# 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 this 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 |
| Volkmann & 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; Volkmann & Anderson, 1998; Dillabough, 1999) or unitary (i.e. there are sub-identities) (Volkmann & 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 is 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 | *Journal of Education Policy* |
| 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 | *South African Journal of Education* |
| 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' | *Journal of Curriculum Studies* |
| 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) *Teaching Selves: Identity, pedagogy, and teacher education.* |
| 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 | *Journal of Educational Research* |
| 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 | *Educational Theory* |
| 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? | *Teaching and Teacher Education* |
| 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 | *Teaching and Teacher Education* |
| 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 | *Biographical Methods and Professional Practice: an International Perspective*(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 | *Teaching and Teacher Education* |
| 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 | *Asia-Pacific Journal of Teacher Education* |

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|---|---|---|---|---|
| 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) *Teacher Identity Discourses: Negotiating personal and professional spaces* |
| 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 | *Teaching and Teacher Education* |
| 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 | *Science Education* |
| 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 | *Vocations and Learning* |
| 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 | *Educational Studies* |
| 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 | *Educational Research for Policy and Practice* |
| 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 | *Psicothema* |
| 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 | *Teaching and Teacher Education* |
| Timostsuk & 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 | *Teaching and Teacher Education* |
| 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 | *Journal of Teacher Education* |
| 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 | *Teaching in Higher Education* |

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*

} Content and curriculum domain: what is to be taught

- General pedagogical *knowledge*
- Pedagogical content *knowledge*
- *Knowledge* of learners

} Pedagogy domain: who is taught and how they are taught

- *Knowledge* of educational contexts
- *Knowledge* of educational ends

} 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 learner*s, 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 (Volkmann & 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.

### *Changebility*

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, Wiliam 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 ⇒ teacher instructor ⇒ compliant learner
- Platonist ⇒ teacher explainer ⇒ learner receiver of knowledge
- Problem solving view ⇒ teacher facilitator ⇒ 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 (Volkmann & 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.

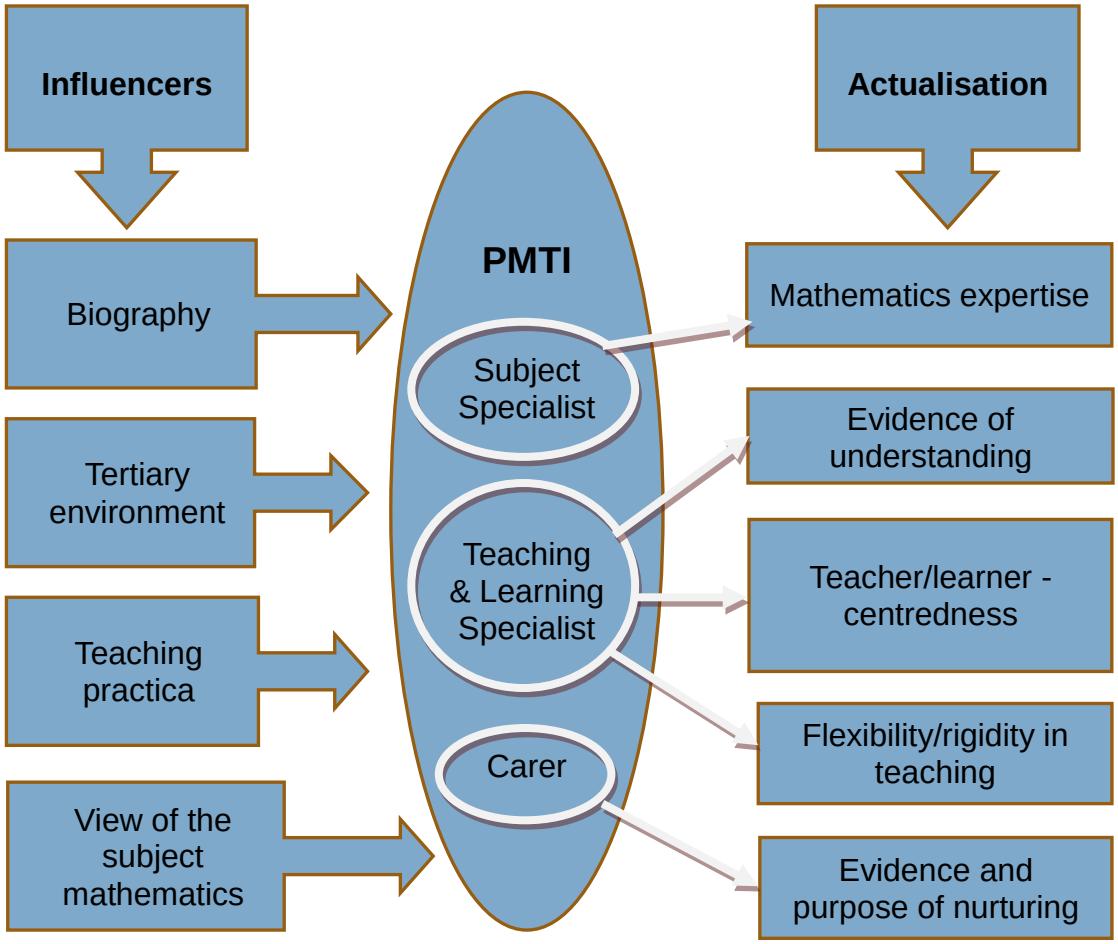


*Figure 1.* Conceptual framework for PMTI

### 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 learner*s, 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 ⇒ teacher instructor ⇒ compliant learner

- Platonist ⇒ teacher explainer ⇒ learner receiver of knowledge
- Problem solving view ⇒ teacher facilitator ⇒ 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.