect, but *how* my presence affected the data. Any such effect then was documented and considered during analysis.

3.4.1.2 The questionnaire

Despite the fact that this study is an interpretive and explanatory case study and therefore deeply qualitative, as Wiersma (2000) so succinctly says, “When doing educational research, sooner or later something is measured”(p. 295). To this end, the questionnaire described in Section 3.3.2.1 was employed at the beginning of the data collection for this study.

Section 1 of the questionnaire dealt only with biographical data, which were used as a basis for sub-sample selection. Section 2 was adopted in tact from Beijaard's questionnaire, and consisted mainly of open-ended questions explaining students' ranking of three aspects of their professional identity: Subject Specialist, Didactics Specialist and Pedagogics Specialist. These three aspects were clearly defined in the questionnaire, but were also explained verbally to the entire class prior to their completion of the questionnaire. The questions in Section 2 served to "catch the authenticity, richness, depth of response, honesty and candour, which... are the hallmarks of qualitative data" (Cohen, Manion & Morrison, 2000, p. 255). These data were analysed in an effort, as Beijaard (2000) did, "to find patterns in teachers' [students'] clarifications of their perceptions of their professional identity and in their relevant learning experiences regarding the aspects of this identity" (p. 755). The patterns which emerged were then compared to the observation data to give further insight into this phenomenon.

3.4.2 Ethical considerations

Approval for this research was sought and granted from Ethics Committee at UP's Faculty of Education. The entire sample of Fourth year pre-service mathematics students were asked to sign a letter of consent if they were willing to participate in this research. The six participants in the case study, whose anonymity was guaranteed, were invited to read the transcripts of their interviews and they viewed the videos of themselves teaching in order to satisfy themselves that no misrepresentation took place.

A further ethical matter that had to be considered was the fact that I am a lecturer of mathematics methodology and the participants had attended my classes. There is therefore the concern about "the potentially distorting effects of power" (Cohen, et al., 2000, p. 123) and advocate awareness of this possibility. I was very much aware of the possibility that our relative positions would make the participants uncomfortable in both the interview and the observation situations. Three factors were significant in this regard and were discussed with the participants: they had successfully completed the modules taught by me, so they were technically no longer my students; this research was not in any way related to their academic results or progress, so nothing they said or did would affect those

results; and I was not their mentor lecturer for the practica, so my presence as an observer would have nothing to do with the university's assessment of their performance in the practica.

Given the fact that the interviewee has the power to withhold information and to decide what is important to divulge, "power is discursively constructed through the interview rather than being the province of either party" (Cohen et al., 2000, p. 123). I believe that the fact that the participants and I were familiar to each other was a strength rather than a weakness: they understood that the openness and sensitivity (which are requirements for effective interviewing, according to Kvale (1996)) with which the research was conducted were sincere because they were accustomed to my manner, and they could respond accordingly. In fact, using their familiarity with me as a basis for honest, open discourse is, I believe, the sort of responsible use of power to which Denzin and Lincoln (2003) refer.

However, it was not only the participants whose familiarity to me as the researcher had to be considered. I knew them as students in my class, but I now had to see them as participants in my research, and I had to remain on my guard to avoid impressing upon them my thoughts about methodologically appropriate beliefs and behaviour.

4. The PMTI's

Data for this study were gathered in four phases. Phase 1 started at the beginning of the Fourth Year methodology course, when the entire class of FET students ($n=25$) was asked to complete a questionnaire. The information garnered through this exercise was used to select the sub-sample and to provide a launching point for the individual interviews. The second phase of data collection involved the selection and individual interviewing of the sub-sample of six students, based on information from the questionnaire. In the third phase, the students left the campus to do their term-long teaching practicum at various city schools where they were observed and filmed while teaching and their mentor teachers were interviewed and asked to fill in an abridged questionnaire; and finally, upon their return to campus after the ending of their teaching practice, they were again interviewed in the fourth phase of data collection. Three groups of people thus provided information: the students, their mentor teachers and the classroom observer. Data had to be collated and analysed across all four phases in order to answer the research questions.

This chapter begins with a description of the perceptions of the Fourth Years regarding their PMTI. While the entire Fourth Year class per se was not the subject of this study, the data gathered through the questionnaire they completed, form an information-rich background to an analysis of the sub-sample data, and thus provide contextualising information for this qualitative study. The results are presented as follows: the questionnaire data are at first analysed in terms of the whole sample ($n=25$), and are organised around the three aspects of PMTI that are the subject of this study: Mathematics Specialist, Teaching-and-learning Specialist and Carer. This is followed by a detailed analysis of the sub-sample data. First under scrutiny are the influencers of these students' PMTI. Subsequent to this there is a descriptive analysis across two broad sub-sections: how the students perceive their own PMTI in terms of the three aspects, and then how their PMTI is actualised in their practice. Data from both the mentor teacher questionnaire and the interviews with the mentor teachers are discussed as part of the analysis of the sub-sample data.

4.1 The Fourth Year class

Who is the pre-service mathematics teacher at UP? Beijaard et al. (2000) investigated their respondents' *perceptions* of their professional identity. In this study also, the Fourth Year students' perceptions of their PMTI were analysed. In Section 2 of the questionnaire, the students were required to indicate and explain how and why they ranked the roles of Mathematics Specialist, Teaching-and-learning Specialist and Carer in their perception of themselves as educators.

4.1.1 Perceptions of their PMTI

Section 2 of the questionnaire began with a ranking table in which the students were required to rank the three aspects, Mathematics Specialist, Teaching-and-learning Specialist and Carer, as they perceived them within their PMTI. This table was followed by an open-ended question in which they were asked to explain that ranking. The data from this question were transcribed and coded in Atlas.ti in an effort to understand how these students perceive their own PMTI around the three Beijaard criteria which constitute part of the conceptual framework of this study. Twenty one codes were generated from the data as the students explained what made each aspect important to their way of thinking.

4.1.1.1 Mathematics Specialist

In the ranking exercise, eighteen of the twenty five students in the Fourth Year class placed Mathematics Specialist first. Analysis of the open-ended question in this regard yielded eight different codes in Atlas.ti, providing insight into *why* these students hold to the beliefs that they have concerning being a Mathematics Specialist as a mathematics teacher. By far the most common reason (six out of the eighteen) for attaching superior value to Mathematics Specialist, was the belief that learners cannot be expected to understand mathematical content that the teacher does not understand. Therefore, they explained, sound mathematical education is not possible without the teacher being possessed of sound mathematical content knowledge. Five students indicated that they believed that being a good mathematics teacher equates to being a Mathematics Specialist and that this was how it should be. The third most common belief was that being recognisable as a

Mathematics Specialist automatically engenders respect within a school. The remaining five beliefs about the necessity of the teacher being a Mathematics Specialist were each mentioned by only one student.

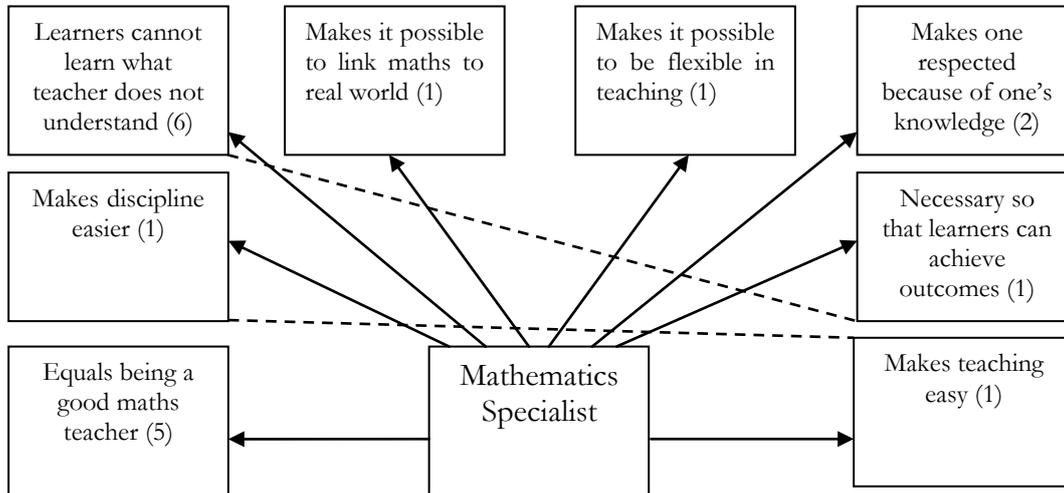


Figure 2. Mathematics Specialist: reasons for prioritisation

The dotted lines in Figure 2 above indicate possibilities for clustering of these codes based on underlying similarities.

4.1.1.2 Teaching-and-learning Specialist

In Section 2 of the questionnaire, the notion of Teaching-and-learning Specialist, or one who is a master of the skills and processes of teaching, was allocated first place by five of the students. All but one of the eighteen students who placed Mathematics Specialist first, placed Teaching-and-learning Specialist second. The most common explanation (given by five students) for this was that teachers should know how to teach. Three students referred to the need for teaching skills to bring about conceptual and not just procedural understanding of the subject in the learners. Two students thought teaching-and-learning specialisation was important because it provided the necessary knowledge of different learning styles to be able to adapt one's teaching to suit. Three other reasons, one referring to the necessity for skills to be able to convey subject knowledge efficiently, and the other two dealing with classroom diversity and the need to make mathematics relevant to real life, were mentioned by one student each. In Figure 3 below, clustering may occur as indicated by the dotted lines.

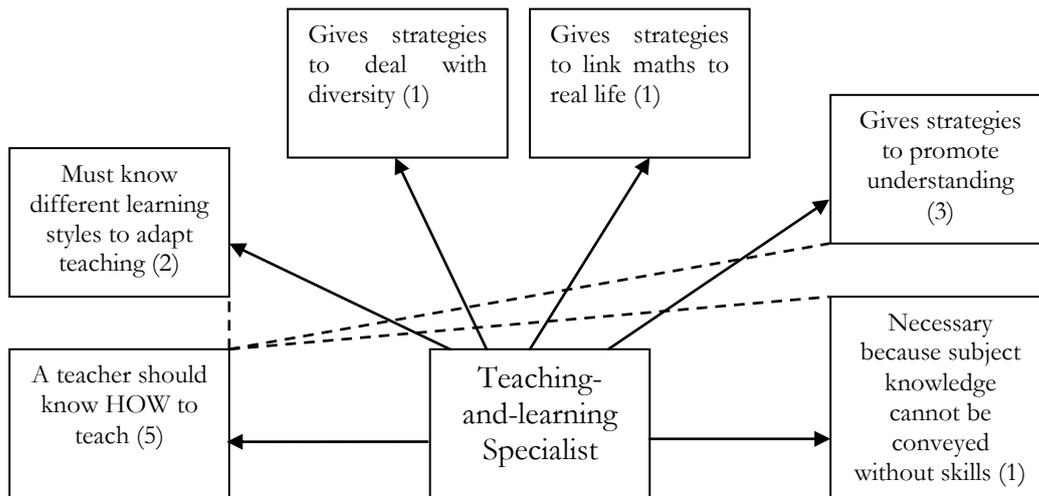


Figure 3. Teaching-and-learning Specialist: reasons for prioritisation

4.1.1.3 Carer

In their explanation of their ranking exercise, very few students even mentioned the role of teacher as Carer, and instead concentrated on why being a Mathematics Specialist and a Teaching-and-learning Specialist were more important. Only two of the twenty five students placed this aspect first in their PMTI. Nevertheless, a variety of beliefs regarding the importance of this aspect were mentioned by the students. Seven different codes were in fact identified, the most common of which (mentioned by three students) described the belief that a teacher should be a moral and life guide to the learners. Two reasons, each referred to by two students, explained that being concerned about the learners as individuals and caring about their personal problems allowed the teacher access to solutions for blockages in their learning of mathematics, as well as making working with multifaceted learners easier. One student thought a teacher should be a role model, another felt that being a Carer allowed her to be more patient with slow learners, and a third believed that being a Carer helped her prepare her learners for real life challenges via the mathematics classroom.

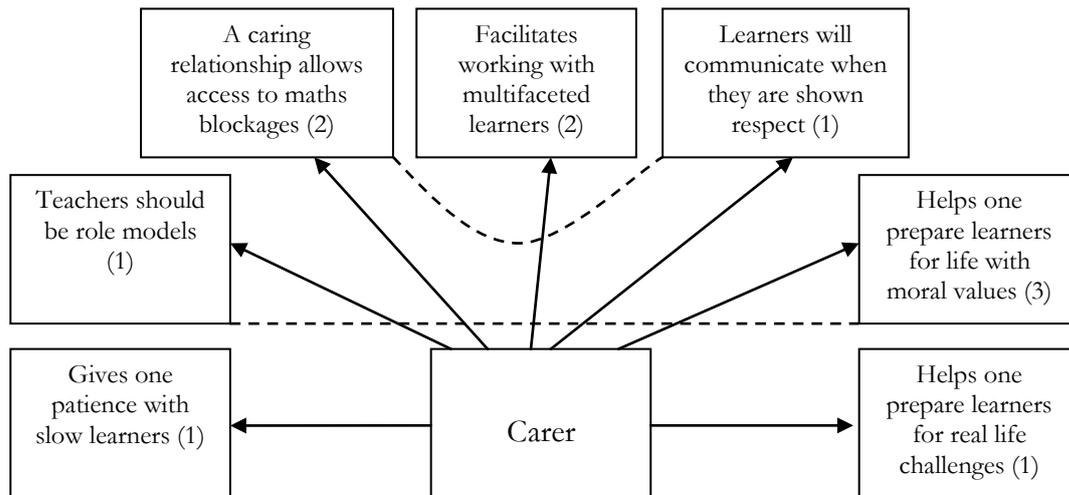


Figure 4. Carer: reasons for prioritisation

The open-ended responses indicated that, although the notion of Carer was not given much weight in terms of point allocations, the students nevertheless were very much aware of the need for and the value of being involved with their learners on a personal yet professional level. One student said, “Learners are made up of their social space/world” and therefore need to be handled as unique individuals. Dotted lines in Figure 4 above indicate possible clustering of these codes.

4.1.2 Learning about these aspects of PMTI

The remaining three open-ended items in Section 2 of the questionnaire each began with the statement “With regard to my role as Mathematics Specialist (or Teaching-and learning or Carer) I have learnt that ...” However, the students did not differentiate between their own perceptions of their PMTI and what they had learnt about the three mentioned aspects of PMTI at university. The discussion of the ranking in Question 1 was expanded upon in their descriptions of “I have learnt that...” in Question 2. Therefore these answers actually form part of the discussion in Section 4.1.1.

Summary

Who is the pre-service mathematics teacher studying at UP? Before homing in on the PMTI of such a student, data supplied by the Fourth Year class begins to fill in the background of the picture. Being a Mathematics Specialist is clearly most important to the majority of students in this group.

The students believe that no matter how well one can teach, if one's mathematical *knowledge* is deficient, one is simply not a good teacher. Closely seconding this category in strength is the conviction that no matter how well one knows one's subject, if one cannot *teach* it, one is simply not a good teacher. It would appear, however, that the third category, that of caring, is not one to which the students give nearly as much recognition in terms of the constitution of their PMTI. Nevertheless, this should not be interpreted as a lack of care for their learners. To some students, however, there seems to be a sequential aspect to these categories: one has to *firstly* know the mathematics, *then* one can figure out how to teach it, and *finally* one can think about nurturing the learners. The students did not differentiate between what they had *learnt* about the three aspects of PMTI in question, and their *own* perceptions of these aspects of their PMTI. In fact, the reasons for their prioritisation were generally based on theory they had acquired during their tertiary training.

4.2 Insight into students' PMTI: six case studies

It is against the background of the Fourth Year class as discussed above that the six students who were selected to form the sub-sample were initially individually interviewed. For purposes of simplification and easy recognition, the six candidates were given pseudonyms: Martie (White, Afrikaans, female), Ayesha (Indian, female), Thandi (Black, Sepedi, female), John (White, English, male) Thabo (Black, Zulu, male) and Sipho (Black, Seswati, male). Since the initial interview took place before the commencement of the teaching practicum, the questions appertain to influencing factors, as well as the students' perceptions of their PMTI at that time. The individual's questionnaire responses were used as a springboard for discussion. Their responses to the questionnaire were therefore analysed in conjunction with the information gathered through the interview. The codes were inductively generated through analysis of the data. The table below indicates the number of codes that were created as the data were analysed in terms of the conceptual framework. A total of seventy three codes were created.

Table 13

Influencers and PMTI: Number of codes in terms of the conceptual framework.

CATEGORY FROM CONCEPTUAL FRAMEWORK	SUB-CATEGORY FROM CONCEPTUAL FRAMEWORK	NO. OF CODES
Influencers	Biography	14
	Tertiary environment	12
	Teaching practicum	18
	View of mathematics	14
PMTI	Mathematics Specialist	6
	Teaching-and-Learning Specialist	5
	Carer	2

The six students were then observed and filmed teaching in the schools where they were doing their teaching practicum. The video clips were studied with a view to analysing the actualisation of their individual PMTI in terms of the three aspects, Mathematics Specialist, Teaching-and-learning Specialist and Carer. The initial codes which were used in this analysis, using Atlas.ti, were those generated through an analysis of the entire Fourth Year class's answers to the open-ended questions around these three aspects in Section 2: the videos were thus coded deductively at first. These codes were used to tag scenes in the videos in order to organise and facilitate discussion of the videos with the students. Then, during the individual interviews that were held subsequent to the completion of the practicum, the video clips of themselves teaching were shown to each candidate and together the student and I discussed the videos and associated codes in terms of the actualisation descriptors in the conceptual framework. The table below indicates the number of codes that were inductively created in the final individual interviews through discussion of the videos.

Table 14

Actualisation of PMTI: number of codes from conceptual framework

CATEGORY FROM CONCEPTUAL FRAMEWORK	SUB-CATEGORY FROM CONCEPTUAL FRAMEWORK	ACTUALISATION CATEGORY FROM CONCEPTUAL FRAMEWORK	NO. OF CODES
PMTI	Mathematics Specialist	Mathematics expertise	5
	Teaching-and-Learning Specialist	Evidence of understanding	7
		Teacher/learner-centeredness	7
		Flexibility in teaching	11
	Carer	Evidence and purpose of caring	8

The questions in this second and final individual interview were designed to:

- access the participant's understanding of the subject mathematics in terms of how they teach it (constructivist, Platonist or instrumentalist) and what they perceive as its purpose as well as what their attitude is toward the subject;
- investigate the participant's practice in terms of teaching-and-learning through examination of their locus of control,
- determine what they see as evidence of understanding
- find out how flexible they are in their teaching;
- and ultimately what evidence there was in their observed practice of caring for the learners as individuals.

In the rest of this chapter, the data from the questionnaires, video clips and interviews are used to provide deeper insight into the students' PMTI. Each of the six participants is discussed firstly in terms of the influencing factors within their personal history as well as those that have affected the development of their PMTI, such as their tertiary training and practica. Their view of the subject is discussed as an influence not only on their PMTI but (in the second interview) on the way they teach. Their PMTI is considered under the headings of Mathematics Specialist/Teaching-and-Learning Specialist/Carer through a discussion which includes both what I observed and their own

perceptions of their PMTI. Subsequently, the actualisation of their PMTI is discussed under the heading from the conceptual framework: mathematical expertise, teaching-and-learning skills viz. evidence of understanding, teacher/learner-centeredness, flexibility and evidence and purpose of caring.

Quotes are referenced as follows: (ISI or SSI, or Q, 1:17) i.e. Initial Student Interview or Second Student Interview or Questionnaire, primary document 1: line 17). All quotations are presented exactly as they were recorded in the interviews, so grammar errors have not been corrected, unless meaning became unclear. Mentor Teacher interviews are referenced as (Mentor Teacher interview, 1:12), with the numerals representing the primary document and the line number in Atlas.ti. The Mentor Teacher questionnaire responses consisted of a single short paragraph each and were not coded in Atlas.ti. At the end of each case is a visual representation of that particular student's PMTI according to the conceptual framework. Each figure has a colour key, indicating which of the aspects are high, medium or low in significance or prominence in that particular PMTI. Font sizes also differ accordingly.

4.2.1 Martie

Martie is an Afrikaans student who received her high schooling in a former Model C School in Pretoria. At school she was strong academically, demonstrating a particular aptitude for mathematics for which she earned a distinction in Grade 12. She began to study teaching after spending two years studying first Occupational Therapy and then Construction Management. Her academic record in the Faculty of Education is good, and she has shown herself to be a serious and motivated student. She received additional credits for completing modules that are not part of the BEd degree: Psychology (up to Third year level), Statistics, Criminology and Sociology (the latter three up to First year level). Her overall average is 67% and her average for mathematics is 72%, three percentage points short of a distinction.

4.2.1.1 Influences

Biographical factors

Martie begins her story about being a mathematics teacher when she was in Grade 10. She had a mathematics teacher who, while able to do the work himself, was unable to explain it to the class in a way they could understand. She, having managed to grasp the concepts, then would re-teach the work to her classmates. This experience would appear to be the actual genesis point of her PMTI and is the result of the coming together of two factors: her ability to understand mathematics alongside of the opportunity to teach it to her class, who lacked her understanding. At this stage in her life she became aware of an inherent desire to teach: “Well, very honestly, initially I wanted to study teaching” (ISI, 3:10). However, despite the apparent clarity of this desire, Martie was not sure upon leaving school about what she actually wanted to do with her life. It is only now, in retrospect, that she is able to see where the idea of teaching mathematics as the career for her actually began. At first, she was unable to define what she felt she wanted to do, and as a result was unable to find a career to match.

“Well, I wanted to work with both children and adults, both individually and in groups. To do both remedial and do like emotional, if I can say that way, like emotional work. Be both creative and systematic and everything at once, pretty much, because I’m... that’s just how I am... I wanted to study medicine and then I wanted to do engineering, just one of those, I couldn’t decide. So I wound up somewhere that the lady told me that occupational therapy seems like what I want to do and one of my friends studied it.” (ISI, 3:26)

So she enrolled for a Bachelor of Science degree in Occupational Therapy (OT), but was not fulfilled by what she was learning: “And, ja, one of my friends studied OT and when she told me what they did I told my parents it’s not it, that’s not it” (ISI, 3:26). Then she switched to BSc Construction Management which she did not find satisfying either. Nevertheless, she was unable to find the career path which she really desired until a particular incident re-awakened the initial ideas she had entertained at school:

“Eventually one day a social worker, one of my mom’s friends- she’s a social worker, they were talking about this little boy, he was sixteen and had just finished primary school but he was too old and the high schools didn’t want him, they couldn’t take him. And my heart just bled for this little boy, I almost told her to give that boy to me for three months, I don’t know why I felt that but

that's what I thought. Give that boy to me for three months, let me work with him and I'll get him back to track that he, like back on track, so that he'd be able to do grade 10. That's what I thought. And then the moment I thought that I realised Ah! That's what I want to do. It's like an aha moment." (ISI, 3:26)

It would seem that her father believed that for Martie to devote herself to a teaching career would be wasting the academic prowess she demonstrated as a learner. However, since no other career choice seemed to be satisfying to her, her father acquiesced, provided she teach a subject that involved her intelligence:

"Initially the mathematics thing was my dad, he said since I'm going to become a teacher and I don't want to do anything else, he would like me to do something that at least requires some mental...some brain power, ja, and something that's a bit of a shortage almost. But I loved mathematics since I was a little girl." (ISI, 3:10)

At the end of two years of pursuing other courses, the almost-buried memories of her school experiences along with the desire to help and to make a difference to young people, combined to make her change to doing a Bachelor of Education degree, which proceeded to confirm to her that this was the career for which she was best suited.

From Martie's account of her personal history, I identify three influencing factors: her enjoyment of teaching while she was still at school; her love of and prowess in mathematics, and her desire to help others by using her skills. While all three of these factors were instrumental in her ultimate career choice, it would seem that her mathematical ability played a crucial role – she could teach her fellows at school because she understood the work better than they; she could choose from a number of courses where high marks for Grade 12 mathematics were required, like medicine, or engineering, or OT. Paradoxically, it would seem, judging by her father's reaction, that her mathematical ability was one of the reasons for which she did *not* embark upon teacher training immediately upon leaving school – teaching would be a waste of such ability.

Influence of the tertiary environment

In Martie's case, the tertiary environment included a year of training in Occupational Therapy and a year in Construction Management. She therefore embarked upon her teacher training as a seasoned

university student with experience of working in two other faculties. She declared in the initial interview that she believes the BEd course did little for her in terms of preparing her to teach mathematics: “I really...I could’ve studied anything else and do what I do. Maybe it’s just me but... But I don’t know if I really learnt much here” (ISI, 3:60). In the initial interview, in fact, she said,

“Well, I did expect the mathematics to be similar to BSc [Bachelor of Science] mathematics which it wasn’t. It was really easy, or here compared to there and I did expect it to be almost BSc third year level. I don’t think it’s even first year level, very honestly my opinion, so I found it very easy and that was a bit disappointing.” (ISI, 3:58)

She did however indicate in the questionnaire that some experiences during this training *did* influence her thinking, but she associates this with people rather than modules: “The processes I learnt at high school was often better, yet there were some (two) maths lecturers in my three years who influenced and developed my own thinking” (Q, 2:217). She does not consider the BEd course to be good value for money – “we were given the theory (some of it) of how to be a specialist in the pedagogics field, but never HOW to... I learnt more necessary skills in the Psychology and Sociology and Criminology that I have also done [before studying education]” (Q, 2:220). Her particular interest is in modules that deal with personal issues: relationships, people skills and psychology. The bulk of the information in this regard came from courses and modules that she did outside of the BEd requirements:

Ok, ... I did psychology and sociology on main campus, [the latter of] which obviously isn’t required here. I think that a lot of the stuff that I learnt there, I incorporate here, or most of it. There, even in the remedial stuff I learnt everything and more in psychology, so I think if I could, I would probably have made that part of *this* course because it just...it teaches you so much more, especially I think with Psychology 220 the module is about...especially our people skills and so on and it had quite an influence on how- not just how I see people but how I know they relate to me and what I have to do to handle them alright and whatever. And child psychology also, it’s really important and I don’t think here it’s covered enough. I don’t think people really talk much. (ISI, 3:70)

In fact, in the quote above she intimates that these additional modules, apart from sociology, were so valuable that she would like to see them added into the BEd programme. Martie’s perception of the course was that it did not adequately prepare her for the exigencies of a career in mathematics

education, but she does believe that she has generally been taught how to be a reflective practitioner. What she did acquire, according to her, was the discipline to sit down and learn:

MARTIE: If I didn't really feel like it before I would just rather set [put] studying off, you know, I wouldn't go study immediately if I didn't really feel like it but now it's all a matter of - I don't care if I want to, I just do it.

INTERVIEWER: So you've acquired a discipline as far as that is concerned.

MARTIE: Um, ja. I've had it before but not like this and now I know how far I can push myself, which I didn't know before.

INTERVIEWER: And then in terms of learning to teach? Has something changed in your mind with regard to who you are? In that field?

MARTIE: I don't think so. (ISI, 3:64)

Her expectations of the course were therefore not met – she had hoped that her mathematical expertise would be greatly increased and instead she found the work either familiar or too easy. She did not fully subscribe to the idea that changing the course to include more practical experiences would make a positive difference to the quality of training the course offers. What would help, in her opinion, is making the electives more difficult:

“Yes, I would make most of the subjects, well, all of the subjects that I've done I would make harder. Like mathematics, I would do it at least up to a BSc second year level in three years... but I can't see why they [BSc students] have to know more than we do and we have to know the background to be able to teach it. I'd make the course a lot harder and not just for making it harder for teachers...students [need] to know more.” (ISI, 3:72)

Martie's description of her university experiences, particularly those in Education, is dominated by her conviction that the work is too easy and not challenging enough, particularly for someone with her abilities. She places an emphasis on the subject mathematics, and seems to think that the skill to teach the subject is an intrinsic part of that ability – her tertiary training, she says, added little to the knowledge of how to teach that she demonstrated while still a learner at school. According to her, her knowledge of mathematics was not much increased either – this she describes as disappointing. Despite her belief that who she is a mathematics teacher was not much affected through her

university experiences, she acknowledges that there were two mathematics lecturers who “influenced and developed” her thinking, and that at least she acquired a knowledge of educational theory.

The influence of teaching practica

Given Martie’s belief in the inefficacy of the BEd course she is in the process of completing, it is not surprising that in her teaching practicum she harks back to her schooling instead of her tertiary training. She believes that the link between actually teaching at a school and learning about such teaching at university is tenuous at best. Neither does she believe that her teaching practicum experiences have been particularly formative, since she does not believe that she acquired new knowledge regarding how to teach. When asked to speak about her teaching practicum experiences, she did not discuss what she learnt or how she developed as a teacher in any way, other than to say that she had not learnt much that she did not already know. Instead, she described her attachment to the learners and theirs to her:

They all thought I was their maths teacher because theirs was, I don’t know where, somewhere. I don’t know where he was. But I took over his classes for three weeks so it was my class and everyone thought I was the teacher and they almost cried more than I did and I cried a lot [when I left]. It was horrible for me to be leaving them alone. (ISI, 3:44)

What was significant to her, was the caring role she played:

If those that don’t really want to know ... I don’t know if I’d really mind it that much if they don’t listen, if they are able to do it. But the learners themselves are very important to me, I know that most children can’t really learn when they’re upset or something else is going on, so their heads aren’t going to be at work, they’re not going to be listening. 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, and if there’s anything...if there’s nothing that’s fine. They can also tell me if it’s going well, obviously I would like to hear that. (ISI, 3:42)

This confirms that what made sense to her out of the BEd course was information largely pertaining to the psychology of teaching.

When Martie was asked to discuss her teaching practica experiences in general, she focused on her interaction with the learners and their response to her. Judging only by her discussion regarding her

time in a school as student teacher, it would seem that the greatest influence of teaching practice in her life was in her role as carer and the interaction she enjoyed with the learners.

Influence of her view of mathematics

Martie demonstrates an understanding of the subject mathematics that goes beyond the level of numbers and operations. She indicates an awareness of the subject in terms of its effect on the student thereof: she believes the subject *is* a way of thinking, which involves the use of procedures and symbols:

I'd say that mathematics was a way of thinking, like it's a, um, ja, it's a subject that pretty much teaches you a certain way to think and how to analyse situations, well not just...well, using abstract um, forms like a b c, you know like stuff like that ja, symbols um to analyse situations, but also like methods... (SSI, 7:9)

It would appear that her view of the subject is inseparable from what she believes is the purpose of the subject: to teach learners to think and reason logically. She includes in this the notion of learning to solve problems and to think creatively in order to find solutions. Creativity, she believes, can be demonstrated through the use of manipulatives to clarify learners' understanding of certain concepts. In terms of Ernest's categorisations Martie's view of mathematics seems to be a combination of the Platonist and the problem solving view: she sees mathematics as something to be analysed and learnt in terms of methods, yet she also believes that it is a subject in which the individual can bring their logic and creativity to bear on problem-solving situations.

Her love of the subject is based on the joy she finds in solving problems and "being right": "I like producing [answers] which no-one else can get right; I like to be right!" (SSI, 7:36) This sentiment is echoed in her explanation of why planning is important: "You need to know exactly what you're talking about, you need to know that it's everything that you teach it's...is correct. You need to know that you're right because you can't... I don't want to teach um, wrong content" (SSI, 7:312)

She is, however, aware that others do not necessarily share her enthusiasm for the subject.

...People in general have this psychological block against, well, mathematics. Um, they just, they think about it negatively and if you as a teacher...a lot of the time the children um, attach the same

emotional value to a subject than they do to the teacher, so if they like the teacher and the teacher is positive towards them, they kind of feel like “hey, maybe mathematics isn’t that bad. (SSI, 7:116)

It seems therefore that in her view of the subject, it is something that can be loved, if one can master it, and disliked or even hated if one cannot. So, as a subject, it has an emotional dimension that engenders strong feelings in those involved with it. She came to understand this while she was a learner and her achievement in mathematics dipped when the teacher she liked fell ill, and was temporarily replaced by someone she strongly disliked. She discussed this link between liking the teacher and mathematics achievement with her friends and her mother. They had experienced similar achievement responses to an emotional stimulus (like dislike of a teacher).

4.2.1.2 Martie’s PMTI

In the ranking exercise in the questionnaire, Martie indicated that she believed that all three aspects of PMTI should be equal and were equally important to her. This belief that these three aspects should be in perfect balance is echoed in her initial interview as well as in her responses to the open-ended questions of Section 2 of the questionnaire where she had to describe what she had learnt at university about the three aspects of PMTI. When asked in the questionnaire to explain her prioritisation of these aspects, she wrote,

I believe that in order to teach the best, you have to know your subject field. You have to be the best in what you do. In order to get your subject knowledge across to the learners it is important to be the best in your knowledge of the methods and processes used, especially in mathematics. I also believe that the level of learners’ achievement are based mostly on their emotional, social and moral state. By being a positive influence here, you will increase their performance and achievement. (Q, 2:210)

However, her mentor teacher, in the questionnaire she was asked to complete, described Martie as predominantly a Mathematics Specialist. Inasmuch as the mentor teacher can be thought to have acquired insight into Martie’s PMTI across the three months of working together, it would seem possible that Martie’s belief of what *should* be the constitution of PMTI is belied by her practice. Martie is driven to achieve excellent results in what she does, as indicated in the quote above. In the space of three sentences she used the word “best” three times: “teach the best...be the best in what you do...be the best in your knowledge”. When her declared disappointment in the BEd programme is placed in apposition to this desire to be the best at what she does, it seems as if her

disappointment may be caused by being good at what she perceives as *easy* – hence not the “best” by being good at what is *difficult*.

Martie as Mathematics Specialist

Martie enjoys mathematics for the sake of the challenge it poses. This love for the subject has been with her since primary school: in the interview she explained, “I just love working with numbers, I love solving riddles and thinking...sometimes you have to think out of the box and sometimes there’s set formulas- I like to do both. So it’s pretty great actually” (ISI, 3:12). She is confident of her subject knowledge, having succeeded very well in the mathematics modules she completed both as part of her education and engineering courses. “So ja, I do consider myself, well, fairly knowledgeable on the subject of mathematics” (ISI, 3:42). In fact, her oft-repeated complaint about the BEd mathematics modules is that they were too easy and did not, in her opinion, give the student more in-depth knowledge than the matric learners the student is being trained to teach.

She sets great store by the conveyance of correct information to learners and by the ability of the mathematics teacher to answer their every question. On one occasion, however, she was unsure of the answer and would handle such a situation as she explained in her initial interview:

Well, if I didn’t know anything that wouldn’t...it happened once that I wasn’t sure about anything, I didn’t mind telling them “Listen, I’m not sure about this. I think I do know but I’d rather not tell you now, I’d rather tell you a bit later. Let me just go make sure about this”. I don’t mind telling them that because I knew they had respect for me for saying that to them because they knew that I would never teach them the wrong thing that I know is wrong, ever. (ISI, 3:50)

In the interview with her mentor teacher, this lady confirmed that Martie is first and foremost a Mathematics Specialist:

I think, in the first place, she’s a specialist in her subject, in mathematics. I think she explains it very well to the children. I think she talks a little bit fast and she’s not always clear with her explanations [in] her speech but she’s very clear with her explanation. I think the children follow her very well but I think she’s a bit quick to explain and then she’s got to do it again. (Mentor teacher interview, 1:8)

Therefore, despite Martie's beliefs regarding her own PMTI, it would seem that Mathematics Specialist is the dominant trait in her PMTI, causing her to teach the way she does.

Martie as Teaching-and-learning specialist

She declared unequivocally that her beliefs regarding what a good mathematics teacher should be, have not been modified and developed during the course of her studies. Her image of a good mathematics teacher, untrammelled by what she learnt in the BEd course, she described as follows in the initial interview: "Well, it would have to be someone that's funny and obviously smart, um, but not too smart, someone that's able to convey what they're trying to teach, but effectively" (ISI, 3:6). However, the knowledge she has acquired over the last three and a half years did creep into her more detailed description of a good mathematics teacher:

So it must be someone that...well, ja...I guess just gets across what they're trying to teach the children but also someone that takes the learners themselves into account- how the learners are performing, not just their performance but their personalities as well and tries to accommodate the different learning styles and different learning patterns and stuff like that. (ISI, 3:6)

Therefore it seems true to say that what made sense to her during the teaching training, was information about the processes of teaching and learning, in other words the psychological aspects of teaching. These were then absorbed into her PMTI. This, she says, is what she then put into practice in her teaching practicum:

I did consider myself, well, fairly knowledgeable on the subject of mathematics. Obviously I've encountered quite a number of methods to teach... So at one section of the work, say now you're doing functions, I know how to teach about three or four different methods. So I have to do more than one method because I know that a lot of the children when I was in school didn't understand, necessarily like the one method, they understood more than one. So I like to use more than one but not...well obviously I try not to confuse the learners when I teach. (ISI, 3:42)

Martie as Carer

When she was asked to describe her own teaching style, Martie immediately referred to the way she handled the learners: she saw the main thrust of her teaching as building up the learners, "while getting the subject content across" (SSI, 7:260). She described her style as "well, I like to think of it as being positive and reinforcing um, to children um, instead of breaking them down, encouraging them

to try at least” (SSI, 7:252). Illustrating this point, in the teaching practicum video she is seen to punch the air when the learners give her the correct answer to a particular sum, because, she explained, she was saying, “Yeah! You can do it! You did it right! Thanks, guys!” She believes in creating a positive, upbeat atmosphere in the classroom; she smiles often – “if you look at me and I’m smiling you start smiling as well and immediately you feel better about whatever is going on” (SSI, 7: 204) – because she believes that “If I’m positive then everyone around me is going to be positive” (SSI, 7:196). For this reason, she is very careful when responding to an incorrect answer. For example, in the video she said to a learner who had made a mistake, “It’s right, you just didn’t multiply it correctly”. In her explanation of this scene, she revealed the connection in her thinking between a positive, caring atmosphere, and learner performance:

Because often children, especially at that age can feel that you break them down by saying “you’re wrong!” because then they feel that “I’m stupid, I’m worth...well, if I’m stupid I’m worth nothing” and I’d rather not do that, I’d rather say “*listen, you’re worth a lot to me um, but try doing this differently, then you might get the right answer as well.* (Emphasis added) (SSI, 7:80)

She explained the root-belief behind her nurturing style:

Because children often think that “I can’t, I can’t, I can’t” and I’ve learnt that if someone, an authority figure tells them um, sometimes by repetition that “you can, you can, you can” even if they don’t believe in themselves, eventually they start thinking that “listen, wait, if this person believes that I can maybe I should think about whether I really can or can’t” so they kind of re-evaluate [themselves]... (SSI, 7:88)

However, she could not pinpoint the origin of this belief. She considered the idea of acquiring this belief in the psychology modules she had done, in her own experiences at school, or during her teacher training, but found none of these rang true. Eventually she concluded, “I don’t know. It’s just stuff I learnt about people at various places” (SSI, 7:99). She indicated that this way of responding to the learners was more instinctive than learnt.

Her relationship with the learners appears not just to be based upon a strategy to provide access to mathematical blockages in a learner’s mind, but shows a very real love for children. She described a teaching practicum in which she actually replaced the teacher, and developed close relationships with the learners:

But I took over his classes for three weeks, so it was my class and everyone thought I was the teacher and they almost cried more than I did, and I cried a lot. It was horrible for me to be leaving them alone. I must've done something right because I know they all came up to me, a lot of them came up to me and a lot of them told me stuff that was going on at home or just asked me what they should do because one time two or three boys were fighting and they came up to me after break and said these teachers...they got into trouble for it and I was like "Oh, well what happened?" and they told me, and they asked me very seriously how they should handle it next time and I remember, it was about a week later, the one boy came up to me again and he's like "Guess what? The same thing happened again and I did what you said and it worked!" and I felt like, aw that's so cute. So I must've done something right with that. (SSI, 3:44)

Martie's mentor teacher revealed a slightly different perspective: "She's a Carer, in a way but not really. She's concerned about them but not so much, I think the subject specialist is her best..." (Mentor teacher interview, 1:8). Therefore, as a close observer over the period of a school term, the mentor teacher indicated that Martie, although a caring, skilled teacher, remained predominantly a Mathematics Specialist. In the videoed lessons, Martie is seen to invite the learners to interact with her, but this interaction is limited to responses to her questions and occurs on a right/wrong basis with little discussion.

4.2.1.3 Actualisation of Martie's PMTI

For the most part, according to Martie, her professional beliefs have their origin in her understanding and interpretation of her own schooling experiences. The dominant theme that colours data gathered through talking to her, is her confidence in her mathematical ability. Martie was videoed teaching classes of twenty three children. On each occasion she presented new mathematical concepts followed by an opportunity for the learners to put the concepts into practice under her supervision.

Mathematical expertise

At no point in the observed lessons does Martie falter or make a mistake in terms of the mathematical concepts that she is teaching. Martie's mentor teacher testified in this regard:

She knows the mathematics, that's for sure. You know, you get people who knows the mathematics but cannot explain it because they're just too clever; [they] do not know how to explain it but they know how to do it. But she knows how to explain it too. (Mentor teacher interview, 1:60)

It would seem as if Martie's confidence in her mathematical skills and knowledge is not misplaced. When asked what she was uncertain of in her teaching, Martie could think of nothing. However, in terms of certainties, she could name a few:

I'm absolutely sure that I know what I'm doing. Um, I'm absolutely sure that I know that I have the best interest of every learner in front of me on my heart... Um, I know that and I know, well, I'm good at what I do. Um, I know what I'm teaching them is right um, and I know...I know I have people skills, I know how to work with them. I know how to get the right responses that I want from them. (SSI, 7:328)

Martie was asked to explain the origin of these certainties, certainties which she describes as knowledge:

Well, firstly, I think the root of it all is I know who I am. Um, I know who I have been made to be so that gives me certainty to act in what I know I have to do. If you know you're a...a tractor you can act certain in ploughing a field. (SSI, 7:336)

Ultimately, Martie said, regarding the way one teaches, "I'm pretty sure it's who you are" (SSI, 7:176), thus unconsciously echoing the words of Palmer (2007), "we teach who we are" (p. 2).

Teaching and Learning

While watching recorded lessons taught by Martie, it became clear that her teaching style is friendly and participatory: she continually invited learners to comment or provide information as to the topic she was teaching. She elicited choir-type responses by suffixing the expression "Né?" (Afrikaans equivalent for 'Isn't that so?') after most statements she made in explaining a concept. However, she was not satisfied with these responses as the sole measure of the class's level of understanding and checked individual work continually by means of the learners' upheld "whiteboards". In reacting to the learners' work as it was shown her, she nodded and smiled if it was correct, and shook her head, still smiling, if it was not. Since her reaction to incorrect answers held no vestige of condemnation or censure, she was able to maintain the level of participation from the class. Not one of the learners observed who submitted incorrect answers appeared in any way crushed or defeated: on the contrary, all seemed eager to keep trying. She used a strategy in which meaning was negotiated as she taught, by asking leading questions and prompting learners to express their understanding and venture suggestions. She explained her belief in this strategy during her initial interview: "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...the more you win" (ISI, 3:50). In this way understanding became a shared experience, instead of a clever lecture. Martie believes that her teaching skills are more intuitive than acquired through modules at UP. However, she testified to the usefulness of the psychology courses she had done; therefore it is possible that at least in part, her appreciation of the fragility of learner confidence was taught, not instinctive. Her friendliness is natural – Martie says of herself that she is always smiling, as indeed I observed.

In the initial interview Martie described a typical lesson she taught as very structured:

I worked very systematically and often I would tell them, "Write down in the little blocks somewhere in your books in colour pen or whatever. Make yourself a little note, here's like a little step for you 'how to do' the specific sum. So these are the steps you are going to use for most of them but you're going to modify them a little, but first you have to look for this then this and then this". And every time they asked me I would ask them, "Did you do the steps?" (ISI, 3:46)

The structure does, however, allow for a repetition of procedure explanations or explanations of various methods. As Martie said in her interview,

I do the one the way...if I can say, the easiest one first, the easiest and shortest way and then if they don't understand I'll go into more detail and do it in different ways- well only for those that does, that really want to know.(ISI,3:42)

From the observation video it is clear that Martie believes that, no matter how structured the lesson, learner participation is essential. She would therefore call on learners by name to elicit responses if they were not readily forthcoming. She also used this strategy to good effect in enforcing discipline or in correcting unwanted behaviour: she would, as she was explaining a concept, mention a learner by name, as if she were having a personal conversation with that learner. This strategy ensured that learners who were chatting amongst themselves were quickly called to order, and that those who were non-participants by habit, were brought into the flow of the lesson. This strategy is mainly intuitive, she believes, although she did subscribe to the teaching she received in her methodology classes in which constructivism in the mathematics classroom was advocated, and she thus tries to be constructivist in her approach.

Evidence of understanding

Martie explains that initially, when the learners complained of not understanding what she was saying, she just thought that the learners were not listening carefully to what she had been teaching them: “I was just like, guys, weren’t you listening to what I was saying?! Eventually I got [understood] that certain learners are slower than others” (SSI, 7:148). However, she believes that she is able to be patient with learners who “are slower than others”. Part of this patience means that for her, explaining and re-explaining in different words is a useful technique to bring all learners to more or less the same level of understanding. She justifies this technique with the following theory:

Because um, people think differently um, I’m lucky, I have both the creative and the logical like, I have both sides um, I can do both, but other people can only think in certain ways and other people well, ...only think in direct ways. So you have to incorporate the methods of thinking for both learners, um, and that means you have to explain it from different perspectives, hopefully someone understands something. (SSI, 7:156)

Once again, the root of this belief appears to lie in her experiences as a learner and student:

When I was in school, when I was in Grade 10 I think, I had this really horrible mathematics teacher and he was brilliant, but he was a horrible teacher, he really...he went and he wrote the stuff on the board and I was the only one smart enough to be able to understand what he did without a word being said from him. Um, so I’d get up the moment he left class and I would explain whatever happened to the class. And there I saw well, that everyone didn’t understand if he’d just do it his way and if ..., at times people would ask “but can’t you do it this way?” and he’d now realise “oh, this is how they think”. And I studied construction management for a year as well and there I found with um, quantities, the one subject, um, the guy...the lecturer gave us certain formulas to work things out, but there were various methods um, and mine were...every time, every time mine were different than his um, than the one he gave to the class, but mine was the one he would use in practice, um, so there you see um, he just said “yes, but I want them to learn this first because there’s a basic way of thinking, then they can come on and learn the more advanced things”. So you have to think of learners of...at a different level as well because often, I wouldn’t say the smart ones, but 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)

She is able to see whether in fact her learners have understood and have, to some extent, reasoned the thing out for themselves, by listening to the kind of questions the learners ask, and by finding who does and who does not do their homework – “So you send them home to do their homework and 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” (SSI, 7:300). Eyes are important to Martie. She believes that understanding is reflected in facial expressions, and, in particular, in the eyes of her learners: “... not just that [their facial expressions], their eyes. 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).

She also had the learners work individually on single examples she provided. Their work was done on plastic sleeves with blank white pages in them, so that, while writing with erasable white board markers, each learner could simply hold up their “whiteboard” for her to check their work at a glance. When she detected errors, she would take the time to stop and correct that error with the individual in question, to the satisfaction of both. She did not seem willing, at any point in the lesson, to allow error and misunderstanding to slip by for the sake of time or continuity.

Teacher/Learner-centeredness

In line with her view of mathematics as “a way of thinking”, Martie also believes that her learners should be encouraged to think for themselves. She provokes responses from them, whether individually, or as a group:

Because it’s important for me to know, well, I know that all the learners aren’t going to give feedback all the time. It might only be some learners in some classes um, but sometimes I try to say “what about, ok, what do you think? What then? How do I go further?” trying to make them think further than...you know, not just spoon-feeding them... (SSI, 7:184)

Her goal in teaching goes beyond even having her learners understand the actual mathematics, she wants them to learn skills which would stand them in good stead for life – like the ability to reason for themselves and to act independently:

Obviously I would want them to understand the work but ...there’s more to understanding the work, I want them to be able to think and reason for themselves um, cause that’s what school is

really about, it's not about teaching them something specific, it's about teaching them life skills, basically and I want them to learn that. (SSI, 7:284)

However, Martie tends to explain quite rapidly, before the learners have had a chance to discover truth for themselves. She, in terms of Ernest's (1988) classifications (see Section 2.6.2), appears to be an Explainer.

Flexibility

Planning a lesson is part of her quest for involvement of all learners in her lessons – through careful planning she believes she can stay a step ahead of the clever learners, and she can explain to them what the content of the lesson is aiming for. She also sees that planning helps her to manage the time and therefore discipline in a lesson efficiently, “because if you don't keep them busy, they're going to eat you up and you just have to keep them busy” (SSI, 7:308). At the same time, careful planning provides a base from which she can be flexible in her presentation: “if you have a framework on which to work, you can pretty much cover it any way you want” (SSI, 7:316).

During the lessons that were observed and recorded, she was seen to do any one sum on the whiteboard repeatedly if necessary, until she felt certain that understanding was achieved. This meant that she would use different methods to complete a sum, explaining to the learners that both, or sometimes all three methods were correct, and that although she felt that a particular method was perhaps the easiest, they could decide for themselves. This flexibility could easily be interpreted as a facility with the topic, based on sound subject knowledge.

Evidence and purpose of caring

Martie's PMTI evidences a care for individuals which often appears to have, as its intent, the accessing of solutions to blockages in mathematical understanding. She confirmed this perception in her initial interview:

But the learners themselves are very important to me, I know that most children can't really learn when they're upset or something else is going on, so their heads aren't going to be at work, they're not going to be listening. 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, and if there's anything...if there's nothing that's fine. (ISI, 3:42)

The care with which she believes learners should be treated is obvious in the observation video. She is seen to leave the whiteboard in the front of the classroom and to bend over a struggling learner's desk, working with him until the problem is solved. She also delivered judgment about the incorrectness of work done by a learner in such a kind way that offence was not caused and confidence was not damaged. She explained the value she attaches to the continued positive attitude of a learner as follows:

They can also tell me if it's going well, obviously I would like to hear that. I would take that into account when a learner performs badly so I would try to set up, say they wrote a test and it went really, really horribly and I know that the learners that usually don't do that badly, I would try to put something to kind of try to lift his marks but not take that away necessarily but just something to help. So I know that that's important, that's important for me as well. (ISI, 3:42)

Martie says she is a reflective practitioner, particularly when things have gone wrong in a lesson, as in teaching a matric class where the learners really did not want to be there – “We did, I think, financial mathematics or something and they just...they had such a hard time seeing ...they didn't get it and eventually they got mad because ...they just didn't want to be in school” (SSI, 7:352). She was confronted with a situation which was unexpected, and her reaction was to analyse both the situation and her reaction to it: “So I sat afterwards thinking to myself, ‘What did I do? What could I have done differently? How could I have responded differently to their responses to me?’” (SSI, 7:352) Her answer was to talk to them about their own futures and their unacknowledged need for knowledge to make their futures desirable. She realises that the positive end to this particular incident is not always guaranteed: “it's good but you can't win them all the time” (SSI, 7:360).

In the video she is seen to be bending over the desk of a learner and talking to him smilingly. However, as she looks at the work he has done in his book she shakes her head and explains again in an apparently friendly way. In discussing this scene, the following comments were made:

INTERVIEWER: Why don't you just stand in front of him and say, right, wrong, do this?

MARTIE: It's closer, personal contact with that specific learner... um... and when you do that, when 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. They're not just someone sitting in your class, you're not just a something to them, you're a someone with a value to them. (SSI, 7:134)

At the same time, Martie does not believe that the learners must be allowed too close; she believes that a professional distance must be maintained:

Yes, there's a definite line, you can't...they're not my buddies, my friends, they're not that. I'm the teacher and they're the student so there's going to...there is a line drawn from "up to this is where I'm friendly" 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 and for that you need a line. (SSI, 7:268)

That "line" in her thinking separates the professional educator from the pastor: "I'm a teacher, you have...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). According to her expressed opinion in the initial questionnaire, Martie placed the subject, the teaching of it, and the nurturing of the learners on the same level; her opinion does not seem to have changed.

INTERVIEWER: ...Let's say that you had to choose between doing that [teaching a topic] and encouraging the children in your class. Which belief weighs more heavily?

MARTIE: I wouldn't be able to choose. Very honestly, I wouldn't be able to choose.

INTERVIEWER: Ok.

MARTIE: I can't...if teaching subject knowledge with um, would mean costing that child's emotional stuff, I wouldn't do it. But if building a relationship with the child while there's no subject knowledge being taught I would, there'd be no point to it, so I wouldn't do that either. So I really...I can't separate the two. (SSI, 7:270)

4.2.1.4 Summary

The driving force in Martie's ultimate choice of career seems to be her need to share her knowledge with others and her desire to help others come to an understanding of mathematics which is as clear as hers. Her father helped her to focus her intention to teach on the teaching of *mathematics*. As is illustrated in the figure below, Martie's biography is a major influence on her PMTI.

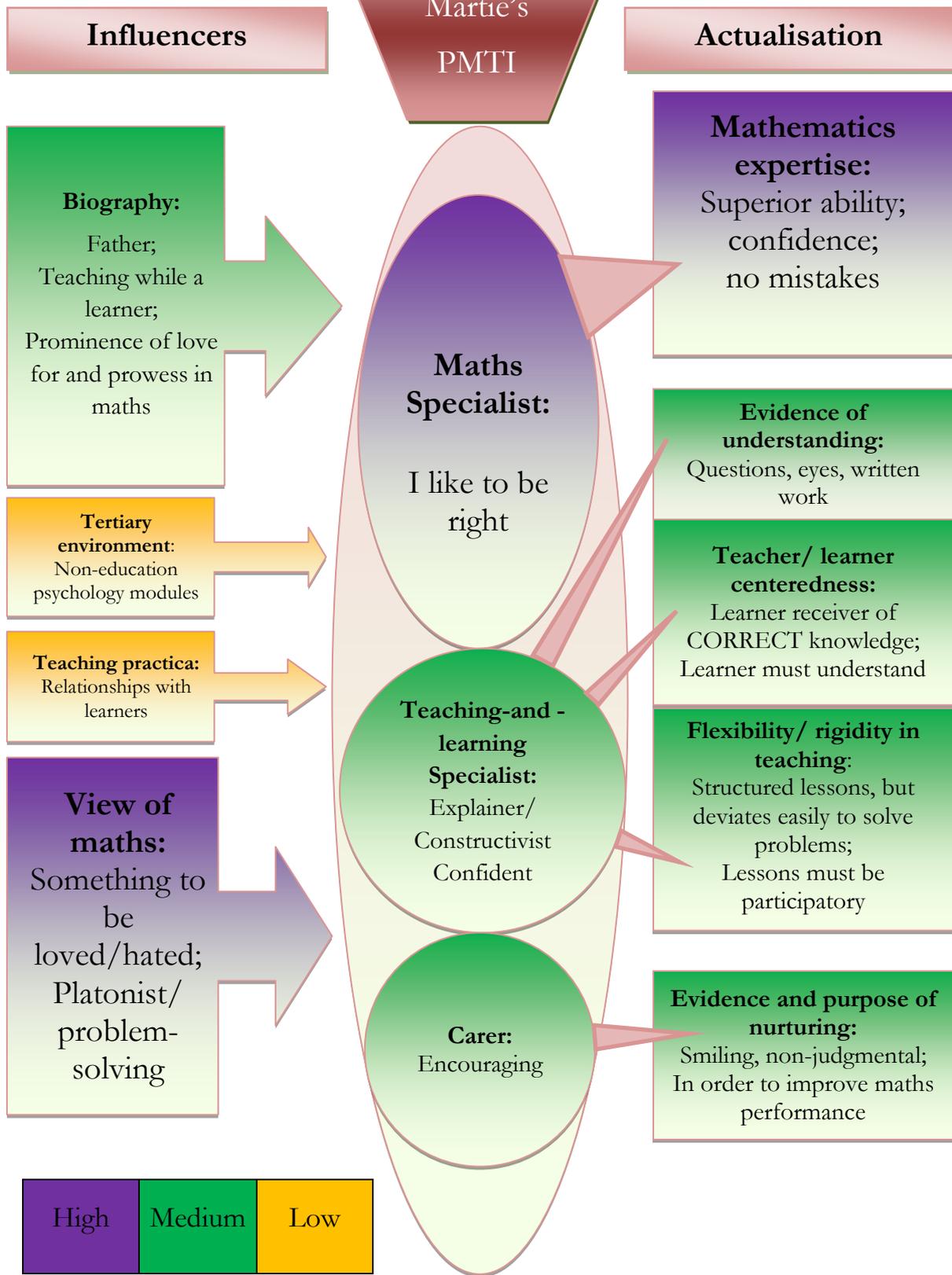


Figure 5. Martie's PMTI according to the Conceptual Framework

At school she demonstrated her love of and prowess in mathematics, and even taught in her teacher's place because she was a better explainer. Her experiences both in class at university and while doing the practica did not rate highly in her opinion in terms of formative value. What she does acknowledge, is a small increase of mathematical knowledge and a useful grounding in psychology theory. In Figure 5, the weakness of these influencers is indicated by the narrowness of the arrow boxes that represent them. Her view of the subject is apparently as great an influence on her PMTI as her personal history. She has a Platonist view of mathematics – what Ernest (1998) describes as seeing it as a connected, consistent, objective structure i.e. it can be understood.

She believes that a good teacher's PMTI should be absolutely balanced in terms of subject specialisation, teaching-and-learning skills and caring. However, this ideal is not clearly manifest in her practice: the figure above shows that her PMTI is not as balanced in terms of its component aspects as she would like to believe it is. As her mentor teacher observed, she is first and foremost a mathematics specialist; the videoed lessons show her as a caring, committed explainer (according to Ernest's model), who will go to any lengths to explain and re-explain until understanding, in her opinion, is evident. She certainly is reflective in that she tries to remediate didactical problems in a lesson and tries to plan for optimal coverage of the required material in the given time without sacrificing comprehension. She *cares*: but she has not yet mastered the technique of maintaining a professional distance without appearing to be more concerned about the topic than the learner despite the fact that she says her main concern is to encourage, so that learners do not fall into the habit of feeling they are unable to succeed at mathematics.

Thus a passionate educator whose PMTI appears dominated by two things: her love of mathematics and her enjoyment of teaching. Her ease of use of the mathematics she teaches is evident in her classroom; her determination to ALWAYS be correct in what she teaches is clearly communicated both in what she says and in what she does in the classroom. In Figure 5, the actualisation of the Mathematic Specialist aspect of her PMTI is preminent. It would seem that it is her aim and desire to put into practice the theory which makes sense to her: learner-centeredness and constructivist teaching strategies. She wants her learners to think and discover for themselves, but finds no way of leading them to the lesson outcomes without explaining and re-explaining while the learners remain passive, so they are receivers of the CORRECT knowledge she shares with them. The Teaching-and-

learning Specialist aspect of her PMTI is illustrated above as ranking below Mathematics Specialist. She sees herself as a Carer, but this aspect of her PMTI is not quite as significant in her teaching as Teaching-and-learning Specialist. Given her propensity for reflection and her belief in the benefits of constructivism in the mathematics classroom, it is possible that the discrepancies between her theoretical beliefs and her practice can be ascribed to a lack of experience.

4.2.2 Ayesha

Ayesha, an Indian student, was educated in a private school in the rural area where she grew up. In the questionnaire she described this school as disadvantaged. Her home language is mostly English. Her performance as a student at university represents steady effort, producing sound results. Her overall average is 58 %, with a mathematics average of 59.3%.

4.2.2.1 Influencers

Biographical factors

Ayesha felt very strongly about the influence of her high school teachers and her family. For this student, the beginnings of the belief that she could teach mathematics seem to have been founded in what she experienced as a learner observing mathematics teachers: her teachers, in her opinion, were very traditional and did not do justice to the subject and the learners in front of them. It would seem that at that point already the thought occurred to her that she could possibly teach it better; she could make a difference.

However, she is not conscious of the motivating quality of her high school experiences, and never once mentioned her schooling when asked about motivating factors. Nevertheless, there is a clear subtext in her general conversation revealing her lack of appreciation of the way she was taught at school, and that the thought of being able to teach better than she was being taught did cross her mind. In fact, when asked about her high schooling she did not discuss it from the point of view of a learner in the school, but rather as a clinical observer ticking off its inadequacies: “I think that school, it needs a lot of development because they don’t have any extra murals whatsoever and they have like one or two sports probably. They don’t even have the equipment, nothing whatsoever” (ISI, 1:6).

Her description of a good mathematics teacher was not related in any way to her high school experiences. Rather, she discussed the concepts of learner-centeredness and teacher-centeredness as taught in her tertiary training. She did however compare what she learned to be good practice, with her high school experience:

INTERVIEWER: Let me ask you like this: if you were to walk into a class and teach directly out of matric, would you do it differently to the way you walk into a class now to teach?

AYESHA: I think I would.

INTERVIEWER: In what way?

AYESHA: In...let me say, right now I would teach in a better way...so.

INTERVIEWER: How were you taught at school?

AYESHA: Which subject? Are you talking about mathematics?

INTERVIEWER: Mathematics.

AYESHA: Mathematics, it was just drilled into us. Yes, we had an extremely strict teacher; I think she took us outside the classroom like once. Ok, that's still fine that she at least took us out, but it was just once. There used to be charts in her room but there was no learner-centeredness, there was no interaction- there was some kind of interaction but we used to be more scared of her than liking the subject.

INTERVIEWER: So it was very traditional?

AYESHA: Ja, very traditional.

INTERVIEWER: Did you use the textbook a lot?

AYESHA: Ye...no, this teacher actually makes up her own sums. She's quite good at mathematics so, ja.

INTERVIEWER: But it wasn't very interactive.

AYESHA: It wasn't interactive. (ISI, 1:61)

From this it seems Ayesha's belief regarding good mathematics teaching generally revolves around involvement of the learners in what she describes as an interactive style of teaching.

While her schooling experiences acted as a negative motivator, her family provided positive motivation for teaching mathematics. In particular, when asked what the greatest influence on her was to choose teaching as a career, her answer was: “It was my father, not the mathematics teacher but the teacher part. Because all my life I did want to become a vet” (ISI, 1:21). However, her veterinarian dream did not prepare her for the realities of animal surgery, so she found herself in a quandary with regard to career choice:

Because I have a passion for animals, so I wanted to become a vet, but I think the whole operating and the dissections and all that freaked me out and then my father said, “Become a teacher.” And I thought, yes, children are my second passion. (ISI, 1:23)

Her father, who had been a teacher in India, was able to assist her in identifying her love for children as a reason to teach and it would seem that this deciding moment in her life was based on her father’s input. She then remembered that she was also passionate about children. Her cultural background, of which her father reminded her, played the deciding role. Her father, clearly a strong influence in her life, pointed out to her the cultural requirement of an Indian wife looking after her own children at home.

So he thinks that...because for us Indians it’s better if the woman has a job where she can even be attendant to her children. So he feels that, even during my holidays, they would have holidays also and then I can be attentive to the children. He thought ahead for married life, but I thought about it and then I said that I do like children, I do want to educate the future and I see that there are many teachers who are not qualified but because the schools are desperate they are appointing those. So I said let’s do it. (ISI, 1:28)

While recognising the legitimacy of his motivation and the fact that he had thought ahead of her life as a married woman, she also identified within herself the desire to make a difference to future generations. When asked whether she thought she really could make a significant difference as a mathematics teacher, her reply was emphatic: “Yes, yes!” (ISI, 1:29)

It would seem, therefore, Ayesha’s cultural predisposition to parental guidance is so embedded that her own desires are easily dislocated. In point of fact, her decision to become a mathematics teacher seems to have been based on a process of reasoning rather than an inherent compulsion. She loved children; she wanted to make a difference to them by being a good mathematics teacher, therefore,

“Let’s do it”. Nevertheless, her reasoned approach was not devoid of passion, as demonstrated in her response to the question of whether she really could make a difference. Upon being questioned a little more deeply, she confirmed that in fact she believed that she was born to teach:

AYESHA: “...one can’t really teach someone how to teach, I think it comes to you naturally and...

INTERVIEWER: Or not!

AYESHA: Or not, but I think it is in me, I do have it in me.

INTERVIEWER: So, do you think you’re born to teach?

AYESHA: Yes, I think so. (ISI, 1:48)

Her ambition to become a veterinarian and the notion of being born to teach are in conflict – it is possible that she has tried to convince herself of being born to teach in order to confirm the correctness of her father’s guidance and her decision to acquiesce to it. This explanation is borne out by the fact that she began to doubt the wisdom of her career choice when it was met with disparagement from people for whose opinion she cared.

I just want to add on to that, when I did come to university and people would ask me things like, ‘What are you studying?’ and then I would say, ‘Teaching’ and they would be like ‘Teaching?!’ I got that a lot, I even went into some...ok, it wasn’t depression, but I was a little sad and I was thinking whether I should change my course and...because people around me, they do influence my decisions and stuff because, ja, they’re the people around me. I was thinking whether I should change my course but no, I’m fourth year now, I’m almost finished and I’m going to be a good teacher and educate the future. (ISI, 1:52)

There is a strong sense of resignation and making-the-best-of-one’s-lot in these words. It would appear that the negative views of others regarding teaching as a career very nearly outweighed her father’s positive view. However, having embarked on a course and, in her opinion, being past the point of no return, she settled into an acceptance of her vision of herself as a mathematics teacher since this was in accordance with her desire to make a difference to future generations and to comply with her culture’s requirements.

Influence of the tertiary environment

Although she feels adequately prepared from the point of view of teaching mathematics, her overall opinion of the BEd course is not high. She claims that many of her initial expectations were not fulfilled. Her disappointment appears to lie in the perceived paucity of practical experiences. She indicated that she felt strongly that improvement in this area would enhance the course. However, positive changes in her thinking regarding the teaching of mathematics did in fact occur:

INTERVIEWER: What changes do you see in yourself as a result of your training here at varsity?

AYESHA: I think...what changes?

INTERVIEWER: Think about yourself in matric to who you are now.

AYESHA: I have changed a lot; there is a lot of personal development.

INTERVIEWER: In what way? Give me some ideas.

AYESHA: I don't know, I just know I have changed a lot. I know that...ok, I think the OPV [Education] modules, they also helped me understand how children think, how you should behave with them and how to deal with children with problems. (ISI. 1:53)

So her tertiary training has allowed Ayesha to believe that she is adequately prepared to teach the subject, and that being a good mathematics teacher requires more than she originally supposed upon leaving school. She also learnt about education theory and educational psychology, allowing her to give an informed opinion of her teacher-centred high school experiences.

The influence of teaching practica

She believes there is a discord between what she was taught at university and what she actually experienced as a student teacher, and between *the way* she was taught at school and the way *she* taught at school. This may well be ascribed to what Feiman-Nemser and Buchmann identified as the “two-worlds” pitfall in which the more theoretical aspects of teacher training appear to be in conflict with “real world” of the classroom. Her perception is that her tertiary training within the confines of the university lecture halls was not adequately connected to the real-world classroom. She believes the school to have been a better mentor than the university. Nevertheless, she was unable to identify particular aspects of her teaching practica that were significant in her personal development as a teacher of mathematics. Ayesha experienced teaching practica generally as a place where she could

put into practice what she thought was the correct way to teach, while at the same time being guided by an experienced teacher, while her university training was put aside and classified as out-of-touch with the reality in which she worked at a school.

Influence of her view of mathematics

Ayesha described her view of mathematics as follows:

Ok, I would start off by saying it's a set of numbers - obviously mathematics only works in numbers and digits and it's what...it's how you count and as...as you go to a higher grade it gets complex but when you begin with mathematics it's all about numbers. (SSI, 1:8)

When asked whether she thought mathematics was a finite, closed system, she seemed unsure, possibly because she was not quite sure what the question meant. However, she could think of four reasons why she believed that mathematics was in fact not a finite system: the numbers go up to infinity; the curriculum keeps changing; new research results in new discoveries and new technology is invented all the time (paraphrased). She sees the purpose of the subject as being related to real life practicalities and mental exercise.

There is no question of creativity, other than in the lower grades, she said, where one may use boxes and colours and so on. In fact, in the video she was seen to be demonstrating congruency to a Grade 8 class using pink cardboard triangles. Asked why she did this, she said she was afraid the learners might otherwise find the lesson “boring and dreary” (SSI, 1:106). She also believed this made explaining the concept easier: “And then because I was proving, I was doing something about similarity and so I can actually turn the triangles and show them that they do overlap and, ja” (SSI, 1:118). In Grade 12, according to her understanding, there is no time for creativity in mathematics classes. However, at the same time, she indicated that she believed that creativity was essential since this is what she was taught at university:

I can't remember the name of the module but it was something about the right brain and the left brain and they inter-correlate. I found that very striking because if both your sides, well, the sides of your brain are working, it will be more effective and you would understand better. So in mathematics, when you do something creative, it would awaken both sides of your brain and that's why I think it's important. (SSI, 1:94)

She described her attitude toward the subject as “passionate”. The reason for this was, “because I understand it and want to share it with other people and I want them to understand it too” (SSI, 1:60). In terms of Ernest’s (1988) model, it would seem as if Ayesha’s view of mathematics is an amalgam of the instrumentalist and Platonist views: she believes it to be about numbers, which though infinite, are rule-bound; she admits to new discoveries being made and new developments occurring. As a subject, it can be understood through the learning of steps and procedures.

4.2.2.2 Ayesha’s PMTI

In the ranking exercise in Section 2 of the questionnaire, Ayesha placed Mathematics Specialist first, followed by Teaching-and-learning Specialist, and last came Carer. She felt that this distribution was indicative of balance:

I feel that the category should be balanced. I want to be a teacher who is able to focus on the subject knowledge and skills, the evaluation of the teaching and learning processes and moral development of learners. I feel that all these categories are equally important. (Q, 2:183)

She seemed unaware of any conflict between the ideas she expressed: although she ranked the three aspects very clearly in the questionnaire, in the interview she declares that she believes they should be equal. It would seem as if her instinctive prioritisation in the questionnaire was revised in the interview situation when she thought about how things *should* be.

Ayesha as Mathematics Specialist

In Section 2 of the questionnaire, Ayesha linked the importance of being a Mathematics Specialist to the achievement of the learners: “It is important that the learners understand the concept, otherwise they are unable to complete the given tasks and the predicted outcomes would not be achieved” (Q, 2:187). She reinforced this statement during her initial interview, again explaining her beliefs regarding these three aspects of her PMTI:

I do see myself as caring but I feel that I want to be a subject specialist; I want to know my work. It’s no use knowing how to teach when you don’t know what you’re teaching. So that’s why I think that holds the most value, knowing your subject and then knowing how to teach. (ISI, 1:34)

Not only does she value mathematics specialisation as paramount, but she believes that her knowledge of mathematics is such as to make her a Mathematics Specialist:

I have...about the subject specialist until the past two teaching practicals that I did do; I did not get any challenging questions from the learners so I think I am a subject specialist, I'm good at my subject because I didn't get any questions that I couldn't answer or that I was dumbfounded by. (ISI, 1:40)

Her assessment in this regard is based on the belief that knowing more than her learners about mathematics is enough to make her such a specialist. In the video she proves that no learner question goes beyond her knowledge of the topic at hand. Her preparation was in fact very thorough, and the use of manipulatives enhanced the understanding of the learners of the concepts she was explaining. Her lesson was dominated by her determination to convey knowledge in such a way as to allow the learners to memorise the procedure in proving congruency. She reminded them in so many words of the specific three steps required to prove two triangles congruent, and the five steps required to be followed in a specific order for the proof to be completed correctly. The learners having been drilled in this regard appeared comfortable with the procedure, although in-depth understanding as to why the specific procedure was to be used was neither communicated nor solicited.

Ayesha as teaching-and-learning specialist

Ayesha seemed to confine this particular specialisation to knowledge of how to deal with learning problems in the mathematics classroom:

It is important to be a life-long learner. There are different kinds of improvements in world of education and one needs to be aware and alert about these implementations. One also needs to know if learners are struggling and what needs to be done. (Q, 2:190)

Judging by the following statement in her initial interview, Ayesha believes that didactical expertise is not something one can be taught: "I see you did try to teach us how to teach but one can't really teach someone how to teach, I think it comes to you naturally..." (ISI, 1:48). The instinct to which she refers takes precedence in her classroom practice, because, to her way of thinking, that is as it should be.

However, this instinct seems to have been at least partially influenced by what she experienced during her own schooling: she teaches while the learners listen. Ayesha believes that, as a mathematics teacher, she should explain repeatedly until she feels understanding has been reached. In order to facilitate this, she breaks down procedures into recognisable steps.

INTERVIEWER: Alright. As a mathematics teacher, what are your personal goals in the classroom?

AYESHA: Personal goals?

INTERVIEWER: What do you want to achieve?

AYESHA: I want them to understand mathematics. I don't want them to just say "Step A, step B, step C", that is just for them to get the marks. I give them the steps for them to get the marks but I also want them to understand mathematics and like it. (SSI, 1:340)

Ayesha as Carer

Ayesha described herself as someone who is passionate about children. When her father suggested teaching as opposed to veterinary science she said, "Then my father said become a teacher and I thought "yes, children are my second passion" (ISI, 1:23). Nevertheless, in the ranking exercise, Carer came last. In the initial interview she explained that being a caring educator, which she equated to learner-centred teaching, was not easy:

AYESHA: So it's difficult to always make it learner centred, group work and for learner interaction.

INTERVIEWER: Ok, so in one word, no, one sentence- a good mathematics teacher is someone who...?

AYESHA: Someone who takes the learners' differences into consideration.

INTERVIEWER: Ok, very good. What do you mean by that? Do you mean learning, personality?

AYESHA: Learning differences. Also background differences because some people are depressed, some people have ADHD and ja... (ISI, 1:10)

From this it would appear that to Ayesha, being a good mathematics teacher implies knowing one's learners and being able to take into account the diversity in the classroom as well as the personal difficulties which may be impediments to learning. She also indicated that tact was required in teaching in a differentiated way, so that learners were not embarrassed or made conscious of each

other's personal problems in the classroom situation. She elucidated her belief in this regard with the following anecdote:

AYESHA: ... Not that you should treat them differently. Like you don't make everyone aware of it, of their problem. They shouldn't be put in the spotlight but you, yourself, should be aware of it and then take that into consideration with any decision making or situation.

INTERVIEWER: How would you take that into consideration when you're making a decision?

AYESHA: Like, just today my friend was telling me that she was teaching English and she was doing this poem about an abandoned bundle where this woman gave birth but she did not want the child so she just threw it away and then the teacher said it would be better if she [the student] didn't do it because there was a learner who just had an abortion; so in that way taking the learner into consideration. (ISI, 1:17)

Part of caring, according to Ayesha, is the notion of the teacher leading by example:

Learners tend to look up to their teachers as role models. In order for the learners to be morally well developed, we as teachers need to be an ideal icon. Learners do not do as they are told to; but they follow what they see, therefore we have to practise what we preach. (Q, 2:193)

Thus it would seem that her belief regarding what constitutes a good teacher means that not only does the teacher care about the problems of the individual in as much as these hamper learning, but such a teacher must in her conduct also be a moral preceptor. In the video footage of Ayesha's teaching, it is noticeable that Ayesha maintains a dispassionate distance from the learners and does not enter into personal interaction with any learner either during the actual teaching part of the lesson, or during the part where she walks amongst the learners as they complete the examples she gave them. Therefore it would seem that Ayesha's beliefs regarding being a caring educator do not include casual interaction during class time. She explained in her initial interview that her understanding of caring involved a sort of counselling situation: "Well, there weren't any situations where I had to care for the children, like someone who had a special need or something. I do care for them but there was no specific situation, ja, there was no opportunity" (ISI, 1:40).

Ayesha's mentor teacher seemed to think that this particular aspect of PMTI was not well developed in this student, but explained that the context of the mathematics classroom did not lend itself particularly to caring:

Due to time constraints, we as mathematics teachers are governed by the number of minutes a mathematics period has. We need to concentrate on completing subject knowledge and skills and are sometimes unaware of the evaluation of the learning process and socio-economic and moral development of the learners. With experience to different schools and learners, I am sure that [Ayesha] will develop in the categories that she lacks. (Mentor teacher questionnaire)

4.2.2.3 Actualisation of Ayesha's PMTI

This student demonstrates a determination for the learners to be fully occupied throughout the lesson, so that there is no time for discipline problems to arise. Her lessons were well-structured and organised, and the learners behaved circumspectly.

Mathematical expertise

Her approach toward the content in her lessons tends to be formal, demonstrating her confidence in the subject's reliability in terms of consistency, logic and precision. She values procedure as a means of ensuring that the learners are able to score marks in a test; knowledge of the procedure, she believes, builds confidence in the learners and gives them the know-how required to do the sum:

INTERVIEWER: Now you've taught them about congruency, a very...very tight procedure.

AYESHA: Yes.

INTERVIEWER: Um, do you believe that giving them the procedure like that helps them?

AYESHA: I think so.

INTERVIEWER: Why?

AYESHA: Because then they...they know which way to go. They know where to start and where to end, otherwise if you just give them a sum and tell them to do it they wouldn't know where to start. So it's just, basically, to mould them to...ja, to know which steps to follow. (SSI, 1:192)

True to her experience on previous practica, no question posed by learners was too difficult for her to answer accurately and with apparent ease. By her own standards then, she qualifies as a Mathematics Specialist. She was able to teach the mathematical content confidently and she certainly knew the procedures off by heart.

Teaching and Learning

The video footage of Ayesha shows her to be a confident educator, clearly aware of her mastery of the topic at hand. The satisfaction of being able to impart this knowledge successfully to others while doing her teaching practicum served to confirm her belief in herself as a mathematics teacher: “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)

She, like a case described by Thompson, expects her learners to “assimilate the content. Assimilate means ‘see’ the relationships between the new topic and those already studied, as explained by the teacher” (Thompson, 1984, p. 63). In order to make sure that this “seeing” happens, she is willing to explain the same thing several times and will repeat instructions if necessary. In fact, the only situation which would make her nervous while teaching would be finding that the learners do not understand despite her many explanations:

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.

INTERVIEWER: Has it ever happened to you?

AYESHA: Um, it hasn’t actually.

INTERVIEWER: But it can.

AYESHA: But the thing is, maybe I don’t know if it has happened because what I do, 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, 1:394)

In the video clip it was clear that repetition of process and re-explanation were techniques she firmly espoused:

INTERVIEWER: Ok, now you’re explaining procedure, following very tightly what you said before and here they are doing the sums, you’re reminding them of things. Now you’ve explained angles to them before, why do you do it again? You’ve explained alternate angles during the lesson.

AYESHA: Ja, because I've noticed that uh, there's lear...there's different levels, there's learners that learn quickly, there's learners that are learning slow. You have to explain to them two or three times, so I was just keeping my options open.

INTERVIEWER: Ok.

AYESHA: I was trying...trying to accommodate all the learners. (SSI, 1:236)

The statement above indicates a belief that multiple repetition brings about understanding - at least enough to be able to complete the task at hand successfully.

Evidence of understanding

Observation of her teaching style revealed that she applied herself to making the topic accessible to all the learners, not just to dealing with stragglers. She was able, through using different examples, to explain the meaning of the congruency of triangles in such a way that the particular steps which had been taught were reinforced and that very few questions were asked by the learners, given that the procedure was simplified into five easy steps. She interspersed her teaching with chorus-answer type questions which may be interpreted as symptomatic of a desire to make sure that everyone understood all of the time. She appeared to believe that such answers were true reflections of the learners' understanding. While the learners were given the opportunity to complete individual exercises in their books, she walked around the class repeatedly, checking their work, but not pausing to interact on a personal basis. In this way, she says, "And I also know what they understand and what they don't. If...if I see a common mistake I know I should emphasise on that" (SSI, 1:262). At the same time she is able to maintain a certain atmosphere 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). She claims to have begun believing that this technique is effective while still at school herself. This is not her only means of establishing whether the learners understand as she teaches:

INTERVIEWER: Ok, alright. What do you see as evidence that the learners are understanding what you're saying?

AYESHA: When I walk around I...Oh! Ok, when I'm standing in front, sometimes they ask me questions and when I answer the questions they go "Oh!". I actually love that look, I love it, it makes my teaching worth it, ja, and...

INTERVIEWER: Like a reward.

AYESHA: Yes, it's just rewarding, very rewarding. Ja, and um, and even when I walk around I look into their books and 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)

Teacher/Learner-centeredness

Ayesha believes that she knows how to teach mathematics and that that implies active participation on the part of the learners. In fact, in her initial interview, in answering the question about her understanding of what a good mathematics teacher is, she opined,

A good mathematics teacher? Well, I would describe a good mathematics teacher to be strict but approachable. Firstly because the learners need to know that you mean business and they also need to know that they can ask you any questions if they have any problems and I think everything should be balanced, like there should be learner-centeredness, but at times you also need teacher-centeredness... (ISI, 1:8)

Although the effect of her studies is clearly discernable in the tenor of her answer, she did not explain how she arrived at an understanding of the concepts to which she referred or how the balance she spoke of may be achieved. However, the type of interaction she had in mind is clarified by her answer regarding her style of teaching:

INTERVIEWER: And your own style? Do you involve the children?

AYESHA: Yes, I do. 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. I try to be as approachable as I can. (ISI, 1:74)

It would seem therefore that her understanding of interactive teaching in a learner-centred way implies only concurrence with what she has said or enquiries about concepts they might not have understood properly. This is borne out by observation of the video footage of her teaching. Ayesha favours chorus-answer questions like:

Do you all understand?

Angle A is equal to...?

Angle B is opposite Angle E, isn't it?

Side AB is equal to side BC, yes, no?

No participation from the learners beyond answers to questions such as those above, or posing their own questions when they do not understand, is invited or encouraged. The learners are not prompted to suggest their own explanations or theories to explain the geometric procedures with which they were busy.

Again like the case described by Thompson's (1984), Ayesha believes that "the teacher must establish and maintain an atmosphere of order, respect and courtesy in the classroom" (p. 63). She believes that questions must be dealt with immediately, as they arise, and while the learner still remembers her concern and has the courage to enquire. She also believes that posing questions to the class as a whole is more effective than posing a question to an individual:

I want involvement from everyone. I know if I ask one person then they will all be awake and they'll think "she might ask me now, she might ask me now" but I don't know, sometimes I just prefer asking the whole class. (SSI, 1:134)

Asked why she favours this technique, she explained that individuals might be uncertain and would slow the whole lesson down while they wonder about the answer. If however the answer to the question is obvious, she sees the question as rhetorical, simply a mechanism to keep the class moving along through the work. In the video it can be seen that she believes in continuing to talk while she is writing on the board, with her back turned to the class. She explained that she does not think it wise to stop talking in order to write:

I think if I...I stop and write then they might start talking at the back [of the class], I do have some sort of hold upon them but still, if...if I stop talking they stop listening so that's why I think I continue to talk. (SSI, 1:154)

From this it may be concluded that, while Ayesha firmly believes that the learners should participate actively in the lesson, that participation lies between the strict boundaries of responding to her questions, or posing questions regarding the work immediately before them. Discussion is not something she encourages for any length of time. Locus of control rests with her. When learners appear to be deviating from the strict hold she has on the lesson, she gives them "the silent treatment":

AYESHA: I think they were doing it repeatedly, I think something was going on there.

INTERVIEWER: Now why do you just look and not speak?

AYESHA: It's just... what...what do they call it? Silent treatment.

INTERVIEWER: Ok, so you gave them the silent treatment.

AYESHA: Ja.

INTERVIEWER: Ok, do you find that that sort of sternness is effective?

AYESHA: It does, it works, it works.

INTERVIEWER: Why do you believe that?

AYESHA: Because I have experienced it and I then I just give them a look and then they just stop whatever they're doing because they know what they're doing is wrong and as soon as you look at them and you just don't say anything they...they just stop it, ja. (SSI, 1:205)

In her style of teaching, Ayesha combines two of Ernest's models: she is at times an Instructor, presenting procedural information accurately and intelligibly, and at other times an Explainer, willing and able to explain a concept or procedure repeatedly and from different perspectives.

Flexibility

Planning a lesson is very important to her, since she believes that planning is what directs the lesson toward the desired outcome, while at the same time facilitating the maintenance of sound discipline:

I think you have to plan a lesson, it's very important. You need to know what you want to achieve from the lesson and also you can't just go to a class and just do any work with them. 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)

Her planning is designed to provide direction and content for the lesson from beginning to end, so it does not allow her to be flexible in her presentation. Thus in Ayesha's case, her planning provides a structure for lending rigidity to the lesson rather than flexibility.

Evidence and purpose of caring

At a certain point in the video clip, Ayesha asks the learners to determine the magnitude of a particular angle. Although most of the learners are unsure, several venture ideas and make suggestions as to how the answer may be found. Instead of pointing out their errors to them, Ayesha smiles and says, "No, no, no, no". She explains her response by saying,

I think it's for them to keep on trying, it's so that they don't feel...because there's many children that if...if you say no they feel "maybe I shouldn't ask again" or "maybe I shouldn't try again" so I did not want to condemn them from participating in class because I know in class if you give an answer, you'll remember it and even when you're writing an exam, you'll remember "hey, I gave that answer". So I did not want to condemn them from not participating in class. (SSI, 1:170)

Clearly, Ayesha believes that learners should not be discouraged by a harsh attitude, but at the same time her response is very definitely negative. She appears to believe that her smile counteracts the negative "no, no, no".

She also believes that the learners need to perceive her as available and approachable if they are experiencing problems. Nevertheless, the general topic for discussion at such times would be mathematical issues, not personal ones, "Because I am, how do I say this? I don't mind them coming to me if they have any queries, even after school, it's fine, I'm willing to help them out" (SSI, 1:278). When asked to describe her own teaching style as observed in the video, she re-emphasised this point:

Yes, my teaching style. I believe in being firm, equal...treating all learners equally. Uh, well there might be instances where the learners...some might need more help, that's why I walk around if they have any questions to ask and many people they feel shy thinking that their question might be a stupid question, that's why it's better that I walk around and then they can...how do you say it? Like confide in me and ja, ask some questions. (SSI, 1:326)

While her observed technique and even her explanations confirm that Ayesha sees interaction with her learners as mostly professional – about mathematics – she holds a belief that she needs to be available also as a personal counsellor:

INTERVIEWER: Do you think it's important that they trust you?

AYESHA: Ja, very much.

INTERVIEWER: Ok, good.

AYESHA: Because even if some learners have problems at home and they don't know who to talk to, I might be able to help them so it's not just in the classroom situation but if they trust me maybe with their personal matters then maybe I could help them.

INTERVIEWER: Would you be available?

AYESHA: Yes, I would. (SSI, 1:327)

Even such a discussion about personal issues is seen as having professional concerns at the core:

There's people who learn quickly, there's people who learn slowly, there's students who at home have extra tuitions so when they come to school they are prepared, they know what you're talking about and then there's other students who have no idea what you're going on about because there's no one helping them at home, they have dishes to do, they have chores to do, they can't finish their homework in time. So I think it's better to be available, it's very important actually, it's very important to be available after school if they have any questions or any problems that they need to share with you. So it's vital to be available. (SSI,1:430)

Thus, while Ayesha sees herself as a Carer, this nurturing appears to be motivated by the concern that learning is hampered by emotional or personal problems, and that if learning outcomes are to be achieved, the teacher has to be available as an uninvolved counsellor who can help to remove personal issues which are barriers to learning. Despite what she says about caring for the learners on a personal level, this “care” has an ulterior motive – its purpose is to eliminate blockages to understanding, which, as an “explainer”, is her main mission.

4.2.2.4 Summary

Wanting to make a career of veterinary science, Ayesha was persuaded by her father that culturally she was required to be at home in the afternoons so that she could be with her own children, one day. Therefore teaching was a suitable career – mathematics education in particular, since she was good at the subject. She was persuaded on two accounts: she set great store by her father's opinion; and the exigencies of her culture made sense to her. At this time she was able to identify within herself a love second to her love of animals: she also loved children. This student did not originally want to be a teacher at all. However, while a learner at high school, she was taught mathematics in what she describes as a very traditional way, and the thought occurred to her at the time that she could do a better job of it. Her teacher was good at mathematics, but did not teach in a way that involved the learners. Nevertheless, in observing Ayesha teaching, the influence of her high school mathematics classes can be seen – she teaches procedure which the learners have to memorise. Interaction between her and the learners is very limited. The strength of her biography as an influence on her PMTI is represented in the figure below with a large arrow block. Ayesha's tertiary training allows her to put a name to what she had observed as a learner: the class was very teacher-

centred. In her personal history there appear to be three influencers: her conviction at school that she could teach mathematics better than her teacher, her father's opinion, and the exigencies of her culture. Her tertiary training seems to have influenced her only in terms of the acquisition of educational theory regarding the psychological aspects of teaching. Teaching practicum served to confirm to her the differences between tertiary training and the real world of the classroom. Ayesha's PMTI was certainly developed through the tertiary training she underwent, but her "sense-making" of what she was taught during this time was filtered through existing beliefs of what mathematics teaching is in practice: the teacher teaches and the learners respond according, usually, to specific prompts. Her tertiary training and practica experiences are represented as smaller arrow blocks in the figure below, as they appear to be of less significance than her biography and view of mathematics in her PMTI. Therefore, while she accepted what she had learnt at university as useful in helping her to teach better, when juxtaposed with the reality of classroom practice, the university's influence became irrelevant. Ayesha's view of mathematics is a combination of Ernest's instrumentalist and Platonic views: she sees it as a set of rules which can be learnt; a body of knowledge that can be discovered with the help of a teacher who can teach the necessary procedures correctly.

Ayesha sees herself primarily as a mathematics specialist, although she believes simultaneously and without apparent internal conflict, that the three given aspects of PMTI should rank equally in one's professional identity. In terms of Ernest's model, Ayesha would seem to be both an instructor and an explainer whose mission it is to transfer information as accurately and intelligibly as possible to her learners. Chorus-answer questions are used to assess learner comprehension. She also evaluates the expressions on their faces, looking for the Aha! moment of understanding. She knows her subject and seems comfortable answering the few questions that arise. However, questions outside of the 'perimeter' of the lesson plan are not encouraged. She believes that a good lesson is an interactive one – yet her lessons are not designed to encourage learner participation. This apparent conflict is resolved when she explains that she makes a point of asking the class continually whether they understand. They answer in chorus. She describes this as interactive teaching. Ayesha is particularly concerned with discipline, and believes that if she stops talking or allows the learners a freer participation, discipline will be lost. She believes a good teacher is a moral preceptor who cares about a learner's problem inasmuch as they inhibit learning. She is friendly, without being particularly warm or caring in her attitude.

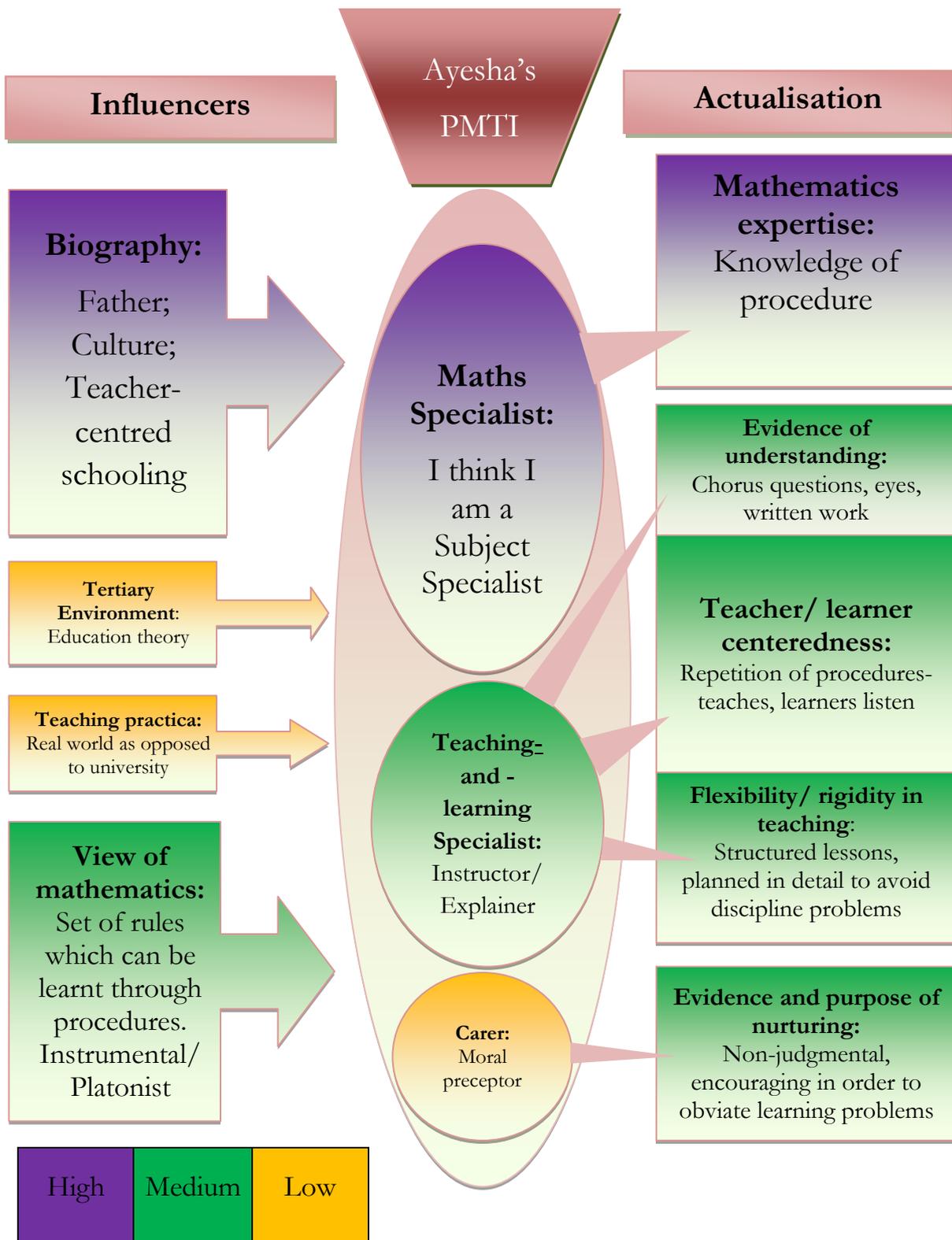


Figure 6. Ayesha's PMTI according to the Conceptual Framework

4.2.3 Thandi

Thandi is a black student who was educated in a private church school in a black township near a large city. She passed mathematics in Grade 12 with an E symbol – between 40 and 49%. She enrolled into the BEd course in the Faculty of Education, UP, immediately after matriculating, completing her degree in five years, instead of the usual four, since her first year was spent on foundational courses in the sciences, English and mathematics. This “bridging” year, which is intended to bring students onto a level where success in their tertiary studies is more likely, allowed her access into the BEd course. Her academic progress in the BEd programme was good, ending with an overall average of 61%, but her mathematics average was 53%, only three percentage points above a pass.

4.2.3.1 Influencers

Biographical factors

In her interview, Thandi identified her reason for choosing mathematics education as a career as simply her love for the subject.

“I’ve always loved mathematics, even though I did badly in mathematics in high school. I love mathematics because, especially geometry. I was bad in geometry but still I loved it. Why? Because it challenged me and it made me to think out of the box...” (ISI, 2:9)

She added to this by explaining that mathematics was taught selectively in her school, in that certain aspects were emphasised and others neglected or abandoned. This, she claimed, made her want to not only conquer the neglected topics, but teach them properly, in contrast to her own experience.

I went to a private school and they were setting their own question papers at the end of the year so they neglected some of the chapters in the syllabus like geometry. They did not do much geometry like in grade 10 and then we had to...maybe they give us a handout this week, next week we are writing an examination and they, uh, pushed mathematics negatively with some chapters. So I just want to be a mathematics teacher and then learn to love those chapters, because I already love the chapters that challenge me but then learn the [neglected] chapters and be able to teach learners. (ISI, 2:9)

When asked whether she was influenced in her career choice by any particular person, she indicated that the choice was based on an inherent factor.

INTERVIEWER: ...Were you influenced by a particular person?

THANDI: Not really, Ma'am.

INTERVIEWER: Not your family or your teachers?

THANDI: No.

INTERVIEWER: So it really just comes from inside?

THANDI: Yes, Ma'am. (ISI, 2:10)

Nevertheless, her response was not delivered with passion, nor with any further elaboration of this idea. It seemed necessary, therefore, to delve further into her reasons for becoming a mathematics teacher. If she did not see it as something she simply *had* to do, then why, apart from loving the subject, which could easily have led her down a different career path, did she choose to *teach*? The answer seems to lie in the following quote: "The other thing, when I enrolled to become a teacher I just wanted to be a better person, a person with a profession, to start something of my own" (ISI, 2:30). She seemed to perceive a teaching career as one that would give her status in the community, that would make *somebody* of her. Therefore, her choice may be seen as one driven, not by the passion to teach, but by the desire *to be a teacher*, and that of a sought-after subject like mathematics. Having such a position would then allow her to go back into the community from which she came and change things.

INTERVIEWER: Would you like to teach at a school like that?

THANDI: Yes, Ma'am.

INTERVIEWER: Why?

THANDI: To change things.

INTERVIEWER: So you see yourself as a pioneer, going to go and fix it!

THANDI: No, Ma'am, not to change the school as a whole but if you want to see the change then you have to be the change, like to start in your own space. (ISI, 2:41)

It would appear therefore, that this student has a very specific idea of the position of a teacher in her community and the possibility for bringing about change which that position allows. Her experiences as a learner in her particular high school did not birth within her a passion to teach, but rather a passion to be someone who could bring about change in the dynamic of mathematics education at that sort of school.

Influence of the tertiary environment

Thandi has strong positive feelings about most of her experiences as a BEd student. The factor about which she is slightly less sure concerns the practicalities of teaching: she indicates that she is not absolutely sure about how thoroughly she has been prepared to *teach* mathematics. However, when asked in her initial interview what she would like to see changed in the BEd course, she spoke not of practical experiences, but of psychology modules:

Ok, I think here at varsity there are some things here by modules, they repeat some stuff, like maybe OPV [Education], JPS [Professional Studies] or just OPV. Maybe do psychology in first year and they repeat psychology in third year and it's a lot of work and it's a waste of time, that's just what I would change. (ISI, 2:38)

Judging by this statement it would seem that Thandi is not as interested in the psychology of teaching as she is in the more clinical aspects of the subject of mathematics itself. She emphasises her belief in the importance of subject knowledge:

So I wanted to know more about the teaching profession, what it entails and the other thing, I wanted information about the subjects which I'm going to teach and then more information- not just come here and then they teach me using high school textbooks just because I'm going to teach high school and stuff. I expected more information, the teacher information like maybe in mathematics. We didn't use the high school textbooks; we did mathematics in tertiary level, not in high school level. If we use mathematics in tertiary level, obviously you will be able to teach mathematics at high school level and primary school. (ISI, 2:30)

Thandi is very conscious of the changes that have come about within herself during her tertiary training. She explains as follows:

INTERVIEWER: ... Now, let me ask you more specifically, question 6: what changes do you see in yourself as a result of your training here at varsity?

THANDI: Ok, from first year to now. In my first year I just wanted to be a teacher, make a difference and go and teach and stuff. Back then it was *just* about passing on the knowledge that I have, but now I realise that it's much deeper than that. And the other thing, as a teacher you're not just there to explain knowledge, you are there to teach learners, to facilitate the lesson and to help them learn by themselves, to direct them. (ISI, 2:35)

From this it would seem that Thandi was positively influenced by subject content modules and methodology modules. In this single quote there is evidence that Thandi's PMTI has developed in all *three* areas as identified in the conceptual framework: "Back then it was *just* about passing on the knowledge" indicates change in the domain of subject specialisation; "you are there to teach learners to facilitate the lesson and to help them learn by themselves, to direct them" - this speaks of teaching skills, therefore there has been change with regard to the domain of teaching-and-learning specialisation; and thirdly, "you learn from the learners and they learn from you..." is suggestive of growth in the area of caring specialisation.

The influence of teaching practica

In this area Thandi was less sure of herself and in fact spoke very sparingly about her experiences on teaching practica. In the initial interview she seemed to fall back on the theoretical knowledge that she had gained during the course of her studies rather than discuss how she actually experienced the mathematics classroom as a student teacher. She was more comfortable talking about the state of the school:

INTERVIEWER: Now at the school that you're at at the moment you said it's a bit chaotic. What would you change?

THANDI: I think the thing, the organisation of the school, like start with the principal and the discipline and the other thing, I think that school doesn't think that...it's in a block of flats so it doesn't feel like every teacher has his or her own classroom. It should be teachers who move around and go to the learners, not learners moving from one class to the other because of the small passages...

INTERVIEWER: It's just chaos?

THANDI: Yes, Ma'am. And then they take ten minutes to get to the class... (ISI, 2:47)

Judging by her reticence to speak of it and the descriptions she used when she did, Thandi's practicum experience was not entirely positive. Logistical problems seemed unsolvable and the classroom situation not entirely to her taste. Although she found it enjoyable to be off the university campus, it would seem as if Thandi was not comfortable in the classroom, not at ease teaching, and not particularly interested in forming relationships with the learners. Despite the negative tenor of her practica experiences, Thandi does not seem to have been discouraged by them, nor does she seem to have learnt to modify her own classroom practice in any way.

Influence of her view of mathematics

Thandi's view of mathematics reveals a link in her thinking between numbers and real life: "It's the study of numbers, using numbers to describe um, things that happen in real life, ja to make sense of them but then using numbers" (SSI, 5:6). She believes that mathematics is not finite: "Uh, I think mathematics is part of science; it changes with time and with discoveries and stuff like that" (SSI, 5:10). Learners need mathematical skills so that they can function effectively as adults; so the purpose of the subject is to teach them these skills: in future careers, learners will need mathematical skills like calculation and precision in measurement. According to Ernest (1988), an instrumentalist view of mathematics implies seeing the subject as "an accumulation of facts, rules and skills to be used in the pursuance of some external end" (p. 2). This description seems to fit Thandi's viewpoint, despite the fact that she acknowledges that "discoveries and stuff like that" do occur in science.

She finds mathematics challenging, however. In fact, she believes it to be "a bit difficult, but...then I like challenges so that's why I took mathematics" (SSI, 5:31). She began enjoying mathematics at high school, but passed with an E symbol. She recognises that she was particularly poor in geometry, but still enjoyed even this aspect of mathematics, because "it gets you thinking, ja, ja" (SSI, 5:43). She recognises the shortcomings in her knowledge of mathematics and explains that she has to research the content before teaching it, "making sure that I know my stuff" (SSI, 5:35). Creativity simply takes too much time, since she sees creativity as synonymous with making manipulatives to help learners to understand concepts.

4.2.3.2 Thandi's PMTI

Thandi has very definite perceptions of what is important and what is not to her as teacher. In explaining her prioritisation of the three aspects of PMTI, she wrote,

Subject specialist is the most important as the other two cannot be carried out without it. Didactics specialist and Pedagogics specialist are at all time[s] integrated into subject specialist. Didactics specialist is more important in mathematics than caring specialist. (Q, 2:68)

By implication, to her the carer role is hardly significant compared to the other two. This seems consistent with her opinion of the psychology modules in the BEd programme inasmuch as these modules deal with understanding of the learner's psyche and the teacher's role in caring for the learner: "...they repeat psychology in third year and it's a lot of work and it's a waste of time, that's just what I would change" (SSI, 2:38). Thandi's mentor teacher described her as principally a Mathematics Specialist, but stated that the other aspects of PMTI were hardly observable in her classroom practice.

Thandi as Mathematics Specialist

Thandi's lack of confidence in actually working with learners during her practica is confirmed in her description of what she learnt at university about being a Mathematics Specialist:

I should be a subject specialist to be able to teach learners good in school. I should be well equipped with the subject knowledge that I can pass on to my learners. During my practicals I realised that lots of work is required before one goes to teach in schools like learning what learners should be taught.(Q, 2:72)

Nevertheless, she places Mathematics Specialist first in her ranking exercise. It would seem that she holds to the belief that knowledge of the subject is the key to successful teaching, but acknowledges that she is lacking in this area. Thandi herself is the first to admit that she is not a Mathematics Specialist yet, although she believes this aspect of being a teacher to be of paramount importance:

Ok, I see myself as...ok, I can see a good mathematics teacher because I'm still learning mathematics, I'm not a specialist. Sometimes when you know much about a subject you tend to forget about the learners you're teaching, like they know less, so you tend to jump some stuff. So now I can say I'll be a good mathematics teacher because I have to learn everything 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. (ISI, 2:22)

The fact that she herself does not find doing mathematics easy, she believes, makes her a potentially better teacher, because she will know, from personal experience, what are the “difficult parts”.

Thandi as teaching-and-learning specialist

Although she placed this specialisation second in the ranking exercise, her description of what she had learnt during her tertiary training regarding being a Teaching-and-learning Specialist, gave very little insight into what her actual beliefs in this area are: “The process of learning is the most important when it is accompanied by evaluation of both learners’ work and the process as a whole” (Q, 2:74). She made no mention of teaching strategies or methods which she thought useful in teaching mathematics. In fact, she says she finds linking mathematics to the real world to be problematic, despite the fact that mathematics as a subject appears to be connected to the real world in her view of the subject itself:

So then as a mathematics teacher...I’m more focused on the learner grasping the concept than bringing in the real life situations because in some parts of the mathematics syllabus you cannot bring in... well you can, but it’s difficult to bring in the real life situations and then connect with learners in other levels, like their social. (ISI, 2:18)

In her initial interview she describes belief that, as a teaching-and-learning specialist, she should recognise the diversity of the classroom:

As a teaching specialist, I make sure that I have all my...everything that I’ll need to teach, like all the information and stuff, I’m always up to date with everything. I make sure that when I communicate to learners that they understand and then when I teach I use various methods to explain one concept so that all the learners will understand. I cater for learners who learn first by listening [and] by speaking or doing something, to just include everyone. (ISI, 2:28)

In this statement Thandi reveals what her understanding is of what knowing how to teach means: it means having “all the information and stuff” and always “being up to date with everything”. She attached value to education theory – not its application to the real world of her classroom. Thandi also believes that the university helped her to develop her own teaching style, which she described as “more practical”, because, she explained, she would demonstrate verbally and then allow the learners

to “do”. She learnt the theory of teaching at university, but when in the classroom, she rejected both university training and modelling by her mentor teacher in favour of her own style, developed according to her perception of what the learners need.

INTERVIEWER: So would you say the university influenced you to develop your own style?

THANDI: Yes ma’am.

INTERVIEWER: Ok, how?

THANDI: Ok, from teaching methodologies, and then that’s where I learnt most of the stuff and then also from the practicals because we go there and then we go to real life situations and then that’s when you have to be creative to see how you get learners to understand stuff like that because um, 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. And then, so you have to develop your own way of teaching that the learners would understand, ja. (SSI, 5:116)

The “two-worlds” dilemma (Feiman-Nemser & Buchmann, 1987) is noticeable in Thandi’s explanation. She acquired the theory for teaching during the course of the teaching methodologies presented in her Third year, but was then confronted with the reality of the classroom and the mentor teacher’s way of doing things. Ultimately she had to develop her own style, because what she was taught and what she observed did not, apparently, work for Thandi.

Thandi as Carer

Once again, it would seem that Thandi knows the *theory* of what is expected or required of a good teacher in this regard. In her initial interview she stated,

As a teacher, one of my roles is a pastoral role so when a learner has a problem in my class, obviously that learner will not be able to learn so I’ll have to talk to a learner, maybe after the lesson or during break or whenever they have time and if they’re feeling...they’re opening up to me, they will talk to me if they trust me and I have to keep the information confidential so that they can trust me and then we can talk about their problems and stuff. (ISI, 2:24)

Judging by this statement, Thandi seems to believe that being a Carer is a role she would play in a one-on-one counselling situation. She does not appear to connect this role with caring or caring behaviour within the classroom situation. However, in her succinct description of what she learnt in

this regard in Section 2 of the questionnaire, she wrote, “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)

Even in discussing the practical outworking of her beliefs in terms of this characteristic of PMTI, her answer is theoretical:

Ok, as a social specialist, every day when I go to a class then I greet the class and they see that everyone is ok. And if someone is just sleeping in my class I’ll want to know what’s wrong with the learner so that I will be able to continue with the lesson because I can’t just let someone sleep in my class and maybe that someone is dying and I’ll be responsible and stuff like that. (ISI, 2:28)

Thandi does not link caring with the actual individual learner who may be experiencing difficulties in his life. Her understanding of the pastoral role appears to be theoretical and not part of who she actually is as an educator.

4.2.3.3 Actualisation of Thandi’s PMTI

Thandi’s confidence in herself as mathematics teacher is translated into the classroom as an aloofness from the learners. She speaks of subject specialisation as of paramount importance, and demonstrates in class that the subject matter is indeed what she attaches most value to. However, her presentation of the topic was not without flaws and mathematical inaccuracies.

Mathematical expertise

Despite Thandi’s firmly held belief that knowledge of the subject is the panacea for all the ills of the classroom, and despite the fact that her mentor teacher testified to her mastering of the subject matter, the observed lessons were, in the words of the mentor teacher who was present throughout, not successful. Nevertheless, he did find that she was able to explain concepts and accompanying skills:

For the short time I’ve been with her I noticed in her a good mastering of the subject matter; knowledge and skills so far as the explanation is concerned and with little integration of the subject matter to other aspects of life. (Mentor Teacher questionnaire)

The mentor teacher did, however, find it necessary to call Thandi over during a point in the lesson where she had learners writing their calculations on the board. Two of the learners made glaring

errors which slipped Thandi's notice, and the mentor teacher was forced to point these errors out to her and to ask her to correct them.

Thandi believes being a Mathematics Specialist is more important than any other aspect of PMTI; and she believes, more than that, she knows, that her subject knowledge is, as yet, insufficient for the task of teaching successfully. Her awareness of her lack of knowledge is evidenced in her determination to find out about the topic she is about to teach by researching it in a variety of textbooks.

Teaching and learning

During the lessons that were observed and recorded, Thandi did not use different methods to explain the actual mathematics. However, instead of just telling the learners what the possible applications could be for the kind of trigonometry she is introducing them to, Thandi encourages them to consider for themselves the problems of measuring distances that are very large. So she asks them how they would measure the height of a table; the height of the building over the road; the distance to the moon. Unfortunately, the level of noise outside her classroom was such that it was almost impossible to hear what she was saying. Asked why she used this approach, Thandi explained that she wanted them to reflect on the knowledge they had of measurement and then to realise that it was insufficient for the problem she set them. She was able to demonstrate how useful trigonometric means were to calculate such distances. Thandi does not recognise this as being a creative strategy – she simply wanted them to think. She believes that for understanding to be achieved, the concept being taught needs to be made relevant to real life. Her determination to carry out this particular strategy seems to be firmly embedded in her teaching style, according to this statement she made in her initial interview:

The thing with mathematics...for a student to understand you need to bring in the real life situations into the classrooms. Some mathematics teachers, they deal with the mathematics problems in isolation with the real life situations and still they tend to forget that learners don't think that mathematics is related to them in some real life situations. So I'll say a good mathematics teacher is someone who is capable of relating mathematics to the real life situations. (ISI, 2:7)

Nevertheless, she does not find this easy. In analysing the video footage of her teaching, it becomes clear that Thandi's awkwardness in the classroom is not a matter for conjecture. Her lesson is characterised by long uncomfortable pauses where she says nothing, makes no eye contact with the learners and enters into no interaction with the class at all. During some of these pauses she quickly looks into her file or textbook to find prompts for the next few moments of teaching time.

Evidence of understanding

Thandi's teaching style is characterised by frequent long pauses in which she silently looks at the class while they look at her. Her intention with these pauses was visual assessment: "I look at the learners and then I read their faces if they understand, they're with me or if they're just lost and then I...I just read their facial expressions" (SSI, 5:71). However, the length and frequency of the pauses, as admitted by Thandi herself, are awkward. In fact, to an observer it seems that Thandi's pauses are more indicative of uncertainty than anything else. When asked what she found most striking in the footage of herself teaching, she quite emphatically identified these pauses:

INTERVIEWER: What would you say is really...what stands out in that video? What strikes you?

THANDI: The waiting...

INTERVIEWER: All the pauses.

THANDI: Yes, yes the pauses, yes.

INTERVIEWER: Haha, why? Why does it strike you?

THANDI: No, they take like...I take time.

INTERVIEWER: Perhaps too long?

THANDI: Ja, I take a lot of time, ja. (SSI, 5:125)

About a third of each lesson is spent walking around the class looking at learners' books and talking to learners here and there. Thandi finds this useful in determining whether the learners have understood the content or not. She explained that "cross-questioning" the learners, or asking them to "explain back" provides her with evidence of understanding:

INTERVIEWER: Alright, let's look here. Now here you are dealing with an individual learner. Now what are you doing when you bend over a desk and talk to a learner? What are you doing?

THANDI: Ok, if I notice mistakes and then and even where they...they've done the sum like correctly and then I give comments and then I help the learner get to an answer. I don't like I leave the learner, 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.

INTERVIEWER: Now do you believe in walking around the class and looking at their books during a lesson?

THANDI: Yes, if you're done with the lesson. (SSI, 5:81)

Teacher/Learner-centeredness

Approximately one third of each of Thandi's lessons is devoted to learner-teaching – she invites various learners to come to the front of the class to explain sums that they have done, because she believes learners learn best this way:

Ok because, ok I believe like by...with me like standing in front of the classroom and then giving learners everything, it is best if I just give them examples and then I let them come and then they...they try to solve the problems themselves, rather than me solving the problem for them. (SSI, 5:95)

While this is happening, Thandi stands to at the side of the class and watches the learners, both the one at the board and the class in general. She does not, however, monitor what the learner is writing or saying. The result is that mistakes slip by unnoticed. Thandi explains why she nevertheless considers this strategy to be successful: “sometimes other learners they learn best when they hear stuff from their fellow...fellow learners, ja. That's why I do that” (SSI, 5:79). Her belief in this particular technique was founded in the teaching practicum during her Third Year: “That was teaching for me and then from last year, and then that's when I developed my own way of teaching, ja” (SSI, 5:115).

In observing her teach, it can be seen that Thandi is not at ease with the process of teaching. She is frequently at a loss for words and often seems unsure of what to do next. This possibly explains why she favoured the strategy of allowing learners to come to the board to show how they did the exercises and to explain how they arrived at the answers. At one time another learner asked a question which Thandi, unwilling or unable to answer, allowed the learner at the board to answer and

explain. It would seem that she expects her learners to be compliant, accepting what she says without asking questions. It may thus be that Thandi believes that allowing a learner to take over the lesson for all intents and purposes, is in fact a viable strategy for her as currently inexperienced and inexperienced teacher.

Flexibility

The order of activities in her classroom is a result of planning, she explained. That is what planning is for: “So if you’re planning a lesson and then you know, I’m going to do this first and then this second and this last. Ja, then it will be much easier and then you connect the outcomes” (SSI, 5:187). However, further “research” was also apparently important in Thandi’s lesson planning, since this enabled her to stay ahead of the learners in terms of content knowledge and to maintain her confidence in herself: “Ok, I’m sure that I know the stuff and that I’m confident, ja. And then what I’m not sure of is that the learners understand, ja, that’s what I’m not sure of” (SSI, 5:211). However, she was taught at university about being a reflective practitioner, so she tries to improve on her choice of examples to illustrate a concept if it seems as if a particular class did not really understand what she was trying to convey to them.

She does not allow learners to pursue a line of questioning which has not formed part of her pre-lesson research. When a learner does ask such a question she either ignores it, or asks the learner at the board to deal with it. Her planning and limited content knowledge therefore entrenches her inflexibility in teaching, because her lack of subject knowledge does not allow her to deviate from her planning.

Evidence and purpose of caring

While walking around the class, Thandi bends over the learners’ desks and communicates with them in a way that appears friendly and unthreatening. She explained that she has a very particular reason for using this approach:

Yes ma’am, because uh, one of the problems with learners uh, who have like difficulty in learning and stuff ... is that they are scared to ask questions. 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 and stuff. (SSI, 5:91)

Therefore what appears to be a caring attitude is in fact based on a purely academic exigency – Thandi needs to see their work – and not on a particular concern for their personal wellbeing at that time. She corroborates this with her answer when asked whether she believes in building relationships with the learners: “No, I don’t. No, I don’t, just be professional and approachable and then learners will be able to approach you and then relationships, no” (SSI, 5:155). She explained that building relationships with learners, according to her, leads to problems of favouritism. She also believes that her availability after school is only valid if learners arrange to come in groups. If individuals require assistance, that must happen during class time:

Uh the thing is uh, during...in class like you can be able to help uh, learners individually but then after school you’re taking your time and then the learners time so it will be very nice if they come in groups and then you’re helping more than one learner at a time. (SSI, 5:259)

In observing Thandi teach, it was noticeable that her interaction with learners in the class was stilted and confined only to answering formally posed questions, that is, questions posed by a learner whose hand is raised. She does not react to inchoate murmurings of the class when something she has taught is not clearly understood. Her mentor teacher, in the informal interview he agreed to subsequent to the lesson observations, declared that the single greatest shortcoming he could identify in the classroom practice of this student was that she had no rapport with the learners.

Both Thandi and her mentor teacher stated that caring plays almost no role in her current practice. This student, while admitting the necessity of caring being part of the PMTI of a teacher, at this point attaches little value to its importance. She is cognisant of the theory underlying this characteristic of teacher identity, but is not currently concerned with its practical outworking in the lessons she teaches.

4.2.3.4 Summary

Thandi demonstrates with her academic results that she is a conscientious student, but that her knowledge of mathematics is adequate rather than good. At school she just managed to pass the subject, despite the fact that she loved the challenge it offered. Her personal background offers few clues as to PMTI influencers, other than the fact that she was educated in a private school in an entirely black community, where it would seem the notion of being a mathematics teacher having a

good standing was engendered. Together with the belief that being a mathematics teacher makes one *somebody*, comes the conviction that one therefore has the power “to change things”. In Figure 7 this influencer is represented with a large arrow block, as is the tertiary environment. She experienced tertiary training as positive and life-changing in that she acquired knowledge of the theory of teaching – that it is not just about passing on knowledge, but also about facilitating learning. She regards modules concerning the psyche and emotions of the learners to have been a waste of time, however. This is significant: Thandi demonstrates in her teaching that she has no desire to become involved in professional relationships with her learners- she holds herself distant and aloof from them. Her lack of interest in the educational psychology modules therefore demonstrates a deep-seated disinterest which continues into her classroom practice. In the figure below, the influencing strength of her view of mathematics is presented as a slightly stronger influence than the teaching practica, since it seems as if her view of the subject is more dominant as an influencer of her PMTI. Thandi seems to see mathematics as a series of skills and facts which are useful in the real world – they can be learnt if one listens and works hard. In this she seems to be an Instructor in her intention to impart these skills to her learners.

This a student whose knowledge of mathematics in terms of what is required to be taught at high school, is lacking. She is aware of this inasmuch as she tries to read up on what she is about to teach in various textbooks. Although she states that she loves mathematics and that she finds the subject difficult, she considers herself to be a good mathematics teacher. She reasons that the fact that she has to learn the work alongside of her learners, makes her a better teacher. She prides herself on her knowledge of education theory and the fact that she is always “up to date with everything”, but seems to make almost no connection between theory and her own classroom practice, which she developed without reference to either her tertiary training or her mentor teacher’s guidance. She describes her teaching style as practical, based on the fact that she lets her learners work in class on the concept she has taught. She is hampered in her teaching by this lack of expertise, despite her careful planning. Nevertheless, she tries to bring the learners to an enjoyment of the subject by leading them to link it to the real world and by trying to appear friendly. In Figure 7, Thandi’s PMTI is presented as having a dominant Mathematics Specialist aspect, with a smaller Teaching-and-learning aspect, and an even less significant Carer one.

In terms of Ernest's categories, she is an instructor. Perhaps the most outstanding feature of her PMTI and its actualisation is her total lack of rapport with her learners, despite her theoretical consciousness of the necessity of the pastoral role in a good teacher's classroom practice. There appears to be no conflict between what Thandi understands to be a good mathematics teacher and her own practice: she believes herself to be a good teacher despite lacking in every one of the three aspects of PMTI. She believes her teaching to be learner-centred – she allows learners to teach; she thinks her lessons are thoroughly planned and that she “know[s] the stuff” despite the long awkward pauses in her lessons while she consults her file; she sees herself as a good teacher because she does *not* know the mathematics involved; she perceives herself as available and approachable to her learners, yet she holds herself aloof from them, declaring unequivocally that she is against relationships with her learners.

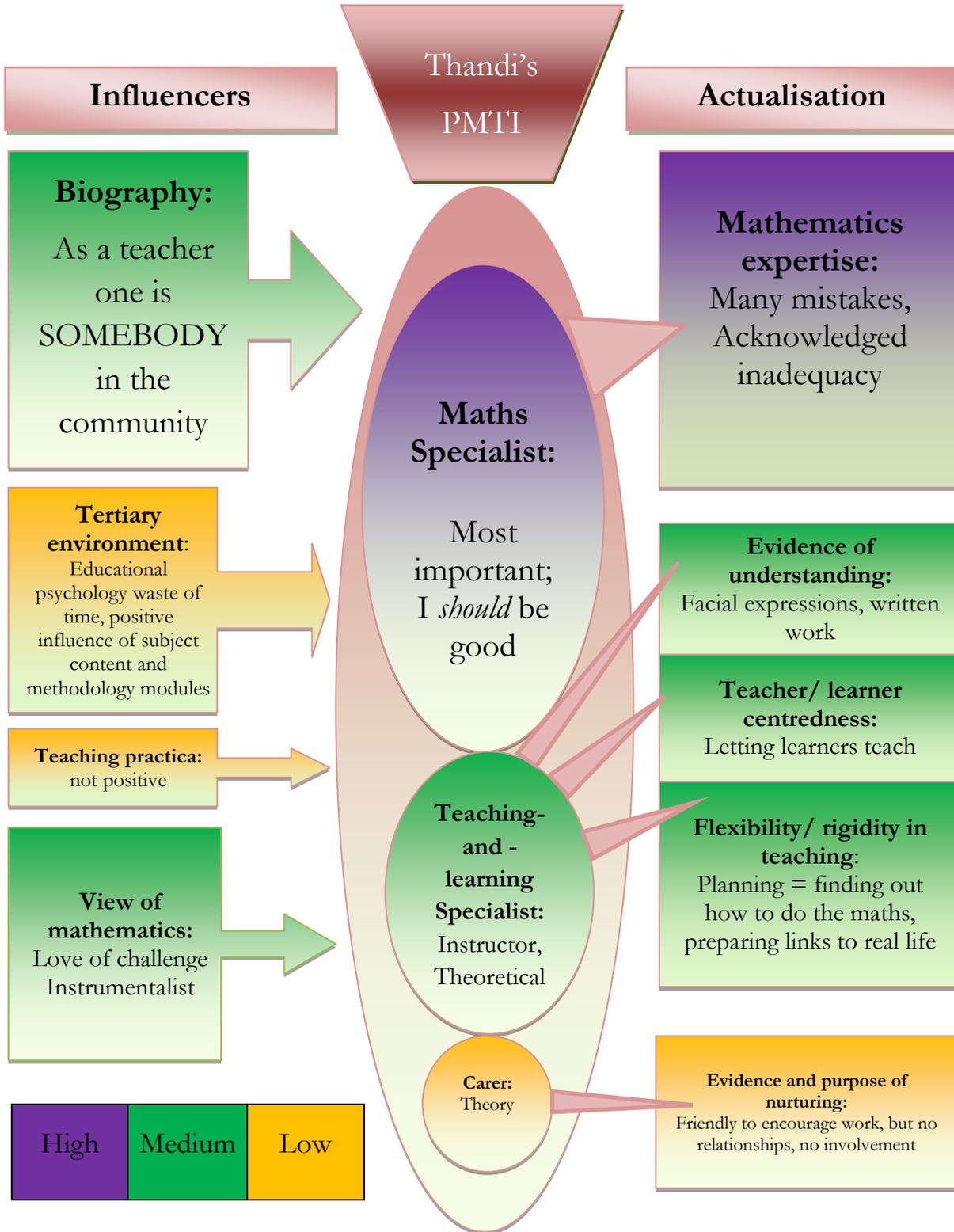


Figure 7. Thandi's PMTI according to the Conceptual Framework

4.2.4 Thabo

Thabo completed his schooling in a large, disadvantaged, rural school, where he stood out as one of the few who did well in mathematics, achieving a C symbol (60-70%) at the end of Grade 12. He had to wait three years to qualify for a bursary before he could enrol for a BEd at UP. At university he proved himself to be a good student, achieving consistently pleasing marks throughout his studies with a final overall average of 66%. For mathematics his average was 68%. During university holidays he returned home to teach extra mathematics classes at his old school.

4.2.4.1 Influencers

Biographical factors

Thabo attributed the beginning of the notion to become a mathematics teacher to the influence of his high schooling. He certainly did not believe that his career choice was in any way influenced by friends or family, or that his conception of what it would mean to be a mathematics teacher was linked to any personal influence other than his own schooling. In the interview, Thabo explained where his conception of himself as a teacher of mathematics began:

It started back in...when I was doing Grade 9, I was used as a substitute for the teacher back at home because she was taken to the staffroom to be a clerk. So she used to call me in the mornings and she would teach me and then thereafter she would say I must go to the class and teach the learners and then give them the homework and mark the homework that was given yesterday. So it started there and then. That's when I had the passion for the teaching. (ISI, 6:32)

Not only did the opportunities to teach while still a learner establish the idea of becoming a teacher in his mind, but they birthed within him “the *passion* for teaching”. Asked why he was selected from amongst all the learners in his class, he replied, “Now maybe it's because she was aware that I was doing well in this thing [mathematics]” (ISI, 6:40). Therefore his own mathematical prowess was the determining factor in the decision of his teacher to make him the surrogate teacher, but in his analysis of this situation Thabo did not directly link his passion for teaching to this prowess - instead he linked it to the experience of actually being a teacher. He emphasised the pleasure teaching gave him: “Yes, I enjoyed teaching the class!” (ISI, 6:44)

Influence of the tertiary environment

Thabo expressed only strong approbation of everything related to his tertiary training. Since Thabo began his tertiary studies having more teaching experience than most students, he thought the actual teaching was what one did instinctively and that his studies would serve only to augment his subject knowledge:

THABO: Truly speaking, I just thought that because I wanted to do mathematics, I thought maybe we'll only deal with mathematics general modules...the majors like physics, general science, and computer technology. I never thought that there were modules related like JPS [Professional Studies] or OPV [Education] and other modules that teach you *how to*...the teaching strategies in the classroom. So I just thought that we'll do mathematics over and over again so that we can be knowledgeable...so that we can teach.

INTERVIEWER: Ok, so you were surprised?

THABO: Yes, I was surprised.

INTERVIEWER: And did you think that it was a good idea to have those modules?

THABO: Yes, it's a good idea.

INTERVIEWER: Have you learnt?

THABO: Yes, I have learnt a lot. (ISI, 6:76)

He experienced his studies as something of a revelation, since he did not know that there was more to teaching than what he already knew and had learnt by copying his teacher. He had not been aware that strategies exist in which one can not only recognise diversity on the classroom, but that diversity can be accommodated:

In Grade 9...so in Grade 9 I was just teaching like that, I meant [like] the teacher, the class teacher. Because I was the head of teaching and then I thought that's the right way of teaching. But when I came here, I've seen that this is not the right way of teaching and then I must try to vary the teaching strategies in order to accommodate all of the learners in the classroom. (ISI, 6:92)

In his initial interview, Thabo confirmed his appreciation of the modules which he completed at university. His approach to his studies appears to have been a very practical one: he absorbed into his understanding that which his experience had taught him would be useful when standing in front of a class. "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" (ISI, 6:104). The criterion for sense-making of the theory he was learning seems to have been that it be useful in the enhancement of his practice. This is demonstrated by his account of the usefulness of strategies he learnt in his methodology module:

THABO: ...Methodology has been very useful also because we have discussed a lot of things that I never knew before. Like for instance, I can give you an example, with the manipulatives... So I've once tried to use manipulatives because we were doing the properties of quadrilaterals. So we used the manipulatives and it was, the learners find it very interesting.

INTERVIEWER: What did you use specifically? Did you have pictures that you cut out, or what?

THABO: No, for example, if we have...about the diagonals of the rectangles, if you fold a rectangle like this and then that side ..[demonstration]. To see that...the diagonals of the rectangles bisected...

INTERVIEWER: They fall on each other, yes. And do you find that the learners could understand better?

THABO: Yes. We also used the diagonals of a cone for the surface area and the volume because we had a tin of coffee and then we cut out the paper and then make sure that the paper is of the same radius as that tin and then we made a cone out of that to show the volume. And then we used some sugar to pour the sugar in that cone, that if we pour it three times into that...

INTERVIEWER: Into the tin...

THABO: Into the tin, and then it means the volume of a cone is a third of the cylinder. (ISI, 6:126)

It therefore seems that Thabo made sense of the information he received as a BEd student by considering its usefulness in view of what he already knew about the exigencies of teaching mathematics. There is a sense of wonderment in the way he speaks of his university experiences – as if his tertiary training has been a very positive experience. Thabo feels that he has grown as a person and as a teacher through the addition of theory he never knew existed, but immediately recognised the value of.

The influence of teaching practica

Just as he saw his theoretical training as useful and learnt from it everything that he thought would make him a better teacher, so Thabo dealt with the teaching practica. For him they were not so much

opportunities to practice as they were opportunities to learn. The one thing he determined not to do was to teach as he was taught at school.

His overall assessment of the teaching practicum is a very positive one. In fact, in his initial interview, Thabo spoke of his approach to teaching practica: he would observe the mentor teacher carefully and follow their example, but where possible or necessary he would include what he had learnt at university: “Firstly, I watched the classroom practice of my mentor teachers and then I followed their procedures but adding to that is what I’ve learnt from the university in JPS and other modules” (ISI, 6:112). In other words, he was able to apply relevant theory to add to the classroom practice he was observing. However, it would seem that the mentor teachers’ classroom practice was sometimes inefficient. Thabo, assessing this, was able to draw from his new-found theoretical know-how to ameliorate his learning experience as a student teacher: “But mostly I would, I like to look at the classroom practice of the mentor teachers and then I improve right then and there with whatever is being taught here at the university” (ISI, 6:64).

Influence of his view of mathematics

When asked to describe the subject as if to someone who knew nothing about it, Thabo spoke of mathematics as “a science of numbers” which would help learners to solve real-life problems, “Uh, especially when coming to geometry. Uh, the reasoning capacity of the students... would be able to increase if they...they...they master the concept, the geometry” (SSI, 4:7). Not only does Thabo not see mathematics as a closed system, but he is also very much aware of the inadequacy of his knowledge of so vast a system – he does not even believe that he knows enough about it to teach the subject efficiently: “So I need to be a lifelong learner in a way that I...I...I still have to learn more on...on...on other topics so that I can be a good teacher” (SSI, 4:9). He came to believe that this was necessary during the period of three years after he matriculated and before he was able to obtain a bursary for tertiary study. During this time his matric mathematics teacher encouraged him to do assignments about topics that he had to study on his own, and to help Grade 12 learners who were experiencing difficulties with their school work. This forced self-study showed him the value of “being in mathematics” and finding out for himself how much he did *not* know.

Because he sees mathematics as part of science, Thabo believes that the discipline is constantly able to “update people about what is...what is happening around and then, uh, ...if they...they...they master mathematics then they’ll be able to conquer any obstacles that are there in life” (SSI, 4:37), which is, according to Thabo, its purpose. In terms of Ernest’s (1988) model, Thabo’s view of mathematics is Problem-solving. He sees mathematical problems as challenges which need to be conquered. He recounts an anecdote of when he was in Grade 12 and he and other friends would work as a study group – “[they] would advise me not to spend too much time on one problem because... I didn’t like *not* to find the solution to the problem and then I would spend *more* ...on the problem until I find the solution...” (SSI, 4:41). He explained that the tenacity required to grapple with mathematical problems “made me to like mathematics, so I like mathematics.”

4.2.4.2 Thabo’s PMTI

When asked how he would describe himself as a mathematics teacher, Thabo said:

Ok, myself as a mathematics teacher, I can say I’m a caring person and I have the time to listen to learners and I’m also approachable. Whenever they come to me and they ask me questions and then I’ll...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)

Thabo’s mentor teacher confirmed that this is true:

He is excellent and then, you know, I wish all the students could be like him. He loves his job, he prepares, you know he focused at the learners more than himself. He goes an extra mile, sometimes he organises some afternoon classes with them. You see, he’s got the potential.

Thabo as Mathematics Specialist

In the ranking exercise of the questionnaire, Thabo stated that being a subject specialist and being a didactics specialist were exactly equal in his PMTI. Judging by this statement, Thabo believes that Mathematics Specialisation without Teaching-and-learning Specialisation and vice versa do not make for good teaching. He elaborated on this by writing, “It is important to know or to have subject knowledge in order to be able to deliver it to your learners. It will be easy for me to teach if I have a sound knowledge of the subject” (Q, 2:124). To him, subject knowledge is therefore directly linked to making teaching easier. Asked whether he felt he knew his subject in the initial interview, Thabo’s

answer was an unhesitating “Yes” which seems to contradict his earlier statement that he felt he had much to learn about the subject. Possibly the certainty with which he answered about knowing ‘his subject’ referred to the topics that are taught in school rather than mathematics as a discipline.

Thabo as teaching-and-learning specialist

When Thabo was asked in his initial interview to describe his idea of a good mathematics teacher, he declared,

I would say the good math teacher is the one who is always well prepared and is willing to help the learners, even if they ask for extra classes, he must be there at all times. So he must help the learners and always be prepared. (ISI, 6:28)

Therefore it seems as if Thabo complies with his own requirements for being a good teacher. Implicit in these requirements is the subject knowledge of such a teacher, who is “always prepared”. His emphasis is on being available to the learners, ready to do what is necessary to help them in every possible way.

Creativity in presenting certain topics is not a problem, according to Thabo:

Uh, I would say like geometry, geometry can be creative using manipulatives and then using the posters and stuff. But then when coming to concepts like uh, ... like financial mathematics, I don’t see how...how one can be creative with that. (SSI, 4:57)

However, it is important to him that lessons are made interesting. Following the teaching style of his teacher while he was in Grade 9 was boring, Thabo declared. He even found it boring when, himself a Grade 9 learner, he was obliged to teach that way because he had no experience of any other teaching style. The lessons followed this pattern:

You’ll firstly start by writing the topic on the board and then from there maybe you make about three examples and then after making those three examples, obviously, the formula...you’ll give them the homework and that is from the textbook. And then the homework that was used, the textbook... (ISI, 6:140)

He explained this more fully when asked why he thought change in this pattern was necessary:

Sometimes when, especially when going to rural schools you’ll see most of the teachers are still using the traditional way of teaching. And then when I add this [didactical expertise acquired at

university], I try to involve the learners in the process because sometimes they [rural school teachers] will teach from the beginning of the period up until the end of the period. (ISI, 6:68)

Therefore, Thabo's first "entries" into his understanding of good mathematics teaching were of the how-not-to-teach type. It was only upon working through the BEd course that he acquired knowledge regarding alternative methods: the how-it-should-be-done know-how. Here he learnt that teaching from the beginning to the end of the lesson was not necessarily successful, and that this teacher-centeredness has in fact been supplanted by a learner-centred approach, which, he says, makes more sense to him: "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).

Thabo as Carer

Both Thabo and his mentor teacher recognised the caring aspect of being a teacher as distinctly lower in priority in his PMTI than the other two aspects. This is accounted for in Thabo's explanation:

I focus more on the subject knowledge and skills. Learners must know the subject. I am also more on the preparation and implementation and evaluation of the teaching and learning process... I lack the skills on socio-emotional and development of learners. (Q, 1:120)

4.2.4.3 Actualisation of Thabo's PMTI

Thabo is a serious young man, an authority on what he is teaching, and yet approachable in his attitude. He was seen to be able to gain and keep the attention of the whole class throughout the lessons.

Mathematical expertise

Analysis of the video footage of his teaching shows that at no point in his teaching does he err or hesitate, nor does he refer to any notes or text books while expounding on the topic. His presentation is smooth, considered and well-prepared. Thabo's mentor teacher wrote the following, expressing his approbation of Thabo's subject knowledge, but pointing out the danger in running ahead with that knowledge:

Thabo knows the subject mathematics very well. He can be good to lecture the university students ... He is good in teaching, but leaves the learner behind. Learners must be included, even those who

are very slow in comprehension. He must give more time to learners to respond. (Mentor Teacher questionnaire)

It would seem that Thabo's own confident handling of the subject matter precludes him from always noticing when the learners do not share that confidence. However, there are certain topics about which Thabo lacks confidence:

There are certain topics that uh, I'm able to go in the classroom and then I can present them, even without preparing. But then there are topics like uh, probability, mostly probability it needs me to prepare more before I go to a class because now, uh, I don't...and I'm scared of...I'm scared of uh, not explaining fully the concepts to the learners... (SSI, 4:225)

These topics are the ones which were not part of the curriculum when he was a school learner himself, and although they were dealt with to some extent at university, he is not as sure of them as of those that he understood as a learner. For example, he spoke of "a very good teacher who was good at linear programming" who taught him so thoroughly while he was at school that when he was required to teach linear programming during his teaching practicum, "I didn't experience, uh, too much problems because I, uh, I remembered what that...I still remember the work that we have done in grade 12" (SSI, 4:13). Nevertheless, with thorough preparation he is able to compensate for a lack of confidence in teaching new topics in such a way that the learners in his class are aware of no difference.

Teaching and Learning

Thabo does not believe himself to be a teaching-and-learning expert, however, despite the developments that have been effected in his PMTI in this regard. He believes he has acquired skills and knowledge in preparation, implementation and evaluation of the teaching and learning process. Nevertheless, he is fully conscious of shortcomings in his teaching skills and the need for further research in this area:

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)

One of the strategies which Thabo made use of in the observation lessons was relating the specific mathematics topic to the real world in an attempt to anchor the new knowledge he was imparting to the learners in their own frame of reference. In the video, Thabo is seen to be drawing graphs on the board with painstaking precision. He does not believe in rough sketches – he drew the axes and marked them with a board ruler; he drew the graphs by linking dots he made on the Cartesian plane. He was also determined that the learners should not just see the graphs about which he is teaching them as precise lines drawn on a board, but that they should also be able to link them to the real world.

To this end, he explained about hyperbolae being used to make lenses, and he explained, using the overhead projector, how these graphs could be used in lens design, analysis of capillary forces and rainbows, and the location of ships at sea prior to the use of global positioning systems. The learners showed interest in his explanations, but it was clear from the blankly puzzled looks on many faces that the idea of ship location was beyond their understanding. Although the real-world applications were entirely correct and accurate, it seemed that Thabo had misjudged the level of application which would make this topic relevant to the particular set of learners in front of him. When asked about the appropriateness of this example, Thabo answered as follows:

INTERVIEWER: Do you believe that they understood what you meant about hyperbola being used for lenses?

THABO: I don't think they... they...they understood what uh, hyperbola was used for lenses. But then, uh, I thought that it might be important that they... they, that they need to know how is it used in...in...in...in other things or in real life situations. (SSI, 4:63)

Thabo therefore prioritised making the lesson relevant to the real world above making it relevant to the learners in front of him. This corroborates the statement made by his mentor teacher that Thabo pitches his presentation above the level of his learners.

Nevertheless, he says he has learnt that, in order to teach mathematics efficiently, it is necessary to take classroom diversity into account. In his initial interview he explained this, but without indicating that he had a very clear idea of what such strategies would entail: “But when I came here, I've seen

that this [what he saw at his old school] is not the right way of teaching and then I must try to vary the teaching strategies in order to accommodate all of the learners in the classroom” (ISI, 6:92).

In his reflections upon what made for good teaching during his teaching practicum, Thabo also compared teaching suggestions from the university with those from his mentor teacher and found that what the mentor teacher told him to do did not work quite as well:

My mentor teacher used to say that we must teach uh, from the focal point, we must stand in front where every learner is seeing you and then for the rest of...for...for...for the rest of the period you have to stand there. And then I found that to be giving me problems because I wouldn't...I wouldn't uh, be able to control the class because those that are at the back, they will start disrupting the class... He was against uh, the...he was against that thing that you must move up and down in the classrooms so that you can control all the learners there. So, for that one I...I...I...I...I weighed the [the suggestion] from the university that you must move along [the rows] and then see how...and then [I am]... able to control all the learners in the classroom. (SSI, 4:309)

Evidence of understanding

Asked how he determines whether his learners have understood, Thabo said that his strategy of preference was observation of body language:

THABO: Hmm, it's...it's through, I would say it's through observation because when I observe them uh, you will see that when...when they're enjoying the lesson uh, they would even ask them uh...uh...uh, one would even ask uh, his or her friend about uh, that or to ensure that maybe his or her friend is understanding that and then 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.

INTERVIEWER: Ok, let me ask the question slightly differently. How...what evidence do you see or do you look for that the children are *not* understanding?

THABO: Hmm, it's mostly when...when they give you that look, that weird look. Sometimes they would be quiet and look, uh, look at you in...in a way that you'd see that they don't even understand what you are saying.

INTERVIEWER: You look at their body language.

THABO: Yes. (SSI, 4:181)

At the same time, Thabo believes that it is important that the learners are with him every step of the way. For this reason he frequently invites their participation by asking questions to be answered by individuals. Observation of the videos shows that he often allows minimal time to lapse after he has posed to a question, and gives the answer himself before the learners have had sufficient time to compose an answer:

INTERVIEWER: Do you believe that there was enough time to...for the learners to think carefully about what you'd asked them?

THABO: No, it...it...it was not enough time and uh, I've realised that in most cases uh, that is my problem because I don't give learners enough... enough time to think about what I've asked them. So I should work on that so...so that I can give them more time to think about it before I can explain that.

INTERVIEWER: Do you believe that it is important for learners to participate in the lesson like that?

THABO: It's very important.

INTERVIEWER: Why?

THABO: Uh, when you learn on your own it's better than when you... when you are told. (SSI, 4:71)

It would seem then that Thabo's motivation for asking questions and involving the learners is based on the belief that they need to be thinking for themselves about the content of the lesson. However, in his execution of this strategy he fails to achieve his own goals, because he answers his own questions before the learners have had a chance to do so. Asked why he believed that it is important for learners to make sense of the work themselves, he explained that at his high school the mathematics class was divided into three study groups which competed fiercely for the best results. The groups were encouraged to learn on their own so that they would not be defeated in the competition. He would have preferred, he said, to allow the learners to puzzle about the work until they arrived at a solution, but he found that they were unable to finish the activities in class time, and did not do their homework, therefore, if he wanted the lesson to be completed in time, he would have to answer the question and supply the solutions himself. Theoretically however, he believes, "So, you must...you must encourage [the learners] to...to be critical thinkers, I think" (SSI, 4:113).

However, he tends to overestimate the level of understanding of his learners, sometimes directing his explanations above their heads. His mentor teacher observed the same thing:

MENTOR TEACHER: What I can say, what I've observed about him, he's beyond the comprehension of the learners so if he can give them more chance to...for responding and asking questions now. They do understand but we don't know how many are left behind.

INTERVIEWER: So his level is a bit high.

MENTOR TEACHER: It is a bit high, it is a bit high, he's going to be a lecturer one day. Ja, that's true, I won't mind to be...

INTERVIEWER: A student of his?

MENTOR TEACHER: Ja. (Mentor teacher interview, 1:12)

Teacher/Learner-centeredness

Thabo's mentor teacher during the long practicum of the Fourth Year, was a man with over thirty years of experience teaching mathematics. He recognised Thabo's potential and was quick to say so in the interview held with him. He saw that Thabo was different from the other student teachers he had mentored:

INTERVIEWER: ...From what you've observed, what really stands out?

MENTOR TEACHER: From him?

INTERVIEWER I: Yes, from him.

MENTOR TEACHER: The uniqueness, I've been a mentor for so many educators that's why I see [when] people are unique. He's unique in a professional way. (Mentor teacher interview, 1:32)

Part of Thabo's uniqueness seems to lie in his self-effacement: when he is in the classroom, what is on the forefront is not himself, but the subject and the learners. Thabo creates the impression of being a very quiet, serious young man with a naturally unassuming nature.

Nevertheless, Thabo does not allow the learners to do much in the way of discovery on their own. He continually guides their every step, making sure that he is with them at every stage of the lesson. It is clear in his manner that he is driven by the need to have his learners understand and enjoy the

work as he himself does. He, by his own admission, does not have the skills to involve them successfully in such a way as to enhance learning.

Flexibility

Thabo believes he is a reflective practitioner, and is able to recognise that when he teaches a lesson repeatedly it improves with each repetition.

I would feel and see that the first lesson was not so good as the second and then the second was not so good as the third because the second lesson 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)

Nevertheless, Thabo believes that a lesson plan provides a necessarily rigid structure to a lesson so that order is maintained and distractions do not scuttle the outcomes required of that particular lesson. This, he said, he learnt at university.

Now if you go to the class and then you are unprepared, you haven't planned the lesson, you won't know where to start and then when to give the uh, and then when to give the...the...the activity, when to ask the questions and the stuff. And then sometimes 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. So, and if they can realise that you are not...you are not so knowledgeable on the top...on that topic, so they will start disrespecting you. So that helps in the classroom management also. (SSI, 4:201)

It would seem therefore, that planning a lesson to the last detail is a strategy Thabo uses to compensate for a lack of experience and/or knowledge. In fact, when asked what would cause him to feel uncertain in the classroom, the only situation he could think of where this would be the case is if he were required to teach a lesson unprepared. Despite his careful planning, he still makes mistakes:

INTERVIEWER: What sort of mistakes do you think do you make?

THABO: 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)

Evidence and purpose of caring

According to Thabo's belief system, caring should take the form of encouragement. He believes that poorly motivated learners sabotage any lesson, no matter what his didactical strategy. He therefore begins every lesson with a motivational activity, which, he says, is a tactic he learned from his mentor teacher:

He would uh, before every lesson he would uh, give them a word or two about motivation and then I would uh, I saw that this...is...is...is it's encouragement for them and then the performance changes because of that. And then, uh, it also worked for me when I went back home because uh, I used these strategies and then it worked for me. And then I was able to achieve the learning outcomes. (SSI, 4:177)

When asked about being available to learners after class, Thabo expressed great willingness, but discussed this only in terms of further mathematical enlightenment:

There are learners that are uh, I would say that are inquisitive, especially after delivering the lesson, that they would want to know more about that, that would go an extra mile on their own. So when sometimes they would express difficulties, some of them, so if you are there for them uh, I think that would be even better. (SSI, 4:265)

Clearly, in Thabo's belief system interaction with learners outside of the classroom revolves around mathematics and not pastoral counselling. The roots of this belief lie in his own experience as high school learner, where the only assistance he and his friends required from a teacher outside the classroom was clarification of difficult sums:

We used to...we used to do that with my friends at school because uh, every time we'd practice... different problems and then those that we...we got problems would go to... the teachers uh, every mathematics teacher that we see in the school we'd go and ask about this and then it worked for us because even when we were writing the...the exam papers uh, we didn't experience much problems. (SSI, 4:269)

Thus, despite the fact that he knew the learners' names and they felt able to talk to him freely, "It was mainly about mathematics, it was mainly about mathematics" (SSI, 4:305).

4.2.4.4 Summary

It seems that Thabo's vision of himself as a teacher of mathematics began when he was in Grade 9 as a learner in a disadvantaged rural school, teaching mathematics to his co-learners in the frequent absence of their teacher. His aptitude for and prowess in mathematics made him the obvious choice for this task. His love of teaching began at this point in his life. At university he expected to learn more only about mathematics but was amazed at how much there was to learn about the *teaching* of mathematics. His tertiary training therefore influenced his PMTI strongly on two levels: Subject specialisation and Teaching-and-learning specialisation. In particular, he learned about making mathematics come alive in the classroom through the use of manipulative and practical demonstrations. His experience on teaching practica influenced his PMTI in that he was able to learn from the experience by amalgamating what he saw in the classroom – the mentor teacher's classroom practice – with the theory he had learnt at university, to develop and improve his own classroom practice. He sees mathematics as Problem-solving in terms of Ernest's (1988) model. As shown in the figure below, these four influencers are almost equal in their effect on Thabo's PMTI.

Figure 8 emphasises the fact that Thabo appears to have a real love and appreciation for mathematics as a subject; in fact it seems almost as if he is in awe of its magnitude compared to his knowledge of it. It is this enjoyment that he wants to share with his learners: he wants them to see what he sees. In his perception of his own PMTI, Mathematics Specialist and Teaching-and-learning Specialist are ranked equally. He does not expect his learners to be compliant listeners and passive absorbers – he explains carefully while also facilitating understanding through learner participation. In terms of Ernest's categories, Thabo is recognisable as both an explainer and a facilitator. His desire is that the learners understand and are able to participate fully in the lesson. Therefore he explains as much as seems necessary and encourages the learners to ask questions and to express their understanding or lack thereof of the concepts he is teaching. However, his relationship in the classroom is with the subject first, and then with the learners, although he does not distance himself from them in any way.

In his enthusiasm and passion for the subject, Thabo tends to pitch some of his teaching above the heads of his learners without noticing that he is doing so. He does however look at the body language of the learners to gauge whether they understand or not; he also asks questions eliciting

individual participation – but he often answers the question himself without allowing the learners enough time to think. This he ascribes to the tight time schedule of the lessons. He believes in thorough and careful lesson preparation: this gives structure to the lesson, and helps in classroom management – the learners can see that you know what you are doing and where the lesson is headed. Thabo admits freely that he lacks the skills to counsel learners in a pastoral sense. He is however available for mathematical assistance at all times, even beyond school hours. He believes that his own learning process has just begun: he thought that, having taught mathematics while still at school that he had nothing further to learn about teaching – by his own admission he will not make that mistake again.

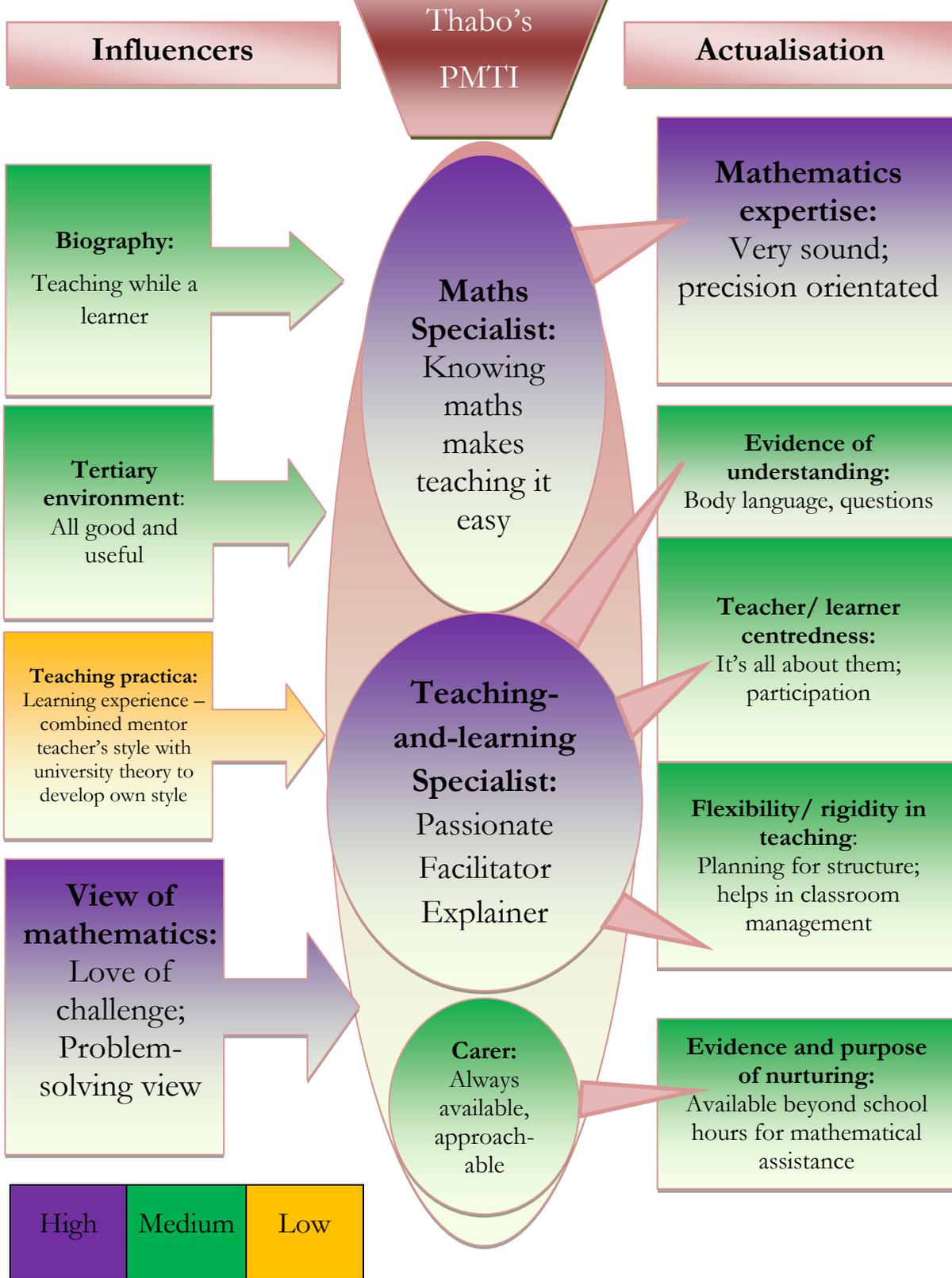


Figure 8. Thabo's PMTI according to the Conceptual Framework

4.2.5 John

John is a keen sportsman and likes being involved in team games. Educated at a private boys' school in Johannesburg, John achieved a D (50-59%) in mathematics at the end of Grade 12. He then enrolled to study engineering at a local university, but his enrolment forms were lost in the process, so he came to Pretoria, where it was too late to enrol for engineering. His only option, where enrolment was not yet closed, was in the Education Faculty at UP. Instead of changing back to an engineering course the next year, he elected to stay in teaching, where he achieved good results, with an average mark of 62% and a mathematics average of 60%.

4.2.5.1 Influencers

Biographical factors

John did not always want to be a teacher. He was a shy boy at high school, but he described his education as good and generally uneventful. His Grade 12 marks were good enough to allow him to contemplate a career in engineering:

Well, first of all I didn't choose to become a mathematics teacher. I was...I applied for engineering before and then they lost my forms and stuff at the University of Johannesburg so I came to Tuks and I was too late and then they said as long as I've been in university I can change. So I applied for, obviously, the teaching. And when I was in here I thought of taking Science and all that so I could change to engineering, but then I decided I was mostly into my sports so I did the sports management degree and I thought, I enjoyed mathematics at school so I might as well take it at university as well. (ISI, 4:12)

It would seem, therefore, that a career in teaching mathematics was not his initial aim or ambition, and that his choice of mathematics as a major subject was more serendipitous than driven. John's first love is sport, which is why he chose a BEd Sports Management. He explained his decision to complete the BEd degree without changing to engineering, as he originally intended on the grounds of his personality, which he described as follows:

Well, in high school I was a very...I was an introvert, basically, I did not...I hardly socialised with anyone, I didn't really have friends. Females were a bit of a distance from me and stuff like that. I went to an all boys' school as well, so from matric to now I've grown in confidence, I've grown in

my knowledge, I've pretty much applied myself to everything that I've done and I know now that whenever I start something I just have to finish it, I can't do it half way. (ISI, 4:64)

It may well be that his initial selection of engineering as a future career was prompted by two factors: his introverted nature, and his ability to do science and mathematics. Possibly the combination of these made engineering seem the obvious choice at the time. However, teaching, despite the fact that he says he has completed his teacher training because of his tenacity in finishing whatever he has begun, is something he finds thrilling: "From visualising yourself as sitting in that seat listening to a teacher and then feeling yourself in the teacher's position and giving that knowledge, there's an excitement about it!" (ISI, 4:68). The strongest influencing factors in his personal history he perceived as lying within his own personality. Friends and family appeared to have exerted little influence on him in this regard. Looking back now on his schooling, he acknowledges that he had good mathematics teachers whose example has helped him to be the teacher he currently is.

When asked whether he would choose to stay in the teaching profession, he confirmed the pleasure it gives him, but could not commit himself to teaching in the long term: "Stay in the teaching profession? It's tough to say at the moment. I'm enjoying it at the moment, but where I want to go with my life I'm not too sure..." (ISI, 4:96).

Influence of the tertiary environment

He seems quite satisfied with the training the BEd programme has afforded him; it helped him form an idea of what a mathematics teacher should be. Upon being asked whether his tertiary training has changed who he is as a teacher, John answered by describing the journey through which he had come as a student:

INTERVIEWER: Let me put it like this, let's say you went into teaching after matric, stood as a teacher in front of a class as opposed to standing in front of a class now- are you two different people?

JOHN: Yes, you wouldn't know what to do if you did it straight after matric. I suppose doing it now it's a lot more because you've come out of that whole school environment completely and you've joined another environment of learning and you've taken that knowledge back. So what you've done

is you've gone in a complete cycle before you even come back to your school which allows you to get rid of all the teenage years, I suppose, or insecurities and things like that, to engage more people. (ISI, 4:78)

John's tertiary training provided him with not only expertise and knowledge, but with the opportunity to mature, to "get rid of all the teenage years". John could not elaborate upon his expectations upon enrolment, but he did indicate that he had supposed the level of mathematics taught at first would be higher.

INTERVIEWER: Given that you tried for engineering first, eventually you enrolled to teach. What were your expectations of the training to become a mathematics teacher? What did you expect of the modules, in the beginning now?

JOHN: Of the modules? In first year and second year I was a bit surprised that all we did was mathematics from matric, I thought being in university and all we'd go a step further and stuff like that and eventually it started coming on that we started developing this teaching style and how you'd implement your teaching style in the class. So I thought the modules are great but I think more practical examples need to be implemented within the works... (ISI, 4:46)

He explained that theory was all very well, but that actual real-life applications of the theory to demonstrate teaching strategies would be more effective:

So, in other words, while learning about the subject and learning the newer mathematics and keeping up with the knowledge; bring people into the class and say, "How would you teach it? Come in front here and present this lesson in the way that you've learnt it right now". Just to give them a feel of how it feels standing in front of people, sharing the knowledge and just also trying new things as well, as opposed to just sitting back in your seats and saying, yes I've got it all the time. (ISI, 4:52)

John's tertiary training was particularly effective in accelerating his maturing process: an understanding developed of what it meant to have changed roles from learner to educator which he described as "... visualising yourself as sitting in that seat listening to a teacher and then feeling yourself in the teacher's position" (ISI, 4:68).

Influence of teaching practica

John admitted during his initial interview that, as a young, inexperienced student, going on teaching practicum filled him with trepidation. These fears were soon allayed when he actually began to teach:

...doing a prac is daunting and like two weeks before it's like, what must I do, shaking, nervous and then once you get in the class and you start engaging with the kids you see how easy it becomes because, I suppose, you were at that level not so long ago... (ISI, 4:72)

John did not experience any conflict between his theoretical training and his practicum experiences; he found that teaching practicum enhanced his own practice – not only could he learn firsthand from his mentor teacher, but he had the opportunity to air and develop his own teaching style.

In her responses in the Mentor Teacher questionnaire, John's mentor teacher expressed her pleasure at seeing how well he used the practicum period to connect to the learners and establish a rapport with them. She claimed that he really made the effort to meet them at their level of knowledge so as to make their understanding and acceptance of new work easier: "By the nature of the visit, John had to focus on the process. He looked at *what* his class knew and concentrated on *how* to lead them into new work."

It would seem fair to conclude therefore that John's understanding of what it means to be a mathematics teacher was modified through the practica, not so much by an increased awareness of the necessity of deepening his subject knowledge, but by an increased awareness of the usefulness of teaching skills and the benefits of being able to build relationships with the learners. He also found that the belief with which he began his teacher training was confirmed in the practica: that relationships are easily established on the sports field and that those relationships make teaching in the mathematics classroom easier.

Influence of his view of mathematics

John sees mathematics as the connectivity between aspects of the real world – it "just brings everything together." Mathematics "helps create equations for us to link things to each other" and it gives values to things "we would not normally value". It would therefore seem that he believes that mathematics is inextricably linked to the real world and that it should not be divorced in any abstract

way from the reality in which we live, since it “creates a different set of terms and situations that we use in our daily lives” (SSI, 2:7).

His understanding of the purpose of mathematics as a subject is influenced by this viewpoint: he believes that, if at all possible, all topics need to be linked to the real world so that learners can understand the usefulness of the knowledge and techniques they are acquiring through study of the subject. This linking is not always easy – for some topics, he says, “I’m still struggling to see the connection, but there is some sort of connection – you just need to always find it” (SSI, 2:9). However, his reasoning goes even deeper: even if the purpose of a topic in mathematics is not obviously discernible, “it always has a purpose no matter what you do, just how it influences your life is, well, that purpose...” (SSI, 2:9). John’s personal experience of the subject undergirds this belief. He explains as follows:

JOHN: I think one day I just woke up and thought, you know, it’s time to take life a bit more seriously and stop messing about and get on with my life. So...

INTERVIEWER: And mathematics was part of that?

JOHN: Ja, mathematics just happened to be the “go for it”. (SSI, 2:21)

The subject itself therefore appears linked in his belief system to “taking life seriously” and becoming a mature, responsible person. The very nature of the subject thus influenced the direction of his life and thinking. It would seem that John’s viewpoint is best described in Ernest’s (1988) model as Problem-solving: “a process of enquiry and coming to know”. He sees mathematics as something to be explored, particularly as it relates to the real world.

John’s appreciation for mathematics and the value and purpose which he sees in it did not originate during his own schooling. He explains that his passion for the subject developed at university to the extent that, in terms of what he should choose to teach, “that is what drove me to mathematics.” In fact, he says that he could have chosen to teach Life Orientation during his teaching practicum, but that seemed to him to be a waste of time. Instead, “I chose to go the more difficult route and teach mathematics” (SSI, 2:17).

4.2.5.2. John's PMTI

When John was asked in the initial interview how he would describe a good mathematics teacher, his description touched on two of the aspects of PMTI that this study examines: Mathematics Specialist and Teaching-and-learning Specialist: “A good mathematics teacher? Someone with a passion for mathematics, someone who is beyond what they would normally learn for mathematics [Mathematics Specialist], and someone who also interacts [Teaching-and-learning Specialist] more than just content based so, ja” (ISI, 4:8). From this statement it can be deduced that John believes that knowing the subject, even knowing more than is required, is as important as knowing how to interact with the learners in a way that is not just subject related.

The question of who he is as educator elicited the following answer:

Ok, myself as a mathematics teacher. Well, obviously you need to know your content to know where you're going with your content, but just as equally I need to know how much I can push myself and how much I can interact with other kids and things like that. Being a pastoral role is for me the main thing. (ISI, 4:20)

John does not believe that he knows it all, to which his mentor teacher testified: “... and also what's been very impressive is that he hasn't come here pretending to know it all. He's come with questions and used that intuition well to supplement with what he's already had” (Mentor Teacher interview, 1:20)

John as Mathematics Specialist

John gave being a subject specialist top priority in his PMTI. “The subject needs most attention because it carries the bulk of the knowledge and skills within a certain context of the learners and teachers” (Q, 2:200) Therefore, it would seem that to John, despite the fact that he says, “being the pastoral role is the main thing” (ISI, 4:20), being a Mathematics Specialist supersedes this because he believes that the subject matter is the vehicle for the other roles: “The subject specialist in my opinion has the most because at the end of the day the knowledge and skills should pertain to the overall likelihood of a person” (Q, 2:196)

John as Teaching-and-learning specialist

In the ranking exercise, John declared that being a Teaching-and-learning Specialist is equal with being a Carer in his PMTI. He explained his reason as follows: “Without the proper implementation or preparation the necessary knowledge and skills will not be understood in the context in which they should be, and thus be linked to abstract knowledge or skill” (Q, 2:203). This statement may be interpreted to mean that John believes that it is the teaching skills and strategies of the adept teacher that take mathematics from the realm of the abstract to the realm of the real and understandable world. To him, creativity is an essential requirement for teaching the subject successfully and is not limited in terms of topic or grade to which the topic is being presented.

Let me explain it to you this way, “Take out your text books, turn to page this. Do this exercise”. It sounds so boring, whereas if you’ve got something on the screen, now you say “Visualise this; explain to me how this happens. Look at this picture, what- if you rotate it this much, what happened to the picture, look how the dimensions change”. There already you’ve just created a whole new perspective of mathematics and a whole new situation that...that can be derived from creativity. So, creativity is essential, for me, in mathematics, not necessarily easy but it needs to try and work its way in... (SSI, 2:37)

The difficulties, according to John, are twofold: creativity takes time, and new ideas are hard to come by: “I mean, within my four years I’ve had probably five great ideas that I’m going to now take into my...my teaching but four years to have five ideas is, if you look at it, not a lot” (SSI, 2:37). He believes that using technology is a boon to the mathematics teacher, and helps to make the mathematics classroom a place of interest which, if the textbook were the only tool, it would not be:

JOHN: Once I tried something different, I tried the textbook approach and I saw that didn’t work. So I went back to the drawing board and said let me create a PowerPoint on it, let me create this on it, let me even use GeoGebra to help them better understand and that...that seemed to have worked.

INTERVIEWER: Do you have GeoGebra on your laptop?

JOHN: Yes I do.

INTERVIEWER: Do you find it useful?

JOHN: Very, very. All teaching tools are made from God; they’re just there to make your life easier so why not use them? (SSI, 2:277)

In close association with his belief that mathematics is consistently linkable to the real world lies his belief that “There always has to be scope for creativity” (SSI, 2:33). In his belief system, divorcing mathematics from the real world would mean losing the power to make each lesson an exercise in creativity and would make dependence on the textbook alone inevitable.

John as Carer

John places a high value on relationships in order to promote the interaction he requires in a lesson. His personal experience has taught him that good relationships promote good communication:

For me, if I don't have a good relationship with someone that communication falls through the roof.... It's happened to me in my life, it's happened to me in my family, it...it just doesn't work without a good relationship... So what I try to do is bring...get onto the learners' level, ...get onto how they react to each other ... (SSI, 2:205)

In addition to finding teaching exciting, he reveals an intrinsic propensity, derived from his own learning experience, for dealing with learners in such a way as to facilitate learning. John declares that the pastoral role of the educator is of paramount importance to him. His intuitive understanding of the difficulties of 'learner-hood', based upon his vision of himself as a learner, is revealed in the reasoning behind this statement:

Being a pastoral role is for me the main thing. The reason why I took mathematics and sports so close together is because I believe thoroughly and that from the sports field to a classroom is a big gap, but that gap is filled with relationships and based on those relationships the learning inside the classroom improves a lot. So with that, knowing my subject, knowing the kids, knowing what I can do for them, that makes life so much more easier. (ISI, 4:20)

John is an avid sportsman, who believes that the relationships cultivated on the sports field make a positive difference to the classroom dynamic. This intuitive understanding guided his decision in studying Sports Management with mathematics as a major subject.

4.2.5.3 Actualisation of John's PMTI

Asked what strikes him most strongly when he sees himself teaching on the video, John refers to the fact that he frequently turns his back on the class to write on the board.

'Cos you break your eye contact for a minute and that's where the trouble starts. That's where they think your back is on them so now they can get away with things ... or it just gives them the opportunity to do something that they shouldn't be doing. So, in that sense, you need to always have eye contact with them and in that way you can always see whether they're lost there or not. (SSI, 2:193)

His own teaching style he describes as interactive, with an emphasis on humour.

Mathematical expertise

It would seem then that although John believes in the importance of being a Mathematics Specialist, he has not yet been able to make that a strong point in his own classroom practice. While John has honed his didactical skills, possibly at the cost of spending the time necessary to improve his mathematical knowledge, he is very much aware of the difference between knowing the subject and knowing how to teach it: "because me understanding the work and giving my knowledge to someone else is two very different things" (ISI, 4:60).

John's admission of not preparing his lessons as thoroughly as he could in terms of the content may be the reason, apart from his lack of experience, behind the shortcoming his mentor teacher was referring to when she said upon being asked where she thought he could improve,

Perhaps in a bit of the background knowledge. It's very much textbook based at the moment but that will come with experience and it will come with more reading, again, that's experience as he teaches. He is able to think on his feet very well, there've been a few times when questions have caught him out and he's coped so well with that and he's gone back to the basics but there are a few basics where he can still read up and improve. Not specifically algebra, not specifically geometry; he has a good over-all knowledge of what's being needed for the FET phase but I think it's mostly experience, that will come. (Mentor Teacher interview, 1:12)

In analysing the videoed classroom observation, it is however clear that John is extremely comfortable with the topic he is teaching. He was able to answer every question without hesitation or consultation with his file.

Teaching and Learning

John is willing to spend much time and thought on making each lesson “work” not only in terms of the learning outcomes, but also in stimulating the interest of the learners. For example, the idea of creating a “knowledge box” on a part of the blackboard into which facts that are discussed and mutually accepted are placed came to him while attending a staff workshop. From the head of the mathematics department at the school he was teaching in he learnt about the usefulness of “teaching Pythagoras using squares to explain how a triangle works” (ISI, 2:53). From a lecturer at university he learnt about the potential of PowerPoint and the Internet in making the topic come alive for the learners: “I take my own laptop, search the Internet for PowerPoints, find something I like and adapt it to what I think is necessary...” (ISI, 2:61). It seems clear then that John believes that teaching mathematics requires continual effort in order to relieve the drudgery of the classroom.

In the observed lessons he used real-world examples to elucidate the concepts he was explaining. While some such explanations were obviously pre-planned, like his slides of various logos and commercial symbols to illustrate symmetry and different types of transformation, others were spur-of-the-moment, used when clarification was required, like his quizzing of the learners about their knowledge of pizzas to clarify his answer to a question regarding fractions.

His personal goal in the classroom is to hear the learners say, “I get it!”

You’re explaining a topic, everybody’s looking at each other and then one boy says “I get it!” and then he explains it and then it’s like a...a rolling ball, it just...it knocks on to every single one in the class. ‘Cause for me that’s just...that’s just the way life should be. “I get it, let’s do it!” So, as a mathematics teacher, ja, that’s pretty much what it’s about. (SSI, 2:229)

Evidence of understanding

In the observed lessons he is observed using a different questioning technique – instead of asking individuals he also poses questions to the entire class, eliciting a group response. Asked why he believed this was effective, he explained:

I suppose it’s to see where everybody is. If ... I choose a person every time then I only know where *he* is, whereas if the general class gives me an answer or gives me an incorrect answer, I can explain

to them ...where they're going wrong, where aren't they going wrong. Whereas with this specific person, he could come up with one issue that another boy doesn't have the [problem] with So in ...general you've got to have the whole class active in the role. (SSI, 4:125)

In addition to this, John believes that observation of the learners' behaviour is a good indicator of whether they understand or not. The rapport he has with them, combined with the ability to envision himself as young learner, enables him to interpret body language in the classroom in what he feels is an efficient and effective way. His strategy in this regard is to keep alert for a change in the learners' expressions, which in turn would cue him to explain again or use different words or examples to elucidate.

Basically, I always link my knowledge back to how I would feel as a child sitting in there, listening to this teacher. I constantly look around the class and see how the boys' expressions are because 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)

In the observed lessons it was noticeable that John not only paid attention to the reactions of the learners, but that he encouraged them to communicate freely with him throughout the lesson. His method of teaching largely entailed posing leading questions, guiding the learners to a discovery of the knowledge about which the lesson revolved. At no time was he seen to be "lecturing" the class. It would seem that meaning in any new topic is negotiated by the learners so that it becomes their own. This is a strategy that he believes works:

You can just see by the way they sit, they react, they work. If they...if they sit in the corner messing around then you know that that's going to now shift over around the classroom, people are going to start laughing, losing their focus and things like that. Whereas if everybody's looking at you, when one person asks, they look at the person or ... they're still looking at you with a blank expression. At least you know they're engaging, they don't understand, but they're still there. Why don't they understand? You see ...you've got to pick up, ...you can't only teach them, you've got to pick up why or how they're learning, pretty much. (SSI, 4:133)

While John believes that homework sounds "horrible... and old-school", it also serves as evidence of understanding.

Teacher/ Learner-centeredness

He is committed to learner-centeredness in his teaching:

Not interacting with someone is...is...is one person talking at a time, is one person teaching a class of quiet kids. To me, interaction breaks that silence, it brings everybody to the party and then at a party you always have fun, so, mathematics makes fun- that's where the humour comes in. (SSI, 2:201)

Not only must his lessons be stimulating, but each one must begin on the right note, lest the atmosphere be lost. The mentor teacher with whom he was placed believed in starting each lesson with a joke, a riddle or a puzzle. John decided to adopt this into his own repertoire of strategies because "to *get* the kids in the class" is "the first mission". So, once the practice has been established that each lesson begins in this way, "as the kids come in the class they go straight to the board and they're looking and trying to figure things out" (SSI, 2:69). As part of his strategy not only to *get* the learners but also to *keep* them, he believes that it is important to access their prior knowledge: "To me it's...it's a building block, if I'm going to build a little thing out of Lego I don't start from the top and build my way down, cause that's impossible. So I start from the bottom and build my way up... And that...that, to me ...every block that you can build up, moves...the learner into understanding why..." (SSI, 2:85).

Once the lesson is underway John favours the Socratic style of teaching by asking. He finds that this provides him with an insight into the level of understanding of his learners at any given point:

So by asking them ...you find out what they, at the moment, think it is, 'cause if I tell them a statement they can either believe it or not, or go with their own way still, or mix it, which is the worst thing you can do because then that completely throws them off, and I find by halfway through my lesson I've got boys ... asking me "What is this? What is that?" So I ask them, see where they are and then I evaluate on that to go further into detail. (SSI, 2:93)

This particular technique he says really became embedded in his teaching identity at university where

They'd tell you what something is but then they ask you why is it like that. The...the question why always creeps its head in somewhere. So at school you had teachers that said "this is like this and this and this", now at varsity you have lectures that say "why is it like this and this and this". So it just puts you on another level of thinking. (SSI, 2:113)

In his own teaching experience he found that explaining to learners the “why’s” behind the reasoning helped them to a deeper understanding of the concepts he was teaching. It also motivates them to engage with the subject:

If they understand why they’re doing it, how it’s going to affect them in the future, then they’re either going to grow a passion for it or they’re going to at least try to do something so that they can use it. (SSI, 2:217)

John’s teaching philosophy is particularly well illustrated in a situation during a particular lesson where a learner makes a mistake in an oral response. John does not correct the learner, but instead asks him twice whether he is sure that his reasoning is correct. Asked why this strategy works for him, John explains:

Because if...if I told him he was wrong he’s going to look at me and say, “Well, why am I wrong?” and I’m going to have to tell him why he’s wrong. Whereas if I ask the question, “Are you sure?” he thinks to himself “Am I right or am I wrong?” So then 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)

This, he believes, instils in the learner the habit of reflection, “So, if they...they are able to do it at that level, they can take that straight through their entire life” (SSI, 2:153).

John also believes that new concepts should be introduced on the basis of what the learners already understand. In one of the observed lessons he spent nearly a quarter of the lesson time drawing information from the learners about fractions, thus making sure that all were on the same level of understanding before he began to deal with new knowledge. His teacher confirmed that this was not just a technique used for the benefit of the camera:

He has a very natural way about him; he has coped with mathematical questions really well; he’s understood what the children’s pre-knowledge has been and he’s realised what they need in order to cope with the new work. So yes, he’s got the makings of a very good mathematics teacher.

Flexibility

An interactive teaching style implies that a lesson does not necessarily proceed according to plan. However, John believes that planning a lesson provides a general structure to which the lesson can return after distractions. It is important to be adaptable, he explains.

So, if you've planned a lesson, you know exactly where you're going with the lesson, you know what you're supposed to achieve with the lesson but then again, as much planning as you can do will never prepare you for the questions that boys ask or anybody, a learner asked. 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. (SSI, 2:241)

The only thing that he can be sure of, he says, given the way he teaches, is the atmosphere he establishes in the classroom.

Evidence and purpose of caring

The most prominent of John's beliefs, both in what he says and what he does, is his conviction that the existence of good personal relationships with the learners makes teaching easier. He believes that sport is a means of building such relationships, the benefit of which is then carried into the classroom. In his initial interview John described his belief that the knowledge about a learner acquired outside of the classroom context was valuable inside the classroom:

Because mathematics...everybody doesn't like learning, well, most people don't like learning and for a kid that struggles to learn, for instance, they're a good sports player or they enjoy being in the sports field, their whole personality opens up to you. So you have a different view of them and you can focus on their strengths and bring it into the classroom. (ISI, 4:24)

His strategy was to get to know the learners by name because that created an immediate rapport:

I basically got to know the kids by name first in the classroom and that lead to me getting involved as quickly as I could with sports, and through my sports I got to know more kids that were in my class that I wouldn't have got to know otherwise. If you would look at it from the point of view as engaging a class of forty kids at a time. So getting to know all of them by name was a very important part of it. (ISI, 4:32)

He recounted an incident where a boy in his class taught him a particular handshake – “and of course I'm going to do that 'cause now he can relate to me and I can relate to him and that puts it on a

completely different level” (SSI, 2:209). The fact that he makes an effort to reach his learners by involving himself on their level in a personal way makes the class more “comfortable”:

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. So it just makes life, in general, more comfortable around. (SSI, 2:209)

This would seem to confirm the notion that John’s classroom practice, in terms of the skills and strategies he employs to optimise the learning opportunity, is based on care and concern he has for his learners. John recounted an anecdote in support of this belief:

JOHN: People respond more to their names and their personal being than anything “Hey you, boy”, “Hey kid” or “Yes Sir” or something like that. So, like for instance, my second year prac, as soon as 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. It’s a very dangerous place to be as well as keeping the professional boundary, but it’s a necessary place that you should be at.

INTERVIEWER: So, would you say it’s easy to become too familiar?

JOHN: Yes, it’s very easy.

INTERVIEWER: Particularly because you’re young?

JOHN: Ja, especially because we’re young because the kids feel “Oh, he’s not that much older than me, why can’t I...?” but you’ve just got to keep that respect the whole time. (ISI, 4:36)

John is therefore aware of the pitfalls of building a relationship with the learners – the line between what is professionally acceptable and what is familiarity can become blurred. However, the benefits of this strategy outweigh the risks. He refers to this as the “pastoral role” which he calls “the main thing”. His ease in his comportment with the learners communicates itself positively even to the most recalcitrant of learners. His mentor teacher was particularly aware of this:

I have loved his relaxed manner with the students. It has appealed especially to the boys. 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.

The result of this mutual respect, as evidenced in the video footage, is an atmosphere conducive to positive attitudes and effective learning. In order to keep this atmosphere intact, John does not respond negatively when a learner provides an incorrect answer. Instead he redirects the learner to

the thought process by asking such questions as, “Are you sure that’s the answer?” or “How did you get to that answer?” His mentor teacher described him as being intuitive and sensitive to the nuances within the classroom. 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).

4.2.5.4 Summary

John did not intend to become a teacher upon leaving school. His enrolment into the BEd course was accidental, an option open to him when engineering was not. Nevertheless, he elected not to change back to engineering after his first year because he found he was enjoying what he was doing. He is aware, retrospectively, of the influence his mathematics teachers have had on him: they taught well and were good role models. He describes his tertiary training as a maturing process in which he could see that he had changed positions from being on the learner side of the desks to the teacher’s side. He described this process as coming full circle. He would have liked the training to include more practical applications of education theory, so that, before entering a classroom, one could experience what it feels like to stand in front of people. The reason for this suggestion soon becomes clear: going on teaching practice filled him with fear. Only when he actually began to teach did the fear dissipate, as he realised he could identify with the learners, having been one not so long ago. He also found that relationships made on the sports field made teaching easier and that the teaching skills he had been taught at university were useful. John sees mathematics as inextricably linked to the real world and that, even when he is unable to see that link in certain topic, mathematics influences one’s thinking bringing about maturation. His view of mathematics is what Ernest (1988) describes as Problem-solving, since he sees the subject as something to be explored and it links to the real world discovered and examined.

Figure 9 shows how John’s PMTI may be presented visually. Despite the fact that John ranks Mathematics Specialist as first in his PMTI, almost every statement John makes reveals the value he attaches to relationship as a springboard for effective teaching. He uses humour to engage all the learners. The equality which he recognises between the aspects of Teaching-and-learning and Caring in his PMTI is confirmed by his mentor teacher. She believes that he has the necessary teaching-and-

learning skills to compensate for his inexperience with the mathematical content of the high school classroom. In the classroom, John demonstrates his ability to use his understanding of the *learners* to improve *their* understanding of mathematics. He believes in being creative and innovative in order to take the boredom out of mathematics lessons and to make them relevant to the learner's lived worlds. He seems to be a facilitator, in terms of Ernest's categories. At all times during his lessons, he has the learners 'eating out of his hand' – their participation is keen and enthusiastic, yet discipline is not a problem. The impartation of content knowledge during the lesson is done almost imperceptibly, as the learners are guided into constructing it for themselves. When they do not understand, he is able to tell from their expressions and behaviour that he has lost them. He poses both individual and chorus-answer questions, believing that his relationship with the class is open enough for them to be honest with him. He describes his style as interactive and spiced with humour. He believes that starting a lesson with a riddle or puzzle of some sort (something his mentor teacher did) works, as it sets the right atmosphere for the rest of the class. He also believes that teaching rules without reasons is futile, and that explanations he gives need to answer the question, "why?" When a learner answered incorrectly, he guided the learner into reflecting on his own answer and correcting it, instead of just supplying the correct answer – all because his aim is to cultivate in his learners the habit of thinking for themselves. He believe in lesson planning, but only because it allows him to be flexible. He says it is impossible to plan a rigid structure for a lesson, because the dynamism of the class may change things.

The most prominent aspect of John's PMTI is that of Carer. His classroom practices are based on relationship with his learners and the concern he has for them to do the very best they can under his aegis. Having been an introvert himself at school, he makes a point of getting to know the learners' names and drawing them out of their shells within the safety of his classroom. His intention is the establishment of mutual respect between himself and the learners, but he is aware of the dangers of over-familiarity. His care for is learners goes beyond the exigencies of the classroom and the subject itself – he believes he is there to help the learners with life in general as well.

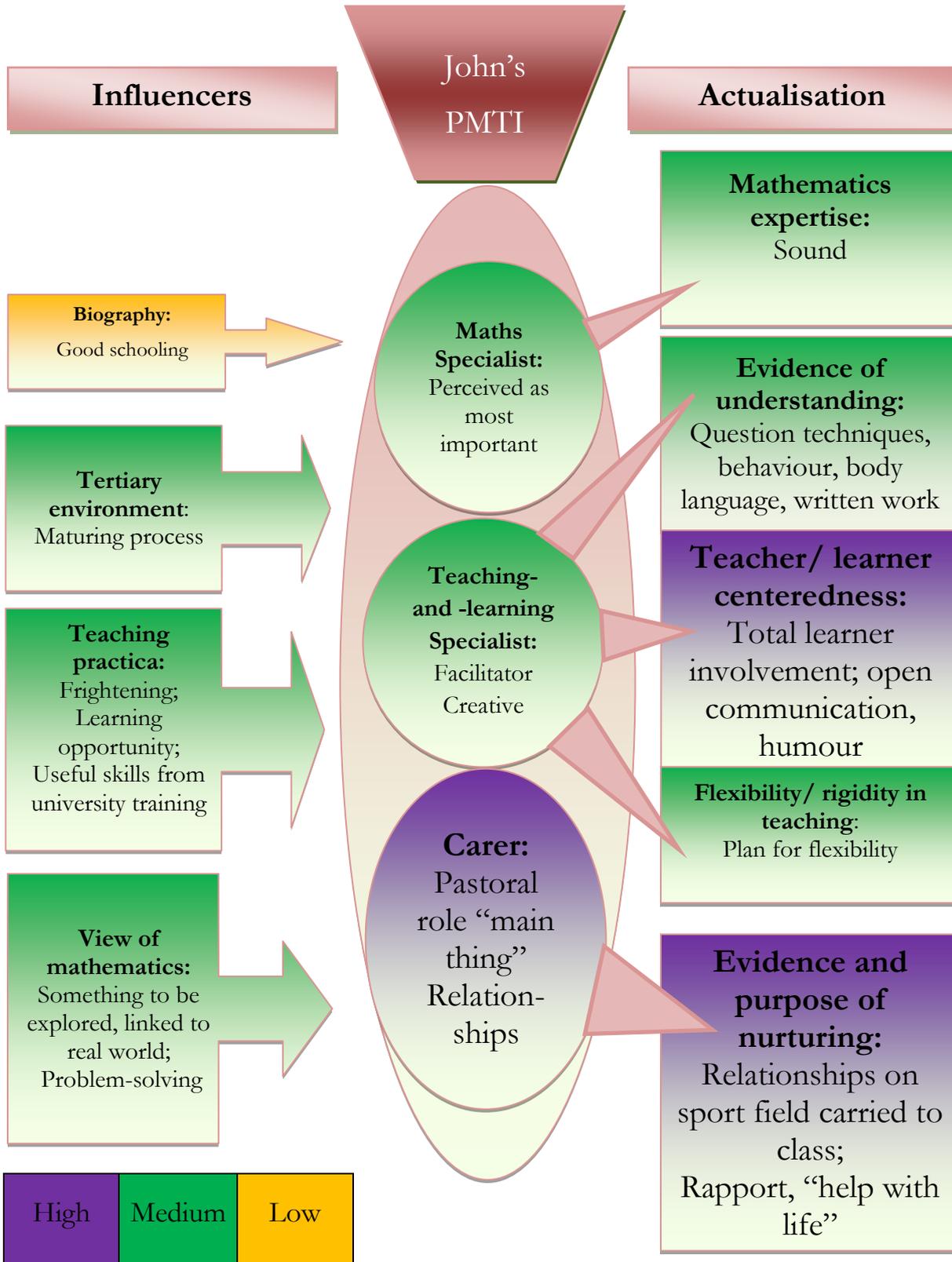


Figure 9. John's PMTI according to the Conceptual Framework

4.2.6 Sipho

This student received his high school education in a school which fitted into the erstwhile ‘Model C’ category in a large town situated in an otherwise rural area. As a young black learner he experienced the mathematics classroom as a place where he had to prove himself. He achieved an E (40-49%) at the end of Grade 12. At university he worked consistently and well, achieving an overall mark of 61%, with an average of 62,5% for mathematics.

4.2.6.1 Influencers

Biographical factors

The nature of the influence of his high school experiences was revealed in the interview. He was taught at a school which fitted into the erstwhile ‘Model C’ category in a large town situated in an otherwise rural area. Here his teacher appeared to be prejudiced against the non-white learners:

Where I was taught, the school I went to was...we had white people and black people and we had a white mathematics teacher. Now, the treatment towards us, towards all of the black learners in the classroom was very bad and she was racist, you know, and every time she would demoralise us. She would make comments, like really seriously bad comments... Like “You wouldn’t pass”, “You won’t make it”, “This subject is not for you”, “Consider choosing another subject” and at that time there was no [subject called mathematical] literacy so you had to change [to standard grade]. I experienced in the classroom where we were mostly half-half, half black, half white - the Indians and the coloureds fell into the black category. Most of them dropped out, left mathematics, moved from higher grade to standard grade... Things like that, to me, 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 that we can, and we will. (ISI, 4:24)

It would seem, therefore, that this student was driven by a need not only to prove himself, but to help others prove themselves as capable students and educators of mathematics, flying in the face of racial prejudice. He felt then already that he could do better: he could not only become a teacher of mathematics, contrary to his teacher’s pronouncements, but he could show that it is possible to treat everyone in a classroom with equal respect. His family’s ideas and his own psychological disposition regarding becoming a teacher of mathematics did not enter into his discussion about who he is as a

mathematics teacher at all. Instead, he emphasised the importance of understanding the psychology behind teaching and how to handle “the mentality that goes with mathematics. In order for you to teach it you have to understand it, you have to understand the whole idea, the feeling people have with this subject...” (ISI, 5:8). He believes that mathematics has an emotion component which needs to be addressed – learners can be helped to enjoy the subject if the teacher makes it a priority to do so.

Influence of the tertiary environment

Sipho entered university directly upon leaving school, determined to learn to teach mathematics. He found, however, that the programme did not quite live up to his expectations, although generally speaking, he believes it was worthwhile. Sipho believes without a doubt that upon completing his training he will be adequately prepared to teach mathematics, and that he has become a reflective practitioner. He also declared unequivocally that his image of a good mathematics teacher has changed during the course of his training.

In his initial interview Sipho indicated that the greatest positive influence of his tertiary training on his identity as a teacher lay in a psychology module, in which the students were taught about the way learners think and learn:

Ma’am, it has to do with the psychology. I am very lucky that I came to TUKS [University of Pretoria] and here they presented a psychology module throughout the whole three years and that helped me a lot in understanding the other person, learner- the person that’s in front of you. Well, obviously I will be a teacher so I see things differently now, I’ll view everything differently as I will be standing in front and looking at the learners, looking into their eyes. (ISI, 5:32)

Sipho described his uncertainty and insecurity as a new young student, unsure of himself and even more unsure of the academic pursuits that lay before him. He was surprised to find that the teacher training course was full and busy:

INTERVIEWER: Alright, now, I want you to think back over the last three and a quarter years. When you enrolled for your studies here at UP, what were your expectations of the training to become a mathematics teacher?

SIPHO: Yoh! Ma'am!

INTERVIEWER: What did you think?

SIPHO: I really didn't expect it to be this intense...

INTERVIEWER: What did you think that we would do with you here?

SIPHO: Oh, let me think. Well when I came here, when I enrolled, Ma'am, for me I still had that mentality that I want to help out, you know, and I was in shock because I was still a bit unsure about myself then on how I was actually going to implement that, how am I going to cope. So I didn't know what to expect, Ma'am. Anything that came, I was ready for it; whether we would do more practicals or more theory, I was ready for that. Honestly, I was ready. (ISI, 5:66)

Clearly, despite his inexperience and uncertainties, he was prepared to do what was necessary to achieve the success required to become a teacher and "to help out". It seems then, that Siphso had few preconceived ideas regarding his tertiary training. He was even unable to arrive at a coherent understanding of the "direction" the course was taking: "I just didn't know in which direction [we were going] until my second year where I went like 'Aha!', so that's where we're going to" (ISI, 5:79). As a First year student he threw himself wholeheartedly into university life, but it was only during his second year that he began to understand how the course was shaping him.

He found himself changing. The first changes he mentioned in the initial interview concerned the subject of mathematics and how it may be taught.

INTERVIEWER: Alright, now, let me ask you this: what changes do you perceive in yourself as a result of the training that you've done here?

SIPHO: Well, firstly I understand the subject better and the skill in presenting the subject- that has changed course. We're all individuals and we're very unique so now I used my experience, the experience that I had and how I was treated at school, I used that and I put that aside and I put what I learnt here on the other side and then I learnt and put another category from the other students, my peers, how they would do this. (ISI, 5:82)

Siphso realised the need to compartmentalise his experiences and beliefs. He identified three areas as his sources of beliefs and development: his experiences and convictions carried over from his own schooling; what he was learning at university in terms of subject knowledge and methodology, as well

as the “psychology” he referred to earlier; and then what he was learning from his peers and their ideas of how the subject should be taught. Eventually he was able to integrate knowledge and beliefs from these three areas into what he describes as his own style, who he is in the classroom:

SIPHO: From that I formulated just one thing...

INTERVIEWER: Your style?

SIPHO: My style, developed my style and I feel it’s effective. I don’t know yet. (ISI, 5:84)

Although Siphon was generally satisfied with the modules, he felt that more practical experiences should be included. He explained that he was really impacted by the methodologies and the technology employed by a lecturer to make the work more visual and comprehensible:

...Especially with the visual presentations ... just gave it that extra kick. It changed us, it changed the way you would view things. Right now you’d see a shape and you’d try and view it on a 3-D and imagine it, so it has changed, ja. That is very good. (ISI, 5:96)

Thus it may be concluded that Siphon truly did find that his tertiary training brought about change within his understanding, not only of the subject itself, but also of himself as a teacher.

The influence of teaching practica

Siphon found the teaching practica difficult because of the limited time given to accomplish the task, as he saw it, of establishing a relationship with the learners and then teaching them topics within the subject in a way that not only made the subject accessible, but that had an effect on the way the learners felt about the subject:

With the time limit that we had, three weeks. The first week you would just bond, you’d simply just talk to the learners individually and find out what they think and most of the time they’re interested, they’re curious- they’re curious to find out about you. Use that as a starting point, use that, the more they ask the more you push them to understanding where they are with mathematics, what they think, what they feel about the subject and then from there you can change that perception and that mentality right there by choosing exactly the right words. (ISI, 5:36)

However, Siphon ultimately felt very positive about his teaching practica. He found his mentor teacher to be a source of knowledge; he could put into operation his own teaching style, which was nevertheless influenced by the school environment, and he was able to make up for a lack of

experience with thorough preparation. He did however find that there was a difference between what he was taught at university and what he experienced first-hand at school. He was not quite prepared for the dynamic of the classroom, since nothing at university resembled the classroom, and no theory can explain how it “actually is”.

Above all, he would never teach the way he was taught as a learner. His teacher at the high school he attended as a learner he believed to be racist in that she frequently pronounced derogatory or demoralising statements over the black learners in her class. She did not believe in their potential, and was not reticent in saying so. He determined at that time to be different in his own classroom, and remained true to that conviction. All the same, issues of race remained part of his teaching experience while on practicum:

Well, I've experienced this thing at [a high school], Ma'am when we were teaching mathematics. Those learners, they are white learners, most of them. You know, just because you're a black teacher and I'm still young they didn't really take me seriously so I had to go the extra mile to prove it to them that I can teach this and I have the skill to help you to understand. Well, I've developed that skill through the years. (ISI, 5:112)

Therefore, although teaching practicum was a positive experience for Siphso, it was not without difficulties. The race issues which had shadowed his learner-hood were not absent from his own classroom as student teacher. The beliefs resulting from the time he was a learner in this regard dictated the way of handling these issues: by going “the extra mile” to prove that his knowledge and skill as a teacher were more important than the colour of his skin.

Influence of his view of mathematics

When Siphso was asked to explain his view of mathematics, he was unable to present a direct answer. Instead he said, “It's the logic behind reasoning” (SSI, 3:55). He was asked to expand on this statement, and did so by connecting mathematics to representations of a physical reality:

If you can explain something in terms of science, if you can explain something you should be able to can compute it into an equation, so that's mathematics. That's how I view mathematics, um, putting numbers to what you...to what you're explaining, putting some representative on paper, calculation, something that is logic, trying to explain the logic, you know. (SSI, 3:9)

He was convinced of the importance of the subject and harked back to his view of the subject. His reasoning followed an if-then pattern: everything in reality we must be able to explain, and if you can explain it, then you should be able to compute it in some way. Its importance as a school subject follows directly: you cannot live outside of reality, therefore you must be able to explain that reality. He does not see mathematics as a finite system, instead, he described it as “an art of science”. This statement led him back to his earlier reasoning, that if a thing could be explained, it can be represented in numbers. Siphó’s responses here may be described as recondite, but about one thing he was very clear: he enjoys mathematics.

4.2.6.2 Siphó’s PMTI

In his initial interview, Siphó described his idea of a good mathematics teacher in terms which touched on all three of the categories: someone who knows the subject, who is an expert in didactical strategies to make the subject accessible, and someone who is concerned with the feelings of the learners:

A good mathematics teacher would be a teacher that’s very professional and understands the subject, understands the psychology...the mentality that goes with mathematics. In order for you to teach it you have to understand it, you have to understand the whole idea, the feeling people have with this subject. (ISI, 5:8)

However, Siphó ranked subject specialist above didactics specialist, which in turn was above caring.

Siphó as Mathematics Specialist

He explained why Mathematics Specialist was ranked highest in his perception of his PMTI:

I believe that to be able to be sincere and focus on the learners, the subject should be well [in hand] in order to identify what learners understand. Once the subject has been mastered a shift can be made to the process of learning and content towards the learners’ capability and level of understanding. (Q, 2:170)

When asked what he had learnt at university about being a Mathematics Specialist, Siphó did not refer to an increase in or an emphasis on subject knowledge. Instead he spoke of keeping up to date with technological developments: “I still have a lot to learn because the processing of information and the information is increasing everyday new discoveries and advancements are being made in our

modern day and society” (Q, 2:174) He is confident in his knowledge of mathematics and of his ability to deal with any questions that may arise in class. At university he worked in a group with his classmates to consolidate the work done in class each day in an effort to ensure that his mathematical understanding was being extended and that he would have the knowledge he thought he may require in class one day.

Sipho as teaching-and-learning specialist

When asked about his perception of himself as Teaching-and-learning Specialist, Sipho spoke only of respect for the learners and treating them with respect. He emphasised the importance of understanding the way the learners think and feel. “Teaching is a two way process of communicating, the learners’ views and opinions should be regarded as equally important because it brings about some sort of uniqueness in the learners,” declares Sipho (Q, 2:180). Because of his personal experiences with a teacher who had a derogatory attitude towards certain learners, Sipho is particularly aware of the way in which a teacher speaks to a learner or responds to learner error. He believes that discouragement and demoralisation are inevitable results of a teaching style in which the diversity amongst learners is not understood and accommodated:

INTERVIEWER: What do you think they [the learners]feel?

SIPHO: There’s this trait that they have, especially when they’ve been taught badly by some teachers that are discouraging, if they’re...kept on being discouraged all the time by the way they worked, for example, a sum. If that learner doesn’t understand, now the teacher, instead of giving credit and trying to identify what it is that they don’t understand, will just chuck them down and they will demoralise them even further. They won’t accommodate and meet them half way. (ISI, 5:16)

In his initial interview, Sipho explained that a good teacher should not only make the effort to understand how the learners think, but should employ psychological strategies to set the learners at ease in the mathematics classroom, removing the blockages to understanding caused by fear and discouragement:

Well, I’ve seen some teachers, some mathematics teachers that teach mathematics, some professional teachers- there are teachers that take the psychology into account. They use psychology to get to the learners, to make them feel comfortable with the subject; to make them understand that it’s not just the subject, the subject is about this... (ISI, 5:20)

It would seem therefore, that Siphó's own negative schooling experiences remain influential in terms of who he is as a teacher. His main concern is that he teaches in such a manner that the learners are not put down in any way, that they are encouraged and continually motivated to do better, whatever their mathematical abilities may be.

Siphó as Carer

Judging by the statements he made during the initial interview, Siphó attaches great value to relationships with the learners. For this reason he found that the limited timespan of the practica was inhibiting: "Well, with the time that we were given it was very hard. By the second week you can bond, you start bonding and then the third week you have to go" (ISI, 5:36).

Siphó also believes that a good teacher should be available outside of class time so that a learner may approach him on an individual basis. This he discovered as a learner himself, when he was forced to walk out of a mathematics classroom with many questions unanswered. Sometimes, he feels, understanding is just one more minute of teacher attention away:

There comes a time, a period is so short ma'am, that for the first, let's say it's forty-five minutes, for the first thirty-five minutes you are clueless, clueless and then, just at the thirty-sixth minute you go like "Ah!" but then the minute you were like "Oh, so that's how you do it" and then you want to enquire further, the bell rings. The minute you start enjoying it ... then the bell rings... (SSI, 3:449)

Were he to prioritise the dynamics of the classroom, Siphó declares, "Learners first, content second" (SSI, 3:459)

4.2.6.3. Actualisation of Siphó's PMTI

Siphó's mentor teacher did not prioritise the aspects of his PMTI the way he did. In her opinion, Siphó manifested a concern with the establishment of personal relationships with the learners which outweighed the other categories:

I think he seemed to be more focused on the wellbeing of the learners as well as how they relate to each other in class. He used to talk a lot with the learners individually about their behaviour and performance. As far as the subject knowledge and his presentation skills I think he can still improve a lot on it. (Mentor teacher questionnaire)

Mathematical expertise

Sipho's mentor teacher, observing him teach on a regular basis, indicated that, despite the assertion by Sipho that being an expert in the mathematical content was most important to him, she witnessed a lack in this area in his teaching. In the video footage Sipho was also seen to make a fairly elementary mistake: in referring to a prime number, he called it a proper number. Generally he presents the mathematical content with confidence and is not at a loss to answer any questions the learners might have. He is unhesitant in his presentation and does not refer to notes or the textbook as he teaches. While there may be gaps in his knowledge of school mathematics as perceived by his mentor teacher, his mastery of the content is adequate. He certainly thinks that he is "covered in that department" (SSI, 3:477).

Teaching and Learning

When discussing the possibilities of being creative in teaching mathematics, Sipho defined creativity in this context as a focus on visualisation. He clarified this by stating that using shapes or objects to elucidate an explanation was an exercise in creativity. To him, then, being creative has mainly to do with the use of manipulatives. In the video footage Sipho is seen to use objects to hand, even the learners themselves, to illustrate the concept (ratios) that he was explaining. He was persuaded during the methodology classes at university that linking mathematics to the real world or at least to that with which the learners can associate, is a technique that works. Explaining this particular situation as he watched the video footage, Sipho said that it was important to him to try to operate on the learners' level. If this meant using very simple techniques, then that is what he would do.

One thing that he is certain of in his teaching, says Sipho, is that one should adapt one's teaching to the particular audience in question, and that every effort should be made to ensure that each individual experiences the lesson as "fun". That, according to Sipho, is the "psychological part" of teaching:

If you know the content you...teaching is about sharing the content, explaining the content to the learners. So if you are covered in that department then you have to try to make the psychological part of it, how are you going to express it? Are people going to listen to you? If they want to listen to you ...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)

Evidence of understanding

Understanding, he knows, cannot be guaranteed. He finds that asking questions of the whole group, eliciting choir-type responses provides sound evidence of understanding or the lack thereof. Firstly, he feels that the individual learner remains safe in this type of questioning – he wants to “save their embarrassment” (SSI, 3:215) – and secondly, he is able to gauge the reactions of individuals in the group response: “I want to hear those guys active and from there I notice, why is he quiet? There’s that, it’s sort of like a little study for me, getting to know the learners” (SSI, 3:215). Generally, he uses questions of this kind to access evidence of understanding.

Teacher/ Learner-centeredness

In his determination to keep the learners involved in the lesson, Siphso adopts what he calls a “dramatic” style. This involves walking up and down the class, rubbing his hands together and generally just “talking to them, make them free, set them at ease” in order that

I can show them that this is going to be fun, just takes them away from “Ah, mathematics is so boring! Numbers again”, Make it 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)

This particular style, Siphso explains, does not work for all the learners in the class – some will find it silly:

Some of them, they don’t really approve of the style, they’re like “ok, he’s a clown” but then you can easily pick that up from a learner that he thinks “ok, he’s a clown. He’s wasting our time”. You always want to be challenging, normally that learner will always be quiet. (SSI, 3:316)

Were he to perceive such a reaction, Siphso says he is able to adapt his teaching style so that all the learners remain engaged:

Get more serious, more serious ...and the tone of voice should change, tone should change. More eye contact towards him, get him involved, ask a lot of questions, try some ideas, let him explain rather than me talking, see that he knows something and he wants to...to share something, let him explain. Let’s see how he does it and then from there I incorporate it to the others so that I can accommodate everyone. (SSI, 3:320)

Involvement of learners, to Siphó's way of thinking, includes allowing them to teach and to be given the opportunity to demonstrate their understanding of a concept. In the video footage, he is seen to invite a learner to explain her answer on the board.

That girl that came up there, I remember, she was the one that was busy. She was all of the time asking, asking so then I wanted to see what she knows, I wanted to find out more, give her the chance because she was...she was jumping up and down, jump...jumping for attention, so I gave it to her, satisfy all their needs, try at least to satisfy all their needs. She wanted to be seen, she wanted to present something to all of us, so give her the opportunity why not and see where it goes. (SSI, 3:292)

In the video footage, Siphó invites learners to participate freely in the lesson, often at the cost of discipline in the classroom. His approach is visibly friendly and jocular: it would seem that his primary strategy is to make the learners enjoy being with him in the class. Part of this strategy implies a negotiation of meaning in the actual content of the lesson: he strives to draw information from the learners by asking questions and prompting them to access the prior knowledge they might have to be able to do the work at hand. He also tried to make the work relevant to the everyday lives of the learners: for example, in teaching about ratio, he used the demographics of the classroom to illustrate comparisons.

Flexibility

His knowledge of the topic in general was broad enough to allow him flexibility in the course of the lesson. For example, he was talking about a ratio of rands and cents, and required the learners to make everything "of the same kind". When some of the learners showed that they were uncertain about the direction of movement of the comma in this conversion, he digressed from the plan of his lesson to expound briefly on place value.

This flexibility is invaluable, according to Siphó. The purpose for planning a lesson, according to Siphó, is to "organise yourself". This involves deciding on "How to present the lesson, make it enjoyable, to come up with new ideas all the time, keeping it fresh" (SSI, 3:356). While the lesson plan provides the basic structure of the lesson, it does not necessarily determine how the lesson is presented: "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). Such factors as the weather, classroom logistics and

the general mood of the class all have to be taken into consideration in presenting a lesson, and that, as Siphso explains, means that flexibility in teaching is the order of the day, since one can never be sure of these things in advance. Whatever the plan for a lesson, if he discerns difficulty and a lack of comprehension, Siphso believes that the plan should be abandoned in favour of another explanation:

SIPHOS: You can't advance ma'am, you can't advance. If...if they fall behind you cannot advance to the next...next...next step, you can't. If they don't understand this part here, I always like to think about it...I always love to use uh, what was it? van Hiele?

INTERVIEWER: Yes! van Hiele levels.

SIPHOS: Yes, van Hiele level like that. I always think about it, if...if you're still at zero, you come off to one. So, equally, if you don't understand what I'm talking about now, I shouldn't leave you behind...shouldn't leave you behind.

INTERVIEWER: Ok, so you think it's worth stopping ...?

SIPHOS: It's worth it, it's worth it. (SSI, 3:380)

Evidence and purpose of caring

Siphso believes that caring implies encouraging the learners and not "crushing" them in any way. Therefore, when an incorrect response is offered by a learner in the video and the class is seen to laugh, he stops the laughter because "I don't want to hurt their feelings, I don't want them to, just because they've answered wrongly or said something which is out of context, to not be involved in the classroom anymore" (SSI, 3:119). It is therefore important to him that the learners feel safe enough to continue to participate in the lesson because, he says, "they all have to contribute something in the classroom" (SSI, 3:231).

Perhaps because of his experiences as a learner, Siphso is tremendously culturally aware. He therefore dedicates time and thought to dealing with cultural diversity in the classroom, despite the difficulties involved:

So with the white learners I had to be extra careful by what I say - choosing the right words, try to perfect the English, which is very hard especially when you have to think on your feet. The treatment, I tried to treat them all equally but now, some of the white learners that may be advancing in the subject, they will try and make a mockery out of the whole lesson. They won't

respect other learners, they won't respect other learners' answers and they won't respect you when you respond to them. (ISI, 5:112)

His belief that skin colour is a barrier to be overcome in the classroom seems to carry the same weight that language does. His home language is not the same as that of most of the learners in Pretoria. He therefore has made a huge conscious effort to become familiar with the more common local languages so that language differences do not constitute an obstacle in his practice. This is important to him, despite the fact that all tuition in the classroom takes place in English.

SIPHO: Yes, I use multiple methods, Ma'am, because the learners are very different. First of all: the culture, our cultures are very different and the language that we speak.

INTERVIEWER: What do you mean by cultures are different?

SIPHO: I'm from mostly rural background and...

INTERVIEWER: What is your home language?

SIPHO: Seswati and here it's mixed, it's mostly Tswana and Sepedi and Sotho.

INTERVIEWER: Can you speak their language?

SIPHO: I can hear [understand] it and I try, but I'm not that fluent yet. So with the language, taking just the language into account, I try to accommodate them. But in most cases you find that they will use their language most of the time and they will try to express themselves in their language - I do not discourage that, instead I use that, I give them the stage. One of the learners in the classroom might know English, might know how to translate it. Instead of showing them that maybe I do not understand in this particular sentence that you mentioned and how you express yourself, I would use that learner to explain to the class as if one of the learners didn't understand, because you'll find in the classroom that one of the learners *don't* understand. So I'll use methods like that just to come around, work around that. (ISI, 5:52)

Sipho's main concern, it would seem, is that all his learners recognise that he treats them equally and respects their cultural and language differences. It would appear that the actual mathematical content of the lesson takes second place to this concern.

4.2.6.4 Summary

Sipho was driven to prove to himself and his erstwhile teacher that he could not only *do* mathematics, but that he could *teach* it; and that he would demonstrate that racial prejudice is taboo

in any classroom. His tertiary training changed and shaped him: in particular, he found that Educational Psychology opened his understanding as to how learners actually learn and how teaching should be adapted to accommodate learning styles. He recognises three influences that shaped his style: his schooling experiences, the modules he was taught at university, and the views and understandings of his peers. Teaching practice gave him the opportunity to ‘try out’ his newly developed style, under the aegis of mentor teachers who he recognised to be sources of knowledge. However, he found that there was a discrepancy between what he was taught at university and what he experienced in the reality of the school. The theory had not quite prepared him for the practice. He did his teaching practica in former Model C schools in Pretoria, where his classes were racially mixed. He found that he had to prove to the white learners that his knowledge of mathematics and his ability to communicate that knowledge were more relevant to the classroom than his skin colour. His view of mathematics seems to fit into Ernest’s (1988) Problem-solving category. He sees the subject as involving logic and reasoning with a view to deciphering the links between mathematics and the real world. His view includes a non-concrete, non-finite aspect – “the art of science” which makes it both beautiful and mysterious, something to be explored.

Figure 10 is a visual representation of Siphos’s PMTI. It is clear that he is confident in his usage of mathematical concepts and teaches the topic at hand with ease and comfort, without making major mathematical mistakes. However, his mentor teacher observed that his knowledge of mathematics required further extension. Siphos *believes* that being a subject specialist carries the greatest significance in his PMTI, but evidence of this practically being the case is absent: both his mentor teacher and the video footage indicate that he is more concerned with making his learners feel comfortable in his class so that they can be free to participate in the lesson. He also believes that learners have a negative attitude towards mathematics which needs to be addressed. In describing a good mathematics teacher, he said that, “In order for you to teach it you have to understand it, you have to understand the whole idea, the feeling people have with this subject.”

He sets great store by the by his knowledge of educational psychology which allows him to understand what the learners think and feel. To improve understanding, he likes to use manipulatives. These can be any object to hand that may be used to illustrate a concept – whatever it takes to get to the learners’ level. He also wants his classes to be fun, a strategy he believes makes

learners *want* to be attentive in his class. He is concerned about shy or reticent learners and this is one of the reasons for which he uses choir-response questions- it allows the shy learner to remain hidden. However, he says he is able to gauge the reactions of individuals in the group response: he can see who is not participating and then proceeds to find out why. The teaching strategies he employs he describes as “dramatic”, and include walking up and down the class making large gestures with his hands. He believes this sets the learners at ease – making the atmosphere more social, if a learner seems to disapprove, he is able to become more serious – thus keeping all the learners engaged. He believes it is useful to allow the learners to teach from time to time: for this task he selects learners who seek attention or approval. In this way he is able to satisfy the need of the learner, while at the same time finding out what such a learner knows. Sometimes class discipline is sacrificed in his application of these strategies. He does not perceive this as a problem, as long as he is able to draw the learners out to reveal their prior knowledge and to lead them in constructing their own understanding. He plans his lessons in order to be organised, but believes in being responsive to the “audience” – if deviation from the plan is necessary, he will do so. In terms of Ernest’s (1988) categories, he is a facilitator. He is driven to facilitate relationships and cultural respect. He wants to please, and to be liked and accepted by his learners.

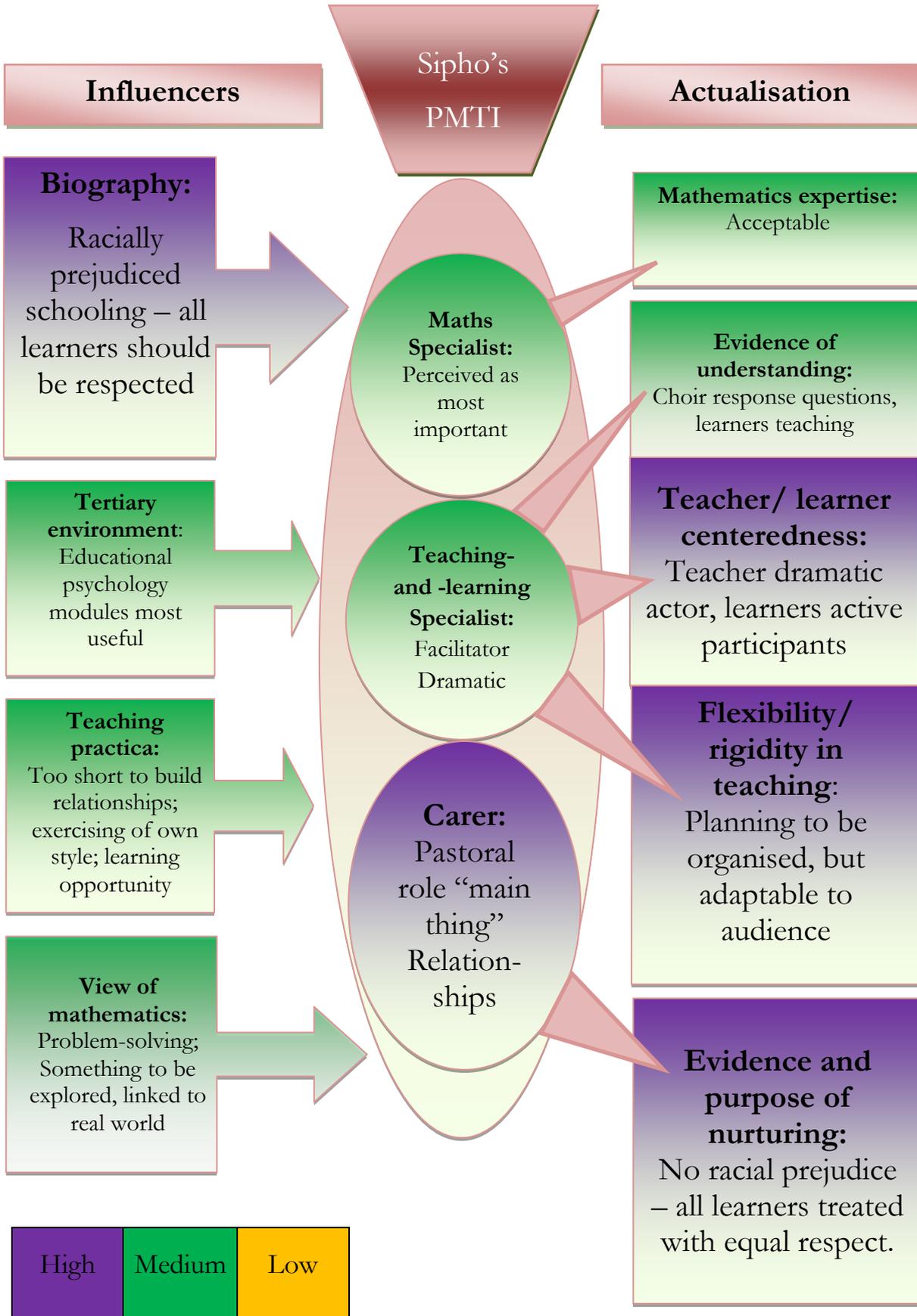


Figure 10. Sipho's PMTI according to the Conceptual Framework

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:

SIPH0: 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. Siphos 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 Siphon, 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). Siphso 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.

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?

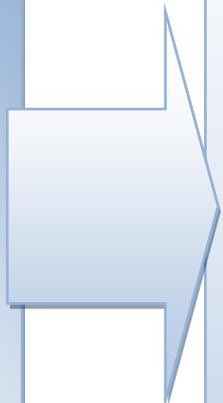
The literature that formed part of this research (see Section 2.1) indicated that, despite all that is written about professional teacher identity, there is not much that is definitive (Fearon, 1999; Abdelal et al., 2006 Castanheira, Green, Dixon & Yeagerb, 2007, Beauchamp & Thomas 2009). Most of the 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:

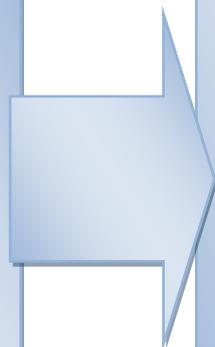
Personal history - her teacher who was unable to explain well. } *This makes of her an Explainer*
View of mathematics }
↓
Affects Carer: interaction with learners is to help them understand her explanations

Tertiary training } *She claims have not influenced her*
Teaching practica }
↓
So Mathematics Specialist depends on her always being right, and Teaching-and-learning Specialist and Carer depend on her instincts.

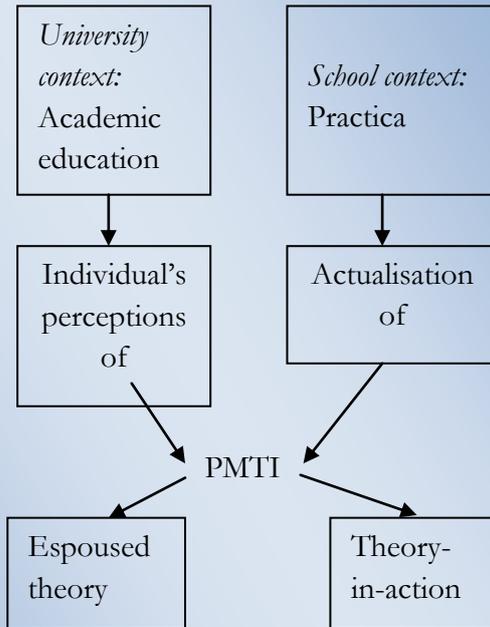
Teacher identity in the literature: Who I am at this moment in this context i.e. it is changeable and susceptible to context

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:



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.

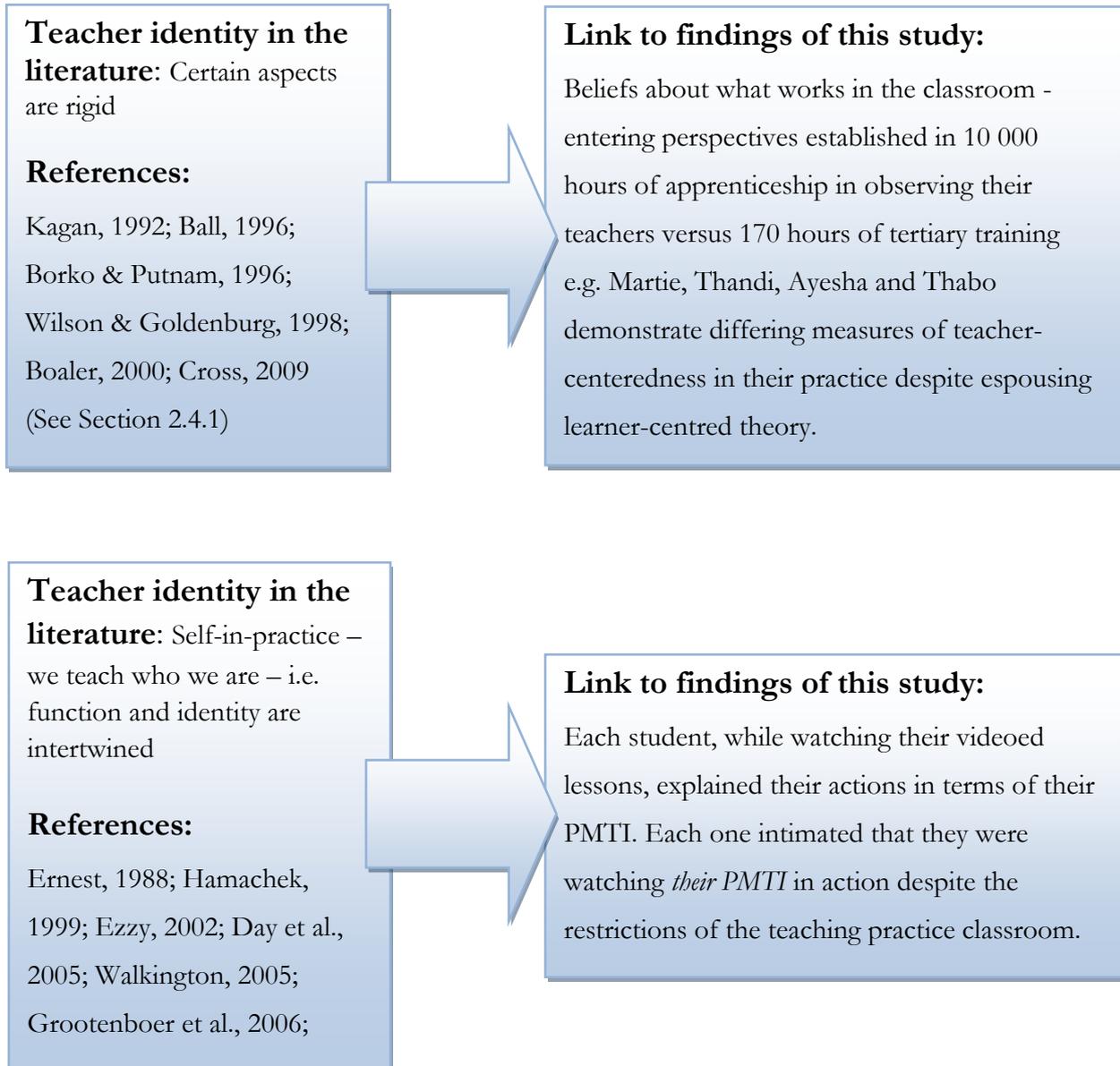


Figure 11. Literature linked to findings

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 PMTT's. For four of the students, their schooling was also a career choice influencer, either initially (Thandi, Thabo, Siphon) or later (Martie). At the same time, as discussed above, their schooling had a strong influence on their PMTT's. The society from which these students come (see Section 5.1.1) also influenced their career choice as well as their PMTT'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 Siphon'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 PMTT 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 PMTT's is not necessarily about the same thing. For instance, Martie, Thabo and Siphon 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 PMTT'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. Siphso, 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. Siphso 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. Siphso 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 Siphon 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. Siphso, 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 Siphso 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 PMTT'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 Siphso 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.

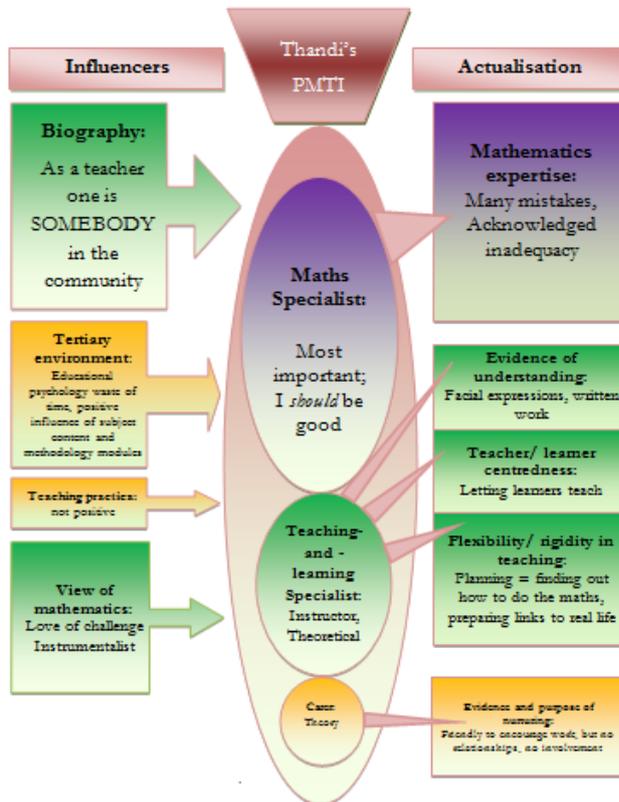
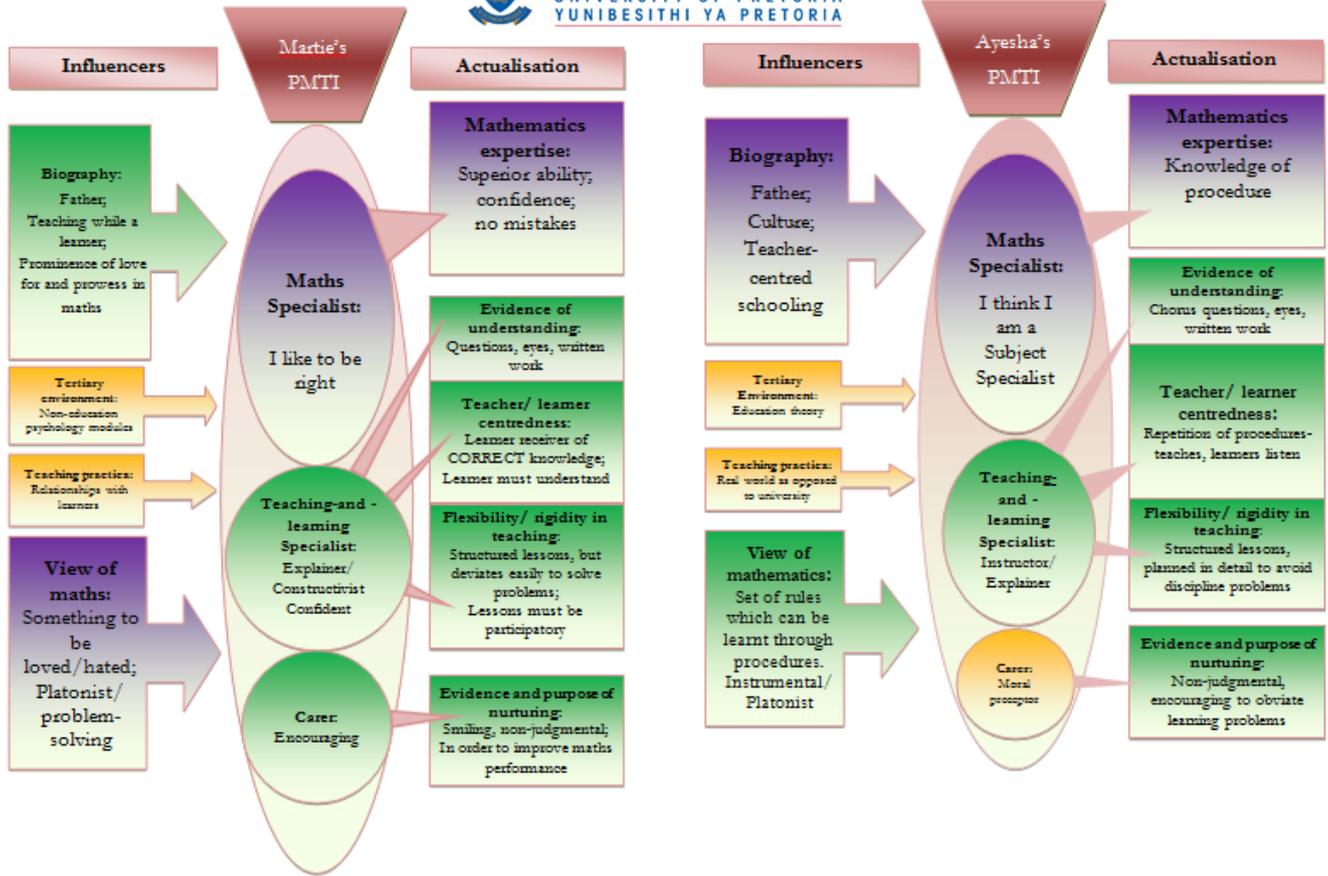
However, in the use of a case study methodology, it is necessary to select a limited number of cases. I used the questionnaire completed by all the students in the sample to help me make my selection. Several possibilities presented themselves: a homogeneous group, or a randomly selected group in which 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.



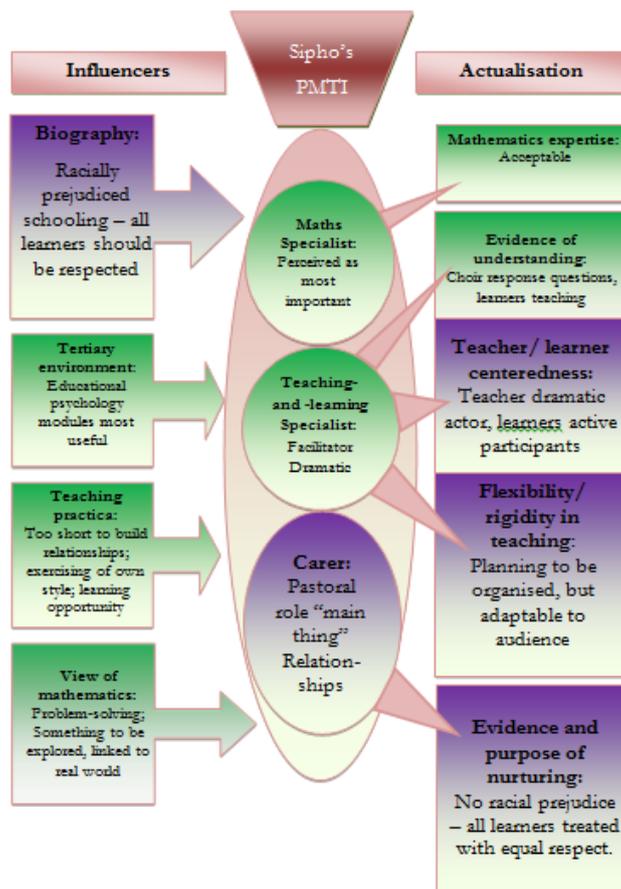
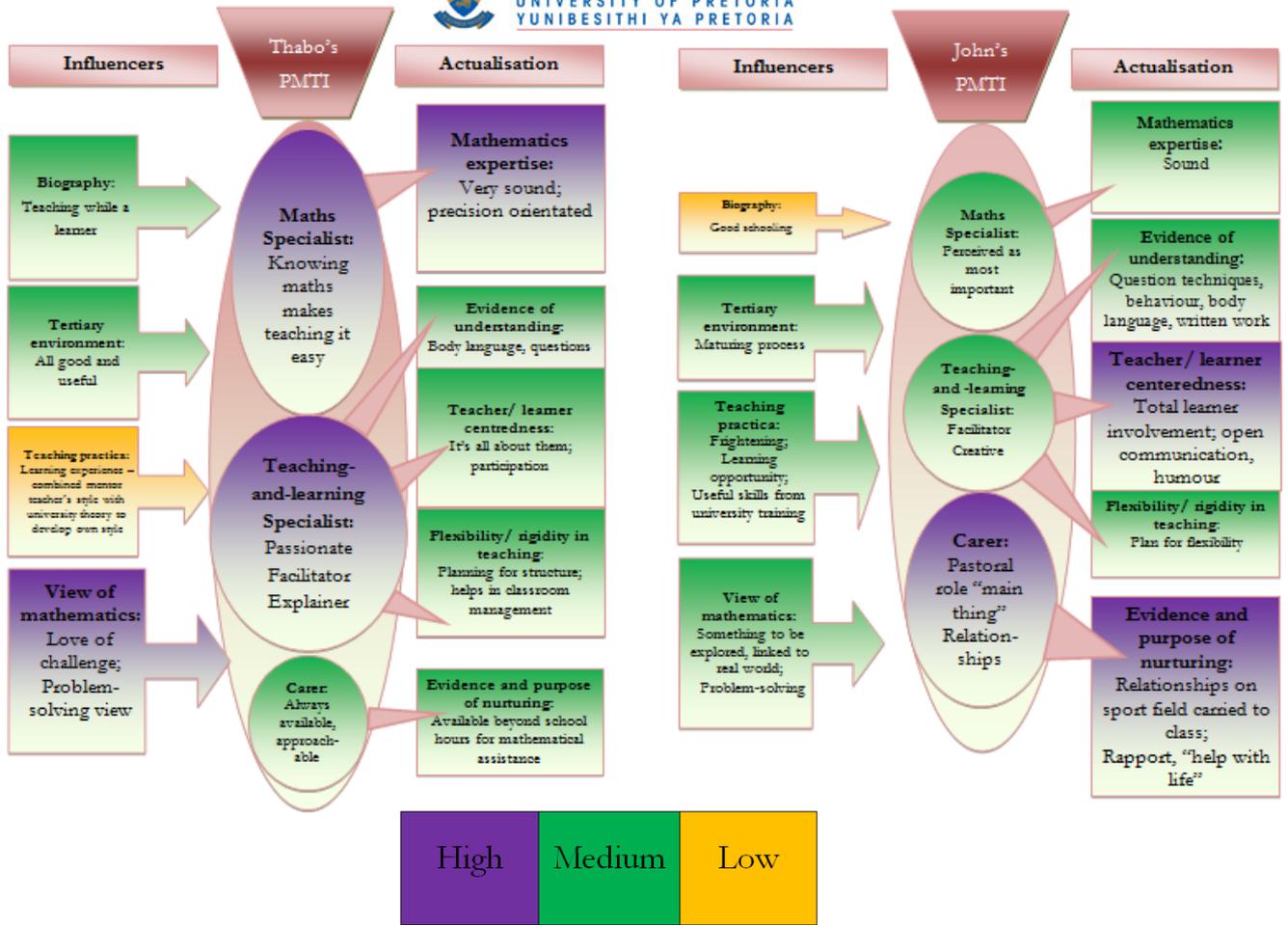


Figure 12. Visual representations of all six participants' PMTI's.

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; Siph'o's teacher was racist – Siph'o 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 Siph'o 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 to 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 Beijgaard 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.

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Addendum A: Student questionnaire

Preservice Mathematics Teacher Questionnaire

(Beijaard, 2000, translated, adapted and modified)

This questionnaire has been designed to provide insight into the way pre-service mathematics teachers regard certain important aspects of their professional identity. The questionnaire consists of two sections and should take half an hour to complete. All information you provide will be regarded as absolutely confidential. Thank you for your participation!

Section 1 : General biographical questions

1. Name:

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2. Sex: Male Female

3. Age:

4. Type of High School you attended (you may tick more than one block):

Rural City Private Formerly disadvantaged Former Model C

5. Final mark for mathematics in matric (approximately):

40-49%
 50-59%
 60-69%
 70-79%
 80-100%

Section 2 : How you see yourself as mathematics teacher

In the table below, being a teacher is divided into three parts: SUBJECT SPECIALIST, DIDACTICS SPECIALIST and PEDAGOGICS SPECIALIST. You are requested to examine how you see yourself as a mathematics teacher and to determine which of these aspects are most important in your own perception of what it is to be a teacher.

NB: In this inquiry sheet the following definitions will apply:

SUBJECT SPECIALIST: a teacher that focuses on *subject knowledge and skills*.

DIDACTICS SPECIALIST: a teacher that focuses on knowledge and skills regarding the preparation, implementation and evaluation of *teaching and learning processes*.

PEDAGOGICS SPECIALIST: a teacher that focuses on knowledge and skills concerning the *socio-emotional and moral development of the learners*.

CATEGORY	PRIORITISATION (First, second or third)
SUBJECT SPECIALIST	
DIDACTICS SPECIALIST	
PEDAGOGICS SPECIALIST	

1. Please give a short explanation of why you prioritised these aspects the way you did in the table above.

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2. This question concerns the significant learning experiences that you have encountered in your tertiary training around these three aspects. Please complete the following sentences:

A. With regard to my role as SUBJECT SPECIALIST I have learnt that

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B. With regard to my role as DIDACTICS SPECIALIST I have learnt that

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C. With regard to my role as PEDAGOGICS SPECIALIST I learnt that

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Addendum B: First individual student interview questions

First Individual Interview Protocol

1. How would you describe a good mathematics teacher? (*Personal background: self-in-the-mind*)
2. Why did you choose to study to become a mathematics teacher? What influenced your choice most heavily and why? (*Personal background: self-in-the-community*)
3. In the questionnaire you indicated that you attach great value to the subject specialist/Carer/technician role of the teacher. Describe yourself as a mathematics teacher. (*Subject specialist/Carer/technician: self-in-the-mind/ community*)
4. How did you implement these roles in your previous teaching pracs? (*Teaching practicum*)
5. When you enrolled for your teaching studies, what were your expectations of the training to become a mathematics teacher? (*Tertiary training context: self-in-the-community*)
6. What changes do you perceive in yourself as a result of your tertiary training? (*Tertiary training context: self-in-the-community*)
7. What aspects of your training would you change if you could? (*Tertiary training context: self-in-the-community*)

Addendum C: Second individual student interview questions

Second Individual Interview Protocol

About the subject mathematics:

How do you see the subject mathematics? Describe “mathematics”.

What is the purpose of the subject?

How do you feel about the subject?

Do you believe that there is scope for creativity in the teaching and learning of maths? (Flexibility)

About the video

Didactics:

What stands out for you in this video clip?

How would you describe your own teaching style?

For example:

Negotiation of meaning – teach by questioning

Emphasis on relationships

Relevance to real life

As a maths teacher, what are your personal goals in the classroom? What do you try to achieve?

What do you see as evidence that learners are understanding?

What do you believe is the purpose of planning a lesson? (Preparation)

Reflection:

What, in terms of teaching maths, are you unsure of?

What, in terms of teaching maths, are you sure of?

Do you look back on a lesson you have taught with a view to finding strengths and weaknesses? Describe an example.

Pedagogy:

Why do you believe that a maths teacher should be available to learners after class? What about during class?

Addendum D: Group interview questions

Group Interview Guidelines

1. Was this teaching prac different from your other teaching pracs? Why? If yes, why; if no, why not?
2. Has anything changed in your ideas of what it means to be a teacher?
3. How do you see yourself in the future in the classroom? Describe you in a classroom next year.
4. Did you teach as you were taught at school or did you teach differently?
5. Now that you know what it's like out there, how would you make the methodology more relevant? More worthwhile?

Addendum E: Questionnaire to be completed by student's mentor teacher

Mentor Teacher Questionnaire

(Beijaard, 2000, translated, adapted and modified)

This questionnaire has been designed to provide insight into the way pre-service mathematics teachers regard certain important aspects of their professional identity.

The questionnaire consists of two sections and should take 20 minutes to complete.

Section 1 : Observed teaching identity

In the table below, being a teacher is divided into three parts: SUBJECT SPECIALIST, TEACHING & LEARNING SPECIALIST and CARER. You are requested to think about what you have observed in your student as a mathematics teacher and to determine which of these aspects are most often observable in his/her teaching.

NB: In this inquiry sheet the following definitions will apply:

SUBJECT SPECIALIST: a teacher that focuses on *subject knowledge and skills*.

TEACHING & LEARNING SPECIALIST: a teacher that focuses on knowledge and skills regarding the preparation, implementation and evaluation of *teaching and learning processes*.

NURTURER: a teacher that focuses on knowledge and skills concerning the *socio-emotional and moral development of the learners*.



CATEGORY	PRIORITISATION (First, second or third)
SUBJECT SPECIALIST	
TEACHING PROCESS SPECIALIST	
CARER	

Please give a short explanation of why you prioritised these aspects the way you did in the table above.

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Addendum F: Interview protocol for interview with student's mentor teacher

1. Would you describe your student as a good mathematics teacher?
2. In which aspects of teaching mathematics do you think your student can still improve?
3. In your observation of this student, what has struck you the most in his/her teaching?