3. Design of the study

In this study my aim is to gain insight into the PMTI'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), Cresswell (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	OB-JECT-IVES	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 observa-tions	
			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 s*ocio-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 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-an-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

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.