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SUSTAINING THE PROFESSIONAL IDENTITY OF BEGINNING TEACHERS IN EARLY MATHEMATICS, SCIENCE AND TECHNOLOGY TEACHING

Marié Botha

2012

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by

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Prof G.O.M. Onwu

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Faculty of Education

I dedicate this study to

My grandfather, Juriaan van Twisk. You came from Amsterdam in the beginning of the twentieth century as a young science teacher to teach the children of South Africa. You were recruited at a time when there was a shortage of science teachers. You inspired your children, grandchildren and other people's children with stories and real life experiences in language, mathematics, science, music and art.

My husband Simon. You gave your time, you listened to me, you provided me with insightful remarks, ideas and you supported me during this long journey.

My daughter Sulette, a committed teacher of young children. During your first year of teaching in 2006 you made me aware of the experiences through which you had to live. Through your stories you made me wonder about the working lives of beginning teachers.

My grandson Jason Philip Smit. Through your eyes I see the future.

Above all else, I dedicate this study to all the teachers who passionately devote their lives to the teaching of young children.

'If a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and the mystery of the world we live in.' Rachel Carson (1907-1994)

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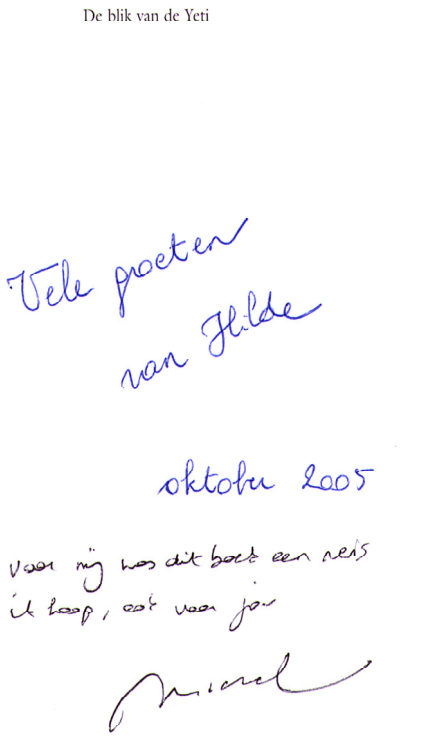

'Wat begin als een zoektog naar het bekende, eindig in een ontmoeting met het vreemde en de ontdekking van de kostbaarste zeldsaamheid' – Michel Vandenbroeck

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ABSTRACT

The focus of this study is on foundation phase and early childhood teachers' professional identity formation. This study is about six beginning teachers in their first year of teaching early mathematics, science and technology (MST) in different schools and grade levels.

Early childhood settings and primary schools in South Africa have a diverse learner body that increasingly demands of beginning early childhood and foundation phase teachers to continually strive to adapt their teaching and young children's learning to the different learning environments for effective implementation of the curriculum.

A learning identity framework was used to generate and analyse data. The learning identity framework is premised on the assumption that identity and learning are closely linked and that both are influenced by factors internal and external to the individual.

Specifically, the study sought to answer the research question of how beginning first-year early childhood and foundation phase teachers form, sustain or change their professional teacher identity in the teaching of mathematics, science and technology (MST) in the early years and in different school settings.

The study used a phenomenological approach and case study method to explain the professional teacher identity formation process and to illuminate what factors influence this process. The study researched how teacher identities can be narratively constructed on the basis of the lived experiences of the six teachers in different school contexts. Data was generated from different sources for the purpose of triangulation which included visual and written narratives, observations and interviews (open and semi-structured). The analysis and results were based on categories of descriptions of themes. The findings indicate that identity formation is an ongoing process of integration of teachers' personal and professional histories and initial teacher education and training, alongside issues of school culture and

institutional (in-school) support. Those key factors emerge as strong determinants of the kinds and the relative stability or otherwise of professional identities which the six teachers develop in the first year of MST teaching, and thus the kind of reform-minded teachers they become.

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KEYWORDS

Beginning teachers
Professional teacher identity
Early mathematics science and technology teaching
Teacher education programme
School contexts, foundation phase
Early childhood education
Inquiry-based approach
Identity formation

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ACRONYMS

DoE	Department of Education
ECP	Early Childhood Phase
FP	Foundation Phase
GET	General Education and Training in Interview
LPTI	Learnt professional teacher identity
MST	Mathematics, Science and Technology
NR	Narrative Reflection
O	Observation
OR	Observational Reflection
OBE	Outcome-Based Education
OECD	Organisation for Economic Co-operation and Development
(R)NCS	Revised National Curriculum Statement

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CHAPTER ONE
INTRODUCTION AND BACKGROUND TO THE STUDY

> 'By three methods we learn wisdom: first by reflection, which is the noblest; second by imitation which is the easiest; and third, by experience, which is the most bitter' – Confucius (551-479 BC).

1.1 INTRODUCTION

In South Africa primary and early childhood education schools have a diverse learner body. It increasingly demands of Foundation Phase (FP) teachers (Grades R to 3) to continually adapt their teaching and young children's learning to the varied learning environments for effective and efficient implementation of the new reform-based FP curriculum (Department of Education (DoE), 2003). One way to address the challenge of teacher quality or competence in the education system is through the development and sustainability of a professional teacher identity that is able to accommodate and respond positively to curriculum reform (Carlone, Haun-Frank & Kimmel, 2010; Day & Gu, 2010). For Walkington (2005:45), positive professional teacher identity formation implies that the teacher is a 'confident' and 'flexible, lifelong learner, able to participate in ongoing change' or in Samuel's (2008:6) view 'an agent of change'. As an agent of change or nucleus of transformation the reform-minded teacher's professional identity is said to consist of knowledge, skills and confidence that will assist teachers to make decisions and to 'take risks' (Walkington, 2005:63) in order to make a difference.

This study presents some aspects of six beginning teachers' professional teacher identity formation in their first year of teaching early mathematics, science and technology (MST) in different South African primary schools and early childhood settings. The study sought to understand their personal biographies and analyse the key factors that are said to influence the ways these new teachers' professional identities are shaped, reshaped and/or sustained in the context of teaching early MST. Their knowledge and beliefs about MST teaching and learning, which are determined by personal histories, professional educational studies and school

context, are conceived of, among others, as important constituents of their professional teacher identity formation (Flores & Day, 2006; Whitelaw, 2007).

Professional teacher identity is thus seen as important because it reflects not only the beginning teachers' view of themselves as teachers but also their knowledge, beliefs and attitudes towards a given subject and how it is taught in a given classroom context (Flores & Day, 2006; Fleer, 2011; Samuel, 2008). Mayer (1999) maintains that the core beliefs a teacher has about teaching and being a teacher are important in order to support and sustain their professional identity.

In addition, Egan (2004) and Smith (2007) describe professional teacher identity formation as the ongoing 'becoming' of a teacher: in other words, how one grows to be a teacher and how one teaches 'in a given social and cultural space' (Flores & Day, 2006:220). Professional teacher identity formation is thus seen as important because it includes personal and professional aspects that are shaped by 'cognitive responses' (Flores & Day, 2006:220) in a given social and cultural space.

According to Davies (2008) and Osgood (2006), developing and sustaining a professional teacher identity is a process that starts during professional studies and is continued during the lifetime of the teacher as a practitioner. If so, there is the need to understand how initial teacher education programmes contribute to professional identity formation. The institutions of higher learning where pre-service teachers are educated have the responsibility and role of instilling in student teachers a sense of purpose of their own developing professional teacher identity and the teacher they hope to become (Day, 2008; Smith, 2007). It is believed that on successful completion of their teacher education programme, beginning teachers may have acquired a professional teacher identity. However, beginning teachers may or may not necessarily define themselves as professionals who can automatically make meaning and implement knowledge and reform in their professional world (Day & Gu, 2010; Flores & Day, 2006). Becoming a reform-minded teacher is a complex process and takes a very long time to accomplish (Day, 2008; Forde, McMahon, McPhee & Patrick, 2006; Vaillant, 2007), in that it involves personal commitment and an availability to teach and learn (Marcelo, 2009), among other things.

Flores and Day (2006:219) refer to the nature of this teaching and learning process as ‘multi-dimensional’ and ‘context-specific’. Various personal and contextual factors which are internal and external to the beginning teacher are said to play a part in the formation and sustainability of a reform-minded teacher.

The high levels of attrition among beginner teachers worldwide have been documented extensively (Cherian & Daniel, 2008; Rizza, 2011). While existing literature suggests that teacher effectiveness improves sharply in the first few years of entering the profession, research shows that many beginning teachers abandon the profession prior to attaining this level of expertise in any appreciable way (OECD, 2005). Teacher retention problems which have implications for professional teacher identity formation are particularly worrisome in light of the wealth of evidence that suggests that well-prepared and reform-minded teachers have the largest impact on learner performance (Cooper & Alvarado, 2006). How to retain teachers in the profession has become an issue of policy for many developed and developing countries (Rizza, 2011).

In South Africa there is a lack of discourse and research into early childhood and foundation phase level teacher education. The poor historical status of this sector of the education system, particularly in respect of the comparatively few African candidates who opt for a teaching career in early childhood education and foundation phase has been of national concern (DoE, 2003; Green, Parker, Deacon & Hall, 2011). Development of a well-established professional teacher identity through a sound teacher education programme may have implications for teacher retention. Therefore, research that would investigate aspects of foundation phase teacher education provision must of necessity be seen as absolutely crucial for teaching and teacher education at that level. At the core of any such endeavours is the understanding that professional development and identity formation for the beginning South African teacher is all about transforming their knowledge into practice for effective implementation of the new reform-based National Curriculum Statement (DoE, 2005, 2007).

This study is about how six beginning teachers in their first year of teaching, in different school settings, shape, reshape or try to sustain their teacher professional identity in the teaching of MST in the foundation and early childhood phases. The

question that is addressed is how their personal and professional biographies and their pre-service education and training alongside issues of work environment affect their practice and in turn the stability or otherwise of the kinds of teachers they become or want to become. The focus is on their professional teacher identity formation and the influence of their teacher education programme.

1.2 BACKGROUND TO THE STUDY

Since its transition to a democratic dispensation in 1994, South Africa has undergone radical social, political, economic and cultural changes. Changes on the education front have included curriculum transformation based on a philosophy of outcomes-based education (OBE). The Revised National Curriculum Statement ((R)NCS) (Bosman, 2006; DoE, 2003) (hereafter referred to as the National Curriculum), is the school curriculum for South Africa. The National Curriculum promotes an outcomes-based approach to education and of necessity demands a range of teacher competencies for its effective implementation (DoE, 1998; DoE, 2000; DoE. 2003).

It is against this backdrop that teacher education programmes offered at the various higher education institutions are expected to provide the knowledge and skills and develop attitudes that will equip beginning teachers adequately for their task. In other words, on successful completion of the programme pre-service student teachers should have acquired competencies that would help them to develop the intended teacher identity (Bradford, Darling-Hammond & LePage, 2005a; Bradford, Derry, Berliner, Hammerness & Beckett, 2005b; Day, 2002; Hammerness, Darling-Hammond, Bradford, Berliner, Cochran-Smith, McDonald & Zeichner, 2005; Hill, 2003; Keiny, 2008; Keys, 2007; Vaillant, 2007). However, in South Africa, according to Samuel (2008), the quality of professional teacher identity formation may differ, depending on the preparation programme.

In order to place the study in its proper context it is important to give a description and an explanation of the MST curriculum and the teacher education programme offered by the institution where the beginning teachers come from.

1.2.1 CURRICULUM: EARLY MATHEMATICS SCIENCE AND TECHNOLOGY TEACHING

For the purposes of this study, two phases of the early MST curriculum are relevant, as the initial teacher education programme that the six beginning teachers were exposed to prepared them for both phases. The two phases are the early childhood phase (ECP) and foundation phase (FP).

1.2.1.1 Early childhood phase

In this study, ECP refers to children aged between three to five where children attend an educational setting outside the home. In an ideal early childhood setting, children between three and five need to explore, investigate and discover MST concepts and skills (Van Heerden, 2011). Children are more likely to develop MST concepts and skills within meaningful, contextualised curriculum activities. MST curriculum activities can be presented as informal or intentional and instructional teaching inside or outside the classroom (Charlesworth & Lind, 2007; 2010; Van Heerden, 2011). The role of the teacher is to facilitate, scaffold and support MST learning by engaging children in planned activities that will allow them to think, reason and solve meaningful problems (Charlesworth & Lind, 2007; 2010; Davies & Howe, 2003).

Early childhood settings use different theoretical and philosophical frameworks that inform their curriculum approach. These curriculum approaches in many instances apply a set of theoretical descriptions for child development, knowledge construction and pedagogical approaches. Cross, Woods and Schweingruber (2009) explain that many early childhood settings use an integrated curriculum where two or more subject or content areas are combined or merged to help children to make meaningful connections. Cross-curricular themes, topics or projects can also integrate and relate subjects or content areas. Researchers such as Clements (2001), Davies and Howe (2003) and Moyer (2000) support the exposure of hands-on, real-life integrated MST content in early childhood settings. Clements (2001), Davies and Howe (2003), Ginsburg (2006) and Seo (2003) argue for the active involvement of children in MST concepts in a playful context where children are provided with ample time, materials and support.

Perry and Docket (2007:2) are of the opinion that early childhood programmes 'draw on a long tradition of play-based curricula'. According to Brock, Dodds, Jarvis and Olusoga (2009) and Moyles (1994; 2010a; 2010b), play pedagogy and practical activities provide a context for exploration, investigation and experimentation which, in their opinion, enhances learning. Van Heerden (2011) found that in South Africa many settings implement an early childhood curriculum that supports play-based and inquiry-based leaning and instruction and some may even include MST activities in the programme.

1.2.1.2 Foundation phase

South Africa's curriculum reform has influenced the teaching of MST at primary and secondary levels of the education system (Bosman, 2006; Botha, Maree & de Witt, 2005; Van Heerden, 2005). The FP is the first phase within the General Education and Training (GET) band, designed for young children between the ages of five and nine years, and includes learners in the reception year (informal learning of five- to six-year-old learners), and primary school grades 1, 2, and 3 (formal learning of learners seven to nine years of age). The main educational focus at FP level is the acquisition of basic educational skills, knowledge and values as prerequisites for further education and training. The eight learning areas, of language, mathematics, science, technology, life orientation, economic and management sciences and arts and culture for the FP, are grouped into three learning programmes, namely:

- literacy
- numeracy
- life skills

The learning area of mathematics forms the core of the numeracy programme, while science and technology learning areas are integrated into all three learning programmes (DoE, 2003). The new vision for the reform-based early MST foundation phase curriculum emphasises problem-solving skills and competencies grounded in inquiry-based education (DoE, 2003; Hoadley, Murray, Drew & Setati, 2010).

In recent years, the results and pass rates of the senior certificate public examinations have shown that South African learners perform poorly in mathematics and science at secondary school level (Howie, Barnes, Cronje, Herman, Mapile &

Hattingh, 2003). The poor performance may be seen as an indication of the foundational problems and challenges of MST education at the earlier foundation and primary stage. The groundings in MST education at that level are likely to determine their future performance as they move up the educational ladder. For example, the Systemic Evaluation conducted by the Department of Education in 2007 indicated that the achievement and performance of the learners (Grade 3) in Literacy and Numeracy was unacceptably low (DoE, 2008). The report indicated a need to have a better understanding than hitherto of factors that mediate teachers' practice, particularly that of new teachers, in the context of implementing the new reform-based early MST curriculum (Jansen, 2003; Jita & Vandeyar, 2006; Onwu, 2008). It may very well be asked to what extent teacher education programmes currently on offer in different higher education institutions are in sync with the demands of the new FP curriculum, particularly in the area of MST education.

Within the last decade several authors (Clements, 2001; Fuson, Grandau & Sugiyama, 2001, Saracho & Spodek, 2009) have advocated the benefits to children of early exposure to mathematics and science. Saracho and Spodek (2009), for instance, refer to the increasing awareness of the importance of mathematics (Anderson, Anderson & Thauberger, 2008; Cross *et al*., 2009) and science (Gillard, 2008; Martin, 2003) to society and to children's development. For young learners, proper groundings in early mathematics and science are necessary in helping them to more easily comprehend the more complex and sophisticated mathematics and science concepts that they will encounter at a later stage. This recognition has led to increased interest in, and attention to, inquiry-based mathematics and science teaching and learning for young children (Saracho & Spodek, 2009; Cross *et al*., 2009; Gillard, 2008; Martin, 2003).

In South Africa, however, for many teacher educators, implementing the new inquiry-based foundation phase MST curriculum has highlighted the fact that inquiry-based education demands of the teacher skills that differ considerably from 'traditional' teaching (Hoadley *et al.,* 2010). Given that beginning FP teachers often find it difficult to teach early science and technology, studies by Bosman (2006) and Van Heerden (2005) have revealed that they invariably enter a period of uncertainty and doubt about the place of science and technology at the FP level. In addition, Furtak

(2006:64) has noted elsewhere that 'it may not be sufficient for teachers to have acquired the skills of inquiry; without the beliefs, the skills fall short of full implementation', therefore teachers need to be convinced of inquiry-based education efficacy.

According to Akerson, Buzzelli and Eastwood (2010), without this belief or conviction for the inclusion of science and technology in the curriculum, they neglect or avoid teaching those two learning areas as much as possible. The integration of science and technology into all three learning programmes is likely to present additional challenges to the FP beginning teacher in implementing the new curriculum because of curriculum constraints. The lack of clear curriculum guidelines on science and technology subject matter integration poses a challenge to many teachers as to how to implement the integration in practice (Hoadley *et al.,* 2010). Although an integrated curriculum approach is not new for FP teachers, the learning area boundaries and knowledge of science and technology (Bosman, 2006; Van Heerden, 2005) are unclear and not well defined and therefore further influence the integration of MST teaching.

Hence, for the beginning teacher, learning to become an effective inquiry-based MST teacher at FP level without proper grounding is not anticipated to be a particularly simple and easy process. Lack of expertise and confidence in teaching MST could negatively impact on the formation of professional teacher identity. The solution apparently lies in equipping student teachers in early MST with sound pedagogical content knowledge in these specific learning areas during their initial teacher education programme (Fleer & Hardy, 2001; Ginsburg & Ertle, 2008).

1.2.2 TEACHER EDUCATION PROGRAMMES

A variety of studies (Cherubini, 2009; Davies, 2008; Green *et al*., 2011) have demonstrated that good teaching brings about valuable change, such as better teaching and learning in language, mathematics and science, in early school education. Becoming a 'good' teacher is a process that starts with initial teacher education and is likely to progress throughout a teacher's career. A well-designed teacher education programme is assumed to prepare teachers who will respond to challenges and are able to adjust to changing and hitherto unforeseen situations.

Green (2008:2) argues that South African teacher education programmes 'should encourage teachers to adopt, from the beginning of their training, a critical reflective stance towards their classroom practice and their development as pedagogues. Such teachers may be described as reform-minded teachers with a well-developed professional teacher identity. These teachers are deemed to be confident and able to teach subject matter and content effectively, even under challenging and changing circumstances (Green, 2008; Onwu, 2008; Walkington, 2005).

Researchers (Anderson *et al*., 2008; Fleer & Hardy, 2001) have described reform-minded teachers as well-trained, positive teachers who try to develop creative thinking and inquisitive minds. There is a strong case, therefore, to be made for the training and development of reform-minded teachers who can teach effectively and are willing to take risks (De Kock & Slabbert, 2008). Such teachers will be able to accommodate and successfully respond to change and curriculum reform (Day, 2002; Day, 2008; Forde *et al.,* 2006; Vaillant, 2007).

In the last decade or so there have been thoughtful and exhaustive debates about achieving the academic and pedagogical objectives of teacher education programmes. For example, Korthagen, Loughran and Russell (2006:1022) call for a 'new effective pedagogy' to reform teacher education and they point out that the 'complex methodological issues' such as the theory and methodology underpinning teacher education programmes need attention.

With regard to MST teaching, Saracho and Spodek (2008a; 2008b) advocate the importance of pre-service teacher education programmes that provide experiences that can improve early school teachers' MST knowledge. More important, Davis and Higdon (2008) and Korthagen *et al*. (2006) argue that student teachers need opportunities during practice teaching to develop and expand their professional knowledge. In this way, they learn to link theory and practical experiences (Cooper & Alvarado, 2006) as they construct their own understandings of MST teaching and learning through critical reflection on their learnt MST knowledge base and their current classroom practice.

Lunenburg and Korthagen (2009) explain that it is difficult for beginning teachers to apply the theory that they acquire during their professional preparation to classroom practice. Therefore, student teachers need opportunities during their teacher education programme to develop and expand their professional knowledge and to apply the theory that they acquired. In their study, Flores and Day (2006:224) found that the 'gap between theory and practice was a recurring theme'. According to Lunenburg and Korthagen (2009), practice theory can be addressed through:

- School-based teacher education to bridge the gap between theory and practice.
- Reflective practice as an important tool to make the connections between practice and theory.
- Research projects that will develop critical thinking and deeper learning practices.

Studies in South Africa (Botha, 2004) and abroad (Bransford *et al*., 2005a) identify the following main components for the Bachelor of Education Degree (B.Ed) Early Childhood and Foundation Phase programme:

- Phase-specific content and pedagogic knowledge (ECP and FP);
- Integrated teaching and learning theories; and
- Practical application of pedagogical theory in the classroom (school-based practical learning).

In South Africa, reform after 1994 had implications for teacher education. For example, the Department of Education wanted to improve the quality and status of FP teacher education programmes and therefore changed the qualification to a four-year degree course offered only by universities (Green *et al*., 2011). According to the Council on Higher Education (2010:69), the aims for the B.Ed. FP qualification are to:

- Integrate the academic components of the programme with work-based learning, i.e. school-based teaching practice.
- Develop student teachers as reflective practitioners, i.e. enable them to see the coherence between theories of teaching and their practice.
- Develop professional competence. For example, teacher education programmes should make provision for teaching and learning theories,

professional and educational studies and FP specialisation modules that include FP pedagogy and knowledge.

In South Africa very little research has been done at FP level on the value and practical implementation of the FP specialisation components of teacher education programmes (Botha, 2004; Green *et al*., 2011). This disparity in teacher education at the early primary level is also relevant to other countries (Fullan & Stiegelbauer, 2000; Hallinan & Khmelkov, 2001; Hammerness *et al*., 2005). For this reason, this study focused on how beginning teachers that have completed their teacher education programme sustain or change their professional teacher identity in the teaching of early MST.

The teacher education programme to which the six beginning teachers were exposed, prepared them for becoming reflective teachers with their own philosophy of teaching. Furthermore, they acquired theoretical and practical MST content and pedagogical knowledge as well as curriculum knowledge through school-based practical learning and a fourth year research project.

The B.Ed Early Childhood and Foundation Phase programme consists of the following MST modules:

- Two modules for mathematics pedagogical knowledge (one in early numeracy and one in numeracy);
- One module in basic mathematical content knowledge;
- One module in technology pedagogical content knowledge, and
- One module in science pedagogical content knowledge.

These specific MST modules aim to develop in the pre-service teachers a deeper understanding of inquiry-based teaching and learning at FP and early childhood level. The programme further aims to develop deep reflective thinking through a fourth-year research project during their 18-week internship period. In this teacher education programme, student teachers are encouraged to construct their own philosophy of teaching (practice theory).

During their research project the student teachers employ a teaching philosophy to interrogate and perhaps change their practice. They have to plan lessons and

teaching strategies based on the teaching philosophy. After implementing the lesson they have to reflect consciously on their teaching activities and explain in written narratives how they will modify and change their pedagogical practices and teaching techniques if need be. The research project and reflective practices are integrated with their practical experiences during the internship period. The philosophy that underpins this programme is aimed at preparing beginning teachers to gain insight into and to understand their practice and to employ innovative and reform-minded ideas that may lead to changes in their teaching practice.

1.2.3 THE BEGINNING TEACHER AND PROFESSIONAL IDENTITY FORMATION

Most first-year teachers are idealistic and positive about their entry into the profession; they enter the new teaching situation with personal histories, attitudes, beliefs and indeed a sense of a variety of roles they feel that they have to play as teachers (Billet, 2008; Cherubini, 2009; Day & Gu, 2010). This sense of teacher identity has largely been shaped by previous and current history or experiences (Cieslik, 2006; Day, 2002; Day, 2008; Day *et al*., 2006; Hamman *et al*., 2010; Sachs, 2001). According to Stanulis, Little and Wibbens (2012), the first years of teaching are an important stage in a teacher's working life because they implement and refine the knowledge and skills they acquired from their initial teacher education programme. The success they experience at the beginning stage of their career is said to have an impact on the quality of their practice (Stanulis *et al*., 2012) and willingness to stay in the profession (Rizza, 2011, Samuel, 2008). Central to the process of learning is the process of constructing knowledge through practice (Billet, 2007; Smith, 2007). Billet (2007) explains that professional teacher identity is formed and implemented through learning activities within their working environment.

Hamman *et al*. (2010) maintain that the school context of beginning teachers can present a background for understanding professional identity formation. Current studies involving beginning teacher socialisation into the school culture (Cherubini, 2009) asserts that the dynamics of school context may challenge their teacher identity development. When teachers enter the new teaching environment, they often feel pressured to conform to the specific requirements of a school's culture (Day & Gu, 2010; Parkison, 2008; Whitelaw, 2007). According to recent studies (Cherian & Daniel, 2008; Parkison, 2008; Whitelaw, 2007), this institutional pressure and

conflicting emotions sometimes isolate the beginning teacher from the broader landscape of the school's social setting, which in turn may prevent them from developing a positive professional teacher identity. These emotional conflicts, feelings of a lack of professional realisation of expectations and coping difficulties are related to the pressure to conform to the school's culture (Alves, 2001). Day and Gu (2010) are of the opinion that the school environment and culture can develop or diminish beginning teachers' willingness to unveil and establish their professional teacher identity. For example when unexpected events occur these experiences cause teachers' to move backwards and forwards trying to make sense of the anticipated or totally unexpected events that occur during the first year of teaching.

According to Fantilli and McDougall (2009) as well as Rizza (2011), the initial teaching experience of the beginning teacher can be positive or negative depending on the nature of mediating influences that are internal and/or external to the teacher. These positive or negative events may cause teachers to become uncertain. Avalos (2011) for example identifies factors such as the teaching environment, curriculum demands and the feeling of isolation, among others that can influence their practice. The upshot is that teacher professional identity can be influenced and affected by personal, professional and social factors.

Many of the studies that have been carried out on teacher professional identity have emphasised the 'personal' and tend to underestimate the contextual side that plays a crucial role in identity formation (Coldron & Smith, 1999; Dymoke & Harrison, 2006; Flores & Day, 2006; Forde *et al.*, 2006; Whitelaw, 2007). The teacher's workplace, as noted by Reynolds (1996) and Samuel (2008), is clearly a landscape which can be very persuasive, very demanding and in most cases very restrictive and constrained. Indeed, various researchers (e.g. Beijaard, Meijer, & Verloop, 2004; Day & Gu, 2010; Flores & Day, 2006; Whitelaw, 2007) have investigated how the social setting is likely to affect a person's professional identity as a teacher. However, hardly any reported studies have highlighted the interaction, if any, between beginning teachers' personal histories in MST education and the contextual influence of school and classroom practice in the implementation of the MST curriculum at early childhood and foundation phase level.

This study therefore sought to address the question of whether the as yet unspecified 'core' professional teacher identity, if any, that beginning teachers might have acquired through their teacher education programme is sustained, changed or adapted when they are faced with the reality of their school and classroom situation. In this study, the school context within which beginning teachers teach was explored as a factor that might or might not influence the formation of their professional teacher identity.

1.3 THE PROBLEM OF THIS STUDY

In South Africa, as in other countries, many early childhood and FP teachers feel negative, anxious and inadequate in teaching early MST (Bosman, 2006; Eshach & Fried, 2005; Ginsburg & Ertle, 2008; Scherer, 2004; Van Heerden, 2005; Young & Elliot, 2004). Various studies (Botha *et al*., 2005; Ginsburg & Ertle, 2008; Perry & Dockett, 2007) on mathematics in early childhood settings have established that not all teachers include mathematics in their planning. In order to feel confident enough to teach mathematics, teachers need to understand the specific nature of the subject matter and the implications it has for pedagogy (Cross *et al*., 2009; Ginsburg & Ertle, 2008).

With the implementation of the National Curriculum, many South African teachers had to adapt to a whole new range of teaching strategies and roles (DoE, 1998, 2000, 2003; Wilson-Thompson, 2005) to effectively implement it. For example the new curriculum emphasises the integration of eight different learning areas into learner-centred, inquiry-based teaching and learning activities. The recommended teaching approach was sometimes difficult and problematic to implement in the classroom (Howie *et al*., 2003; Maree & Erasmus, 2006; Reddy, 2006; Wilson-Thompson, 2005) as little support within the inquiry-based approach was provided and the National Curriculum lacked adequate specification of content knowledge in the eight learning areas (Hoadley *et al.,* 2010).

Furthermore, the implementation of the National Curriculum has led to some uncertainty about how much science and technology should be included in the foundation phase where the time allocation is said to be insufficient for inquiry-based learning (Bosman, 2006; Van Heerden, 2005). Teachers often find it difficult to teach

science and technology in the FP classroom and tend to neglect those subjects (Bosman, 2006; Van Heerden, 2005), because they are uncertain about the place of science and technology activities in the classroom. In addition, anecdotal evidence suggests that technology is a new and sometimes unknown learning area for many teachers and so they neglect teaching it at this level. They are essentially not equipped with the pedagogic knowledge and content knowledge to teach it. Therefore professional teacher identity formation is influenced or not by the curriculum.

The lack of adequate time and space allocated for exploration and investigation during learner-centred activities has had a negative impact on the teaching and learning of MST in South Africa and has led to worksheet-dominated classrooms (Bosman, 2006; Botha *et al*., 2005; Van Heerden, 2005). The use of workbooks and worksheets in early learning (3-8 years) is strongly contested by Carruthers and Worthington (2006), Fisher (1996) and Pound (1998), as they feel that worksheets limit and hinder what young children experience, know and understand about early mathematics. Alexander (2000) found that early mathematics teaching in many countries is influenced by worksheets and workbooks. In South Africa, Schäfer (2011:174) found that teachers in Grade R use worksheets and lessons 'uncritically, without questioning whether they are appropriate for their own context'. Pedagogical approaches where worksheets and workbooks dominate are fundamentally different from inquiry-based pedagogy. The question is what happens in the school context if student teachers are educated in inquiry-based pedagogy.

Egan (2004) shows that beginning teachers sometimes have to work within intrinsic constraints in order to establish their professional teacher identity within their classrooms and often feel obliged to conform to the specific requirements of a school culture. Beginning teachers who do not conform to the specific school culture may be isolated from the school community and this situation may prevent them from developing or maintaining a positive professional teacher identity (Parkison, 2008; Whitelaw, 2007). In this regard Samuel (2008:10) refers to the 'wash-out effect of initial professional teacher education'. He explains that in South Africa beginning teachers are likely to 'face a brick wall of resistance' in the school when more experienced teachers insist that beginning teachers should 'abandon what you have learnt at university' (p10). So the question is: if the beginning teacher has been

trained to use a particular pedagogy such as inquiry-based training, how are any such classroom dilemmas resolved? Is the learnt professional teacher identity, retained or discarded?

The question then is how school culture affects beginning teachers' MST classroom practice in the context of teacher identity formation. With regard to the influence of school culture on professional teacher identity, Flores and Day (2006:221) and Whitelaw (2007) found that the school culture had a strong 'influence on the process of becoming a teacher'. Therefore, it is argued that the teacher education programme should prepare beginning teachers 'to deal with the complex and demanding nature of their daily job in schools and in classrooms' (Flores & Day, 2006:231). But what happens in practice during the first year of teaching? To what extent have their teacher education programme, personal histories and the context of the school been instrumental in professional teacher identity formation? This study seeks to address such questions.

From the discussion it seems that professional teacher identity is influenced by a variety of factors that are both internal and external to the beginning teacher. This study therefore sought to investigates how the identified factors, facilitate, undermine or complicate the identity formation or otherwise of teachers in the first year of teaching.

Problem statement

The problem of this study was to determine how first-year beginning teachers develop and sustain, if at all, their professional teacher identity in the context of teaching early MST and to identify the internal and external factors that influence this process.

1.3.1 RESEARCH QUESTIONS

The main research question was derived from the problem statement.

> *How do beginning first year early childhood and FP teachers form, sustain or change their professional teacher identity in the teaching of mathematics, science and technology in the early years and in different school settings?*

The sub-questions derived from the main question are:

1. What internal and external factors, if any, influence beginning teachers' professional teacher identity formation in the context of teaching MST?
2. How do the identified factors, if any, affect their professional teacher identity formation in the teaching of MST in different school settings?
3. Why do these teachers sustain, change or adapt their professional teacher identity?

1.4 SIGNIFICANCE OF THE STUDY

At the beginning of this study it became clear that although mathematics and science are seen as important in the teaching and learning at FP and early childhood levels, not many studies in South Africa have focused on MST teaching and learning at these levels. Researchers from South Africa, Australia and America have indicated a need for research on MST in the early years (Botha *et al*., 2005; Maree & Erasmus, 2006; Perry & Dockett, 2007; Saracho & Spodek, 2008a; 2008b). For example, Ginsburg and Golbeck (2004:197) contend that '... we know little about what actually happens when teachers teach mathematics and science to young children' and therefore it is important to investigate and understand the factors that affect the complex nature of teaching mathematics and science in the early years. Ginsburg and Golbeck (2004:197) further recommend that there is a need to know what teachers understand about the nature of mathematics and science learning and thinking, what teachers understand about mathematics and science content an pedagogical knowledge and how teachers' own feelings about mathematics and science influence their teaching.

This study is significant because it focuses on beginning teachers' practices in MST teaching at the FP and early childhood levels. This study furthermore explores the teaching of early MST in different learning environments (FP and early learning settings).

In the literature review it is evident that the first year of teaching is a critical stage in a teacher's working life. Cherubini (2009:219) for instance identified three major professional identity themes in the literature over the past three decades on the teachers' transition from student teacher to beginning teacher. The themes include,

in that order, ‘teachers' perceptions of self; professional sustainability; and ‘emerging identity during the process of their socialisation into school culture’. However, hardly any research on early childhood and FP beginning teachers’ professional identity formation has been done in the South African context. There is a void in the voice of South African first year teachers at this level. This study addresses some aspects and therefore hopes to fill the void on professional teacher identity formation in the South African school context.

It is said and indeed assumed that the development of a teacher’s professional identity starts during the initial teacher education programme. However, Flores and Day (2006:224) in their study found that the pre-service programme ‘had a relatively weak impact upon the way in which new teacher approach teaching’. Conversely, Green (2008:2) insists that teacher education programmes ought to be an important professional learning opportunity for identity development and ‘should reflect the pedagogical and professional needs of teachers’. Likewise, in South Africa, Whitelaw (2007) recommends that an initial teacher education programme should prepare teachers for the diverse school culture they are bound to experience. However, Samuel (2008:10) argues that beginning teachers face a ‘wash-out effect of initial professional teacher education’, meaning that they may not be able to apply the skills acquired through their teacher education programme. The reality is that beginning teachers sometimes have to work within intrinsic constraints in order to establish their professional teacher identity and to employ their acquired pedagogical and content knowledge and expertise within their classrooms (Egan, 2004; Flores & Day, 2006; Rizza, 2011; Whitelaw, 2007). This study is therefore significant because it gives some insight into six beginning teachers’ learnt MST identities and the impact of the initial teacher education programme and school culture on their identity formation process.

The study is also considered significant because its findings could provide a deeper insight into how the professional teacher identity of beginning teachers acquired during the B.Ed. early childhood and foundation phase programme at a specific institution in South Africa is sustained, changed or adapted during their first year of teaching in different school contexts. This may provide some information for strengthening teacher education programmes and to better prepare beginning teachers to cope with diverse school contexts and classrooms (Cooper & Alvarado,

2006) and to stay positive and idealistic (Stanulis *et al*., 2012) and to remain in the profession (Rizza, 2011; Samuel, 2008).

1.5 PURPOSE OF THE STUDY

The purpose of this study was to identify what factors affect professional teacher identity development and how they affect the formation process as well as to provide an identity profile of six beginning teachers in the context of MST teaching at foundation phase and early childhood phase level. The voices and practices of these beginning teachers provide some insight into the process of professional teacher identity formation and its sustainability or otherwise in different school settings.

More specifically, this study aimed to:

- Explore how beginning first-year early childhood and FP teachers form, sustain or change their professional teacher identity in the teaching of MST in the early years and in different school settings.
- Identify and gain insight into which factors (internal and external), if any, influence beginning teachers' professional teacher identity formation in the context of teaching MST.
- Gain insight into how the identified factors, if any, affect their teacher professional identity formation in the teaching of MST in different school settings.
- Explore why these teachers sustain, change or adapt their professional teacher identity.

1.6 CLARIFICATION OF CORE CONCEPTS AND TERMINOLOGIES

To ensure a clear and common understanding the following concepts and terminologies are clarified for application in the context of this study.

1.6.1 PROFESSIONAL TEACHER IDENTITY

Professional teacher identity can be defined as teachers' view of themselves as teachers, but also as their knowledge, beliefs and attitudes towards a given subject

and how it is taught in a given classroom context (Flores & Day, 2006; Fleer, 2011; Samuel, 2008).

1.6.2 PROFESSIONAL TEACHER IDENTITY FORMATION

Professional teacher identity formation is an ongoing process of becoming and being a teacher (Beijaard *et al*., 2004; MacGregor, 2009). In other words, it describes how one grows to be a teacher (Flores & Day, 2006). Professional teacher identity is socially constructed and it is a self-motivated, intellectual and emotional process (Day, 2002; Day, 2008; Day, Kington, Stobart & Sammons, 2006).

1.6.3 REFORM-MINDED TEACHER

Reform-minded teachers are defined as teachers with sufficient content and pedagogical knowledge (early MST in the context of this study) to enable them to make informed decisions, to construct their own philosophy about teaching and learning and to become the nucleus of reform in their classroom and professional setting (Egan, 2004; Parkison, 2008; Whitelaw, 2007).

1.6.4 EARLY CHILDHOOD PHASE

Early childhood phase (ECP) in this study refers to children between the ages of three and five years that attend an educational setting outside the home or formal school. The reception year (Grade R), which precedes Grade 1 and caters for five-year-old children, can also be placed in an early childhood setting.

1.6.5 FOUNDATION PHASE

The foundation phase (FP) is the first phase within the General Education and Training (GET) band, designed for young children between the ages of five and nine years, and includes learners in the reception year (informal learning of five- to six-year-old learners), and the primary school grades 1, 2, and 3 (formal learning of learners seven to nine years of age) (DoE, 2003).

1.6.6 INQUIRY-BASED APPROACH

An inquiry-based approach to early MST teaching implies learning through investigation, discovery and inquiry. An inquiry-based approach uses resources that will represent hands-on inquiry teaching and learning. The MST curriculum includes natural phenomena in MST that relate to children's everyday life (DoE, 2003; Hoadley, Murray, Drew & Setati, 2010).

Inquiry-based teaching is a pedagogical approach that allows children to explore, investigate, discover and answer questions (Bruner, 1961, 1999). The role of the teacher in an inquiry-based classroom is to guide exploration, discovery and investigation. Inquiry-based learning further implies different learning experiences and opportunities that are open-ended and will stimulate curiosity (Healey & Roberts, 2004). Inquiry-based teaching and learning allows the development of abilities such as MST knowledge creation and problem-solving and creative thinking skills.

1.6.7 BELIEFS

Teachers' belief systems influence the quality of their learning and teaching (Brownlee & Berthelsen, 2006; Egan, 2004) because individuals' beliefs influence their behaviour (Pajares, 1992). This means that student teachers come into teacher education programmes with a set of beliefs about teaching and how children learn, stemming from their own educational experiences (Pajares, 1992; Thomson, 1992).

Researchers and theorists such as Pajares (1992) and Thomson (1992) have contributed to defining the nature of beliefs. According to them, teachers' beliefs are formed and sustained against inconsistencies and entrenched beliefs that are integrated into a belief system and are difficult to change. On the other hand, newly acquired beliefs are more susceptible to change. Hammerness *et al*. (2005:384) contend: 'Teachers naturally bring their own cultural values, beliefs and understanding to their work with children.'

Teachers develop belief systems about how children learn through the study of learning theories, critical reflection and personal experience (Lundeen, 2004; MacNaughton & Williams, 2004). This leads to the development of teaching choices

that may or may not result in excellence in teaching (MacNaughton & Williams, 2004).

1.6.8 CRITICAL REFLECTION

Reflection is used in teacher education and educational research in several ways. The idea that reflection is an intentional, natural process for the practice of teaching is not a new thought (Schön, 1983; Van Manen, 2007). Dewey (1933: 1) defined reflection as the 'active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends'. Natural reflections occur regularly in teachers' daily lives as they encounter new or challenging situations that require careful thought and judgement (Kelchtermans & Ballet, 2002). Critical reflection can therefore be used in different ways to produce narratives based on the recall of MST classroom experiences and teaching activities. In this study, critical reflection provided beginning teachers with opportunities to reflect on their experiences at schools and to assist them to explain their professional learning within the context of their experiences (Davies, 2008; Rodgers & Scott, 2008; Rots *et al*., 2012).

1.7 CHAPTER OUTLINE

The layout of the study is as follows:

CHAPTER ONE

Provides an orientation and framework for the study; it introduces the reader to the study by providing a brief background to the research problem and a statement of the problem. The chapter includes the significance and purpose of the study.

CHAPTER TWO

Offers a review of relevant literature, which focuses on the research questions. It includes a brief introduction to the contextual background of teacher training in South Africa and further reviews what the literature says about the role of teacher education programmes in the formation of teacher identity. This chapter also explores the teaching and learning of early MST. It concludes with a description of a learning

identity framework as a conceptual framework for the development of the research instrument and data analysis.

CHAPTER THREE

Provides a description of the research methodology employed and justification for the choice of a qualitative phenomenological research approach used to address the research questions.

CHAPTER FOUR

Presents the results of the study. The results are presented in six cases describing each individual beginning teacher's professional identity in the context of teaching MST in different school contexts.

CHAPTER FIVE

Presents the discussion of results and its major findings.

CHAPTER SIX

Gives the conclusions and recommendations of the study including final suggestions for further research.

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CHAPTER TWO
LITERATURE REVIEW

> 'People can engage in learning yet feel that it is peripheral to what really matters in their lives. Alternatively they can value learning as an integral part of their lives and see it as central to who they are.' – Christopher Day and Qing Gu (2010)

2.1 INTRODUCTION

Chapter Two reviews the literature on teachers' professional identity formation at the early stages of teaching. The literature review focuses on how beginning teachers become teachers and the role of the teacher education programme in the professional identity formation process. The review further includes MST teaching and learning at early childhood and foundation phase level. To conclude this literature review section, the conceptual framework of this study is also discussed.

2.2 PROFESSIONALTEACHER IDENTITY FORMATION

This study is about the professional teacher identity of beginning teachers. It examines how they become teachers, how they develop their professional teacher identity and what they experience during their first year of teaching. In this study, professional teacher identity formation is viewed as a dynamic, versatile and active learning process that does not occur in isolation (Vandebroeck, 1999). This means that the personal, the professional and the contextual aspects of learning to teach are important during the formation of a professional teacher identity.

In recent years, researchers have conceptualised professional teacher identity formation as an ongoing process of integrating the personal and professional sides of becoming and being a teacher (Beijaard *et al*., 2004; MacGregor, 2009). It is also said that the institutions of higher learning where teachers are educated and trained have the responsibility of instilling in the latter a sense of relevance of their own

uniquely constructed possible professional teacher identity (Day, 2008; Smith, 2007; Søreide, 2006).

Many studies (Beijaard *et al*., 2004; Day & Gu, 2010; Flores & Day, 2006; Reynolds, 1996, Whitelaw, 2007) argue that identity is socially constructed and can be affected by individual knowledge, beliefs, school context and classroom practice, amongst others. For Day and Gu (2010), the formation of teacher identity is a self-motivated, intellectual and emotional process; in other words, how teachers see themselves as teachers determines their personal and professional actions and classroom practice (Day, 2002; Day, 2008; Day *et al.*, 2006). Beginning teachers' actions in the classroom may be affected by factors that are both external and internal to who they are as teachers (Day *et al*., 2006; Flores & Day, 2006). Examples include the knowledge and beliefs they have about teaching, and their school context.

Watson (2006) and Søreide (2006) describe teacher identity as context-dependent. This is why Samuel (2008:9) asserts that the 'identity of teachers is a kaleidoscope of many permutations' and that teachers' identity is disclosed through their classroom practice and the way they cope with different teaching situations. For this reason, it is assumed that for the beginning teacher the process of becoming a teacher involves continuous self-evaluation, negotiation, compromise and acting in different ways to create themselves as teachers in implementing a particular curriculum (Blumer, 1969; Cohen, 2008; Day, 2008; Egan, 2004; Forde *et al*., 2006; Rots, Kelchtermans & Aelterman, 2012).

In the teacher identity discourse, it is increasingly acknowledged that teachers' professional identity is a socially constructed (Beijaard *et al*., 2004; Flores & Day, 2006; Whitelaw, 2007), context-dependent (Søreide, 2006; Watson, 2006), self-motivated intellectual and emotional process (Day & Gu, 2010). It is further argued that a well-established professional identity can enrich teachers' knowledge, behaviour, beliefs and development (Pinnegar, 2005). The researcher therefore takes the theoretical stance that the personal, professional and contextual aspects of learning to teach are important during professional teacher identity formation. In the light of the above theoretical position the researcher adopted the ideas of Sfard and Prusak (2005) that teachers can change who they are and that teacher identity can

be created and recreated in interactions with other people and situations. The researcher therefore further accepts that professional teacher identity is a continuous learning process. Furthermore, the researcher accepts the notion that professional teacher identity is shaped and continuously developed by extrinsic and intrinsic influences both within and outside the school as workplace. In this study, the nature of the teachers' identity is portrayed and revealed through the narrative of the six beginning teachers. Their schools are socially and culturally constructed contexts and places that provide specific histories, experiences and knowledge that can shape their identity portraits and stories (Sloan, 2006).

In a study in South Africa, Smit and Fritz (2008) observed that the school context together with personal and professional aspects had a noticeable influence on the formation of teacher professional identity. They then suggested that more research was needed on how teacher identity formation impacts on classroom practice in various contexts. From the literature it is evident that a variety of internal and external factors (Day *et al*., 2006; Flores & Day, 2006) can and do contribute to the formation of professional teacher identity. This study therefore focused on factors that contributed to the professional teacher identity formation of beginning teachers in MST teaching.

2.3 TEACHER EDUCATION PROGRAMMES

The literature indicates that teacher education programmes play an important role in the formation of professional teacher identity (MacGregor, 2009; Walkington, 2005). Teacher education programmes provide beginning teachers with knowledge about teaching and can develop a strong professional teacher identity in them, creating committed teachers who can make a difference within their communities (Hammerness, *et al*., 2005). This is important because as Korthagen (2004) says, the experiences that beginning teachers may have had during their initial teacher education programme can lead them to a better understanding of themselves as teachers.

The quality of FP teacher education programmes in particular continues to be a concern in South Africa. The poor historical record of this sector of the education system, particularly in respect of the comparatively few African candidates who opt

for a teaching career in early childhood education and the foundation phase, has been of national concern (CHE, 2010; DoE 2003; Green *et al.,* 2011). As a result the South African department of higher education and training launched research projects at different South African universities to assist in the strengthening of FP teacher education programmes (DoE, 2011). According to Green *et al*. (2011), strengthening FP teacher education programmes is important and necessary to improve FP classroom teaching and learning.

In South Africa, education and training at all levels are in a state of continuous change and adaptation because of the new political dispensation and the need for education to be seen as relevant to society. The debate about relevant education in a changing world is a global phenomenon (Day & Gu, 2010; Fullan & Stiegelbauer, 2000; Manley-Casimir, 2001). Schools and teachers are viewed as the conduit for relevant change in society and therefore, teachers need to be adequately prepared to play their part in effecting this change (Bransford *et al*., 2005a).

It is important to note that in 1994 the first democratically elected government of South Africa transformed education by developing and instituting an OBE approach (Mothata, 2000). This reform had implications for teacher education. For example, the Department of Education wanted to improve the quality and status of foundation phase teacher education programmes and therefore changed the qualification to a four-year degree course offered only by universities (Green *et al*., 2011). In 2005-2006 a national review of FP programmes at institutes of higher education was conducted; the result of this review was that only five out of ten teacher education programmes were granted full accreditation (CHE, 2010). This contributed to a foundation phase teacher shortage and a debate on the quality issue surrounding this phase. A teacher shortage is a worldwide phenomenon. Attracting teachers to the profession and teacher attrition (Cherian & Daniel, 2008; OECD, 2005; Rizza, 2011; Rots *et al*., 2012) are critical matters that are gaining increasing attention around the world. In South Africa, a big concern is the fact that becoming a FP teacher is regarded as less attractive and that such teachers are not so highly regarded, resulting in a decline in the enrolment of student teachers in the BEd foundation phase programmes (Green *et al.*, 2011).

For teacher education programmes to be successful and to improve teaching and learning at primary school level, Day and Gu (2010), Haberman (2004) as well as Hammerness *et al*. (2005) noted that they should aim at preparing beginning teachers that are committed to the profession and to lifelong learning. This means that they should think differently about teaching and that they should be flexible and able to adapt to diverse and unexpected situations and 'be permitted the possibility of exploring alternative approaches to teaching and learning' (Samuel, 2008:14). For this reason it is important to understand how beginning teachers develop their professional teacher identity through exposure to their teacher education programmes (Billet & Somerville, 2004), to know how they see themselves as professionals (Egan, 2004; Smith, 2007) and how they react when faced with diverse teaching contexts and curriculum implementation (Jita & Vandeyar, 2006; Smit & Fritz, 2008).

Samuel (2008:11) argues that professional teacher identity may 'vary in relation to the quality and the philosophy of the teacher preparation' to which beginning teachers were exposed. Precisely for this reason Davies (2008) and Green (2008) suggest that teacher education programmes should be based on a philosophy that encourages student teachers to take a 'critically reflective stance towards their classroom practice and their development as pedagogues' (Green, 2008:2). In practice this means that such teacher preparation programmes should enable student teachers to form opinions and make informed decisions on the profession they are about to enter.

With regard to initial teacher preparation, Korthagen *et al*. (2006) as well as Lunenberg and Korthagen (2009) indicate that many teacher education programmes focus mainly on pedagogic theory and that not enough opportunity is provided for reflective thinking about teaching and the practical application of theory and pedagogic approaches during teaching practice. Flores and Day (2006) as well as Rots *et al*. (2012) stress the importance of suitable schools placement during teaching practice if student teachers are to have an effective and valuable experience in a situation representing their future workplace. Appropriate placement and a valuable teaching practice experience can help to reduce unnecessary stress when they start teaching at the beginning of their careers. In this regard, Levine

(2002) and Botha (2004) assert that the choice of schools during school-based practice is important because not all schools are suitable role models for quality teaching. To ensure a quality work-based learning experience, the solution seems to be to select effective schools where high-quality teaching takes place and to introduce a system of mentorship and support for student teachers (Botha, 2004; Fullan & Stiegelbauer, 2000; Korthagen & Kessels, 1999; Rots *et al.* 2012) during their teaching practice. In this respect, Billet (2008) points out that teaching proficiency is acquired through a process of active participation and learning. Through this study, the effect of the teacher education programme and the variety of work-based learning experiences of the six beginning teachers give insight into professional teacher identity formation.

Ideally, there should be a strong correlation between the preparation of beginning teachers and their effectiveness in the classroom (Bleicher, 2006; Day, 2008; Kanstoroom, 2000; Levine, 2002; Scott, 2002). Initial FP teacher education programmes should therefore prepare beginning teachers to be confident and effective in their work. Green *et al*. (2011) feel that many teachers in the FP phase are not adequately prepared to teach in FP classrooms. At this point it is important to note that according to Davies (2008:4):

> 'Good pedagogy (excellence in teaching) and good teachers are not considered to be the immediate products of pre-service teacher education but rather the long-term outcome of a process of learning that generally begins with formal teacher education preparation and progresses through many years of experience with many children and many classrooms.'

Student teachers have specific preconceptions and experiences from their personal histories when they start their teacher education programme and these influence their emerging professional teacher identity (Cieslik, 2006; Day, 2002; Day, 2008; Day *et al*., 2006; MacGregor, 2009; Sachs, 2001). Student teachers develop firm beliefs based on knowledge they acquire and these beliefs or convictions may clash with the conditions they find at the schools where they work during their internships (Rots *et al*., 2012). It is thus essential to provide student teachers with opportunities to reflect on their experiences at schools and to assist them to assimilate their findings into their own self-image as teachers within the context of their experiences

(Davies, 2008; Rodgers & Scott, 2008; Rots *et al*., 2012). For Samuel (2009:12) the 'personal lives, experiences and histories' of student teachers are an important force in identity formation and teacher education programmes should address and help them to understand their views and beliefs about teaching. These preconceptions may change or remain the same, depending on how they react to the influence of the teacher education programme.

It is clear that initial teacher education programmes expose student teachers to new knowledge and skills regarding what to teach and how to teach (Wilke, 2004). During the teacher education programme, student teachers develop beliefs about teaching and how children learn (Lundeen, 2004; MacNaughton & Williams, 2004). Brownlee and Berthelsen (2006) and Egan (2004) as well as Stronach, Corbin, McNamara, Stark and Warne (2002), feel that teachers' beliefs influence the quality of their teaching. This then leads to the teaching choices they make (MacNaughton & Williams, 2004). In addition, Hammerness *et al*. (2005:384) state that beginning teachers 'naturally bring their own cultural values, beliefs and understanding' to their classroom practice.

From the literature it is evident that a quality teacher education programme seems to be essential for preparing beginning teachers to respond to and resolve the surprises and tensions (Lunenberg & Korthagen, 2009) they may experience during the first year of teaching early MST. It is therefore important to understand how teachers develop their teaching identity through exposure to their teacher education programmes, since students' teachers construct and reconstruct their professional teacher identity through a specific learning process (Billet & Somerville, 2004). Through this learning process they come to see themselves as professionals (Egan, 2004; Smith, 2007) and they learn how to react when faced with the complex problem of curriculum implementation in their diverse teaching contexts. The question which this study addressed was how, if at all, the teacher education programme at a specific university prepared a group of six beginning teachers for to teaching MST in different school settings. For this reason it is important to examine and discuss beginning teachers' professional identity formation, the characteristics of their professional identity and the role of school context in professional teacher identity formation.

2.4 THE BEGINNING TEACHER

Recent research has shown that the first year of teaching is an important stage in a teacher's career. As beginning teachers make the transition from university into the different school settings, they encounter many new challenges and responsibilities and have to find a professional place within the culture of the school (Cherubini, 2009; Cherian & Daniel, 2008; Whitelaw, 2007). The transition from student teacher to beginning teacher requires new roles and responsibilities. Cherubini (2009:83 & 90) defines beginning teachers' identity formation as a stage of 'emerging identity' where the process of becoming a teacher is sometimes a surprising experience; meaning that they have to reposition themselves from 'student identity to teacher identity' (Joseph & Heading, 2010:75), they have to implement theory into their classroom practice and then connect theory and practice.

Flores and Day (2006) in their multi-perspective study note that most studies of new teachers highlight the sudden and sometimes dramatic experience which accompanies the transition from student teacher to beginning teacher, or as Ryan (1986:8) explains, a 'disenchantment' with the reality of teaching. Researchers such as Day and Gu (2010), Cherubini (2009), Pillen, Beijaard, Den Brok (2009) and Rizza (2011) describe this experience as a reality shock during which new teachers experience conflicting emotions as they take on their roles as school teachers.
Research on professional teacher identity formation of novice teachers and the impact of this transition period on their identity construction is well documented (Cherubini, 2009; Day & Gu, 2010; Rizza, 2011). For some, the conflicts and dilemmas they encounter as beginning teachers arise as a result of disparity between personal beliefs, idealistic expectations and reality on the ground; such as the school and classroom environment (Billet & Somerville, 2004; Day, 2008; Keys, 2007; Parkison, 2008; Rots *et al*., 2012). For others, feelings of isolation and the absence of institutional support (Flores & Day, 2006; Whitelaw, 2007) could trigger negative emotions in the complex process of assuming responsibility as effective teachers. Beginning teachers' emotional conflicts and their need to readjust have been attributed to coping difficulties, related in particular to school cultures and feelings of lack of professional fulfilment and expectations (Alves, 2001). They attempt to resolve their dilemmas by reinterpreting their own values and experiences in light of the 'powerful socializing forces of the school culture' (Day, 1999:59) and beyond the

school environment. Beginning teachers are part of the professional teaching community and they therefore construct their identity as teachers within this community 'as they reflect on experiences, interactions with others and on their knowledge of teaching' (MacGregor, 2009). In this regard Rots *et al*. (2012:9) suggest that teacher education programmes should prepare beginning teachers for **'**the non-technical aspects of teaching, particularly the intense social and emotional challenges associated with learning to teach'. This study explains how the six beginning teachers react to aspects of the school culture, reality shock, and the non-technical aspects of teaching.

The process of becoming a teacher involves the learning and re-learning of content knowledge, skills and techniques (Egan, 2004; Keys, 2007; Onwu, 2008). This may imply that beginning teachers continuously analyse their classroom activities and reflect on their achievements or failures in an effort to fit into the school culture (Flores & Day, 2006).

Nias (1989) found that the majority of beginning teachers have a sense of purpose and are idealistic about the work that they are going to do. They feel that they will have meaningful careers and will be satisfied with the results of their work (Day *et. al.*, 2006; Rippon & Martin, 2006). This illustrates the predicament they may encounter, namely that of idealism for the job versus disappointment in the reality of the job. During this process beginning teachers may encounter an 'intense struggle whereby self-worth and identity are profoundly challenged' (Cherubini, 2009:86). Egan's (2004) work supports this abruptness and other constraints which beginning teachers confront in forming their professional identity. Other researchers (Parkison, 2008; Troman, 2008) also mention the identity crisis and painful beginnings (Huberman, 1989) the novice teachers' experience. They are often compelled to negotiate many different and less than comfortable situations in order to survive. For some beginning teachers, though, the early years in the profession are less negative and less traumatic (Flores & Day, 2006), often because these teachers feel that they are partly successful and that they are making a difference. Therefore, the first year of teaching is often described as a stage of survival, exploration and discovery (Cherian & Daniel, 2008; Cherubini, 2009) which may present positive and negative learning moments.

Cherubini (2009), Day and Gu (2010), Dymoke and Harrison (2006), Kyriacou and Kunc (2007), Rippon and Martin (2006) as well as Rizza (2011) have identified different challenges that first-year beginning teachers may encounter. These challenges relate to curriculum demands such as implementing subject-matter knowledge and making this knowledge teachable, work overload relating to time management constraints, support or lack of support and unexpected experiences in the school culture, for example the hierarchical nature of relationships in schools, just to name a few. In this study the aspects of support or lack of support that the six beginning teacher experienced will be explored.

For beginning teachers to develop, form and sustain positive professional identity entails as Maclure (1993:313) indicated, a 'continuing site of struggle'. Thus professional teacher identity is not necessarily what one has, but as was said earlier something that is continually developing and is used to make sense of one's own values, personal history and experiences.

To be able to be flexible and to adapt to diverse and unexpected situations, beginning teachers need to be creative and innovative (Hammerness *et al*, 2005; Søreide, 2006). During the process of constructing a professional teacher identity it is believed that teachers begin to understand how they 'define themselves, to themselves and to others' (Hamman, Gosselin, Romano & Bunuan, 2010:1350) – in other words, they come to realise what and how to teach and they start to create their vision for the future (Cherubini, 2009).

In this process, beginning teachers often feel pressured to conform to the specific requirements of a school culture. The requirements of a school culture, according to Maslowski (2001:8-9), are 'the basic assumptions, norms and values, and cultural artefacts that are shared by school members'. This pressure, according to recent studies (Day & Gu, 2010; Parkison, 2008; Whitelaw, 2007), sometimes isolates the beginning teachers from the broader landscape of the school social setting, because of their conflicting beliefs about teaching. When beginning teachers are for instance unable to apply the content specific knowledge and pedagogical skills acquired during their studies in the classroom, because of different or conflicting philosophies and practices in their new situation, teaching dilemmas arise. These dilemmas

manifest themselves as a result of emotional conflict between personal beliefs and the reality on the ground (Billet & Somerville, 2004; Day, 2008; Keys, 2007; Parkison, 2008).

Another important factor that may influence a beginning teacher is the school hierarchy or 'veteran-orientated professional culture' (Cherian & Daniel, 2008) where the new teacher has to battle for recognition as a skilled and well-qualified practitioner (Rippon & Martin, 2006). At the start of their careers beginning teachers strive for acceptance within their teaching milieu; they seek affirmation and feel very vulnerable during this crucial period (Billett, 2008; Cherubini, 2009; Rippon & Martin, 2006). It is interesting to see how the six teachers in this study responded to the different school settings. Were their identity profiles similar or different? Could they sustain their developed professional teacher identity? How did they respond to the different experiences and teaching dilemmas they experienced, if any?

How such dilemmas are resolved, would depend largely on the type of relationship between the multi-faceted professional identity and professional characteristics of beginning teachers (Billett, 2008; Gee & Crawford, 1998) and the flexibility or otherwise of the social setting (lisahunter, Rossi, Tinning, Flanagan & Macdonald, 2011; Troman, 2008).

Some schools treat newcomers like outsiders, while others welcome them as established colleagues. Zembylas (2005) refers to this political atmosphere in the school context as an 'emotionally laden power relationship' where the beginning teacher has to contend with the established primary school structures and values (Rippon & Martin, 2006) of the 'political and symbolic frame' of a school (Cherian & Daniel, 2008). Onwu (2008) argues that this phenomenon is a dilemma for the idealistic beginning teacher who may have new ideas and wants to institute them. The impact of this dilemma is filtered through their beliefs and knowledge (Day, 2008; Keys, 2007; Yilmaz-Tuzun, 2008) about early MST teaching and may cause an emotional reaction to the situation.

Beginning teachers, however, are seen to be flexible and able to position themselves within situations at school. When they find themselves within power relation

situations, beginning teachers react emotionally and use emotional rules and support to evaluate these situations (Day, 2008; Reio, 2005; Søreide, 2006; Zembylas, 2005). Identity is also affected by feelings of pride, satisfaction or disappointment, all of which are emotionally laden (Flores & Day, 2006). It is clear that beginning teachers want to construct, maintain and firmly establish a legitimate identity within a valued and authentic situation and context (Onwu, 2008; Parkison 2008). When beginning teachers have established their niche within the school structure, they also feel that they have established a positive teacher identity (Day, 2008; Egan, 2004; Forde *et al*., 2006; Parkison, 2008).

According to Kelchtermans and Ballet (2002) as well as Brunton (2007), beginning teachers need to understand the nature of the 'micro-political' situations that they may encounter during their first year of teaching. They need to be aware of the socio-political structure of the school and how to conduct themselves to retain their positive teacher identity. By implication the teacher education programme should prepare them to be aware of possible situations and to apply strategies to deal with situations such as school hierarchy relationships between the established teachers (Zembylas, 2005).

The situation may become unbearable, forcing the beginning teacher to find creative solutions to the challenge or to leave the school or profession (Cherian & Daniel, 2008*;* Worthy, 2005). One of the most important factors creating favourable conditions for beginning teachers to establish themselves as valued colleagues within the school structure is that of support, both personal and institutional. According to Davis and Higdon (2008) as well as Day (2008), beginning teachers need to be welcomed and supported by more experienced colleagues. Research indicates that support at the beginning of teachers' careers is important in helping them believe that what they are doing is correct and effective (Day, 2008, Day & Gu, 2010; Egan, 2004; Forde et *al*., 2006; Rizza, 2011 Whitelaw, 2007), that they are accepted and valued as knowledgeable teachers who can achieve success and become part of the teaching fraternity, eventually regarding themselves as colleagues (Day, 2008; Rippon & Martin, 2006; Woods, Jeffry & Troman, 1997). According to Cherian & Daniel (2008), collaboration with experienced colleagues and

a school principal who promotes a collaborative school culture are among the most effective modes of support during the first years of teaching.

In reality it seems that beginning teachers often receive no support from their more experienced fellow teachers, as the established teachers are more concerned with their own work and daily routines than with developing collegial relations with newcomers (Rippon & Martin, 2006; Rots *et al.,* 2012; Whitelaw, 2007). Hargreaves (1980), Hammersley (1981), Tickle (2000) as well as Rippon and Martin (2006) also report that a teaching culture where established teachers concentrate on their own work and situations, thus excluding assistance or support for newcomers, is often prevalent in schools. This support or lack of it may influence the beginning teacher positively or negatively. If positive and negative aspects in the workplace influence the professional teacher identity formation of beginning teachers, the question to be asked is to what extent these aspects affect their early MST teaching.

The possibility exists that a lack of support for the positive beginning teacher who has to teach early MST may have a negative effect on the sustainability of the teacher's identity. This study explored the extent to which school support or a lack thereof in early MST influenced the professional teacher identity of beginning teachers.

The knowledge and beliefs about teaching and learning that are determined by beginning teachers' personal histories, the professional educational studies and the school context are perceived, among others, as important constituents of their professional teacher identity formation. Primary and ECP schools in South Africa have a diverse learner body that increasingly demands of beginning teachers to continually adapt their teaching and young children's learning to the different learning environments for effective implementation of the new curriculum. It was therefore important to investigate MST teaching and learning in the FP and early childhood settings.

This study explored the personal biographies of six beginning teachers to ascertain what internal and external factors, if any, affected their teacher professional identity formation in the teaching of MST in different school settings.

When beginning teachers are placed in school settings that differ widely with regard to diversity, context and effectiveness, that may or may not conform to their

expectations and beliefs, these different school contexts might have a profound effect on their idealistic views (Rippon & Martin, 2006; Day & Gu, 2010). The context within which beginning teachers find themselves, and not their attitudes or actions, is often responsible for the identity crises they may experience (Day, 2008; Rippon & Martin, 2006).

Therefore, in the development of a purposeful, authentic, viable view of oneself in this new professional role as beginning teacher, different factors in the new school context including the curriculum to be taught may impact on the already constructed or developed identity (Day & Gu, 2010; Rots *et al.,* 2012; Troman, 2008). These factors may include school culture and institutional support during the first year of teaching.

This study was an attempt to provide some insight into beginning teachers' personal epistemology and curriculum knowledge about early MST teaching.

2.5 MATHEMATICS, SCIENCE AND TECHNOLOGY TEACHING AT EARLY CHILDHOOD AND FOUNDATION PHASE LEVEL

South Africa has adopted an outcomes-based curriculum, with the learning area of mathematics forming the core of the numeracy programme, while the science and technology learning areas are integrated into all three learning programmes (literacy, numeracy and life skills). The term 'learning areas' is used instead of subjects.

The National Curriculum gives broad guidelines on the implementation of an integrated pedagogical approach with emphasis on problem-solving skills and competencies as well as critical and creative thinking grounded in inquiry-based education. This means that MST teaching and learning should be an interesting experience, where children use meaningful hands-on exploration and investigation activities and scientific questions. According to Hoadley *et al. (*2010), the main devices for facilitating integration across MST learning areas are learning programmes, learning outcomes and assessment standards. However, the weakness of an integrated approach is that it is not a coherent curriculum in itself, because MST pedagogical content knowledge may not be clearly defined (Ginsburg & Golbeck, 2004). In this regard Hoadley *et al.* (2010:36) found that in South Africa the

'emphasis is on generic rather on subject-specific' content knowledge and that the 'content and development of concepts and skills' (ibid. 42) are not sufficiently indicated in the curriculum. They further argue that teachers find it difficult to understand and implement an integrated approach because the 'within-subject integration' (ibid. 45) is not clearly explained and in addition the curriculum includes general pedagogical and learning area knowledge.

Worldwide, there is a new interest in the nature and content of early mathematics and science curricula. For Ginsburg and Golbeck (2004:195), the early mathematics curriculum should be 'meaningful' and should 'stress mathematical thinking' and 'the challenge for science education is to decide what the subject matter should be and to develop programs that teach the processes of scientific method'.

Research confirms the importance of early childhood education programmes to provide learning opportunities for effective development and learning (Clasquin-Johnson, 2011; DoE, 2001; Green et *al*., 2011; Krog & Morehouse, 2008; Verhoef, 1991; Weikart, 1991). The results of the High/Scope programme in the USA indicate that children who live in poverty and deprivation can be assisted to achieve success in life by providing effective early education (Schweinhart & Weikart, 1986; Verhoef, 1991). A well-researched example of the benefits that may be derived from early exposure to mathematics and science is the Matal programme.

The Matal programme of the University of Tel Aviv is a kindergarten and primary school programme instituted to support children in mathematics and science thinking and prepare them for later success, and provides a solid foundation in mathematics and science (Tanchel, 1991). Research indicated that children in the Matal programme were better equipped for being successful in mathematics and science than non-participants in the programme. This programme started at early childhood level and was later introduced to the primary and high school phase. The Matal programme not only developed children's thinking processes, but also helped them to apply investigative techniques called 'tools for learning' (Tanchel 1991:356). The success of the Matal programme with young learners strengthens the contention that effective teaching in mathematics and science in the early school years is essential for success in the higher grades.

In this study the six beginning teachers' MST curriculum interpretation and implementation as well as their teaching approaches are investigated. The importance of MST education for young children has created significant interest worldwide. Research indicates that significant early MST learning opportunities for young learners in the formative years can provide a proper grounding in helping them to more easily understand the complex mathematical and scientific concepts they will encounter at a later stage (Fleer & Hardy, 2001; Young-Loveridge, 2008; Wood *et al*., 2009). For this reason, effective MST teaching at FP level is essential for the early acquisition of knowledge, concepts and skills. Despite the fact that the benefits of early exposure to MST have been well documented (Bosman, 2006; Botha *et al*., 2005; Botha & Van Heerden, 2003; Clements, 2001; Copley, 2000; Fuson *et al.*, 2001; Pramling Samuelsson, & Kaga, 2008; Van Heerden, 2005), it is clear that the early MST and learning landscape in South Africa is far from satisfactory (Howie *et al*., 2003; Maree & Erasmus, 2006; Reddy, 2006).

The quality, knowledge and skills levels of MST teachers in the foundation phase in South Africa and in other countries, have been and continue to be a matter of grave concern to both researchers and practitioners in the field (Botha *et al*., 2005; Ginsburg & Ertle, 2008; Green *et al*., 2011). Furthermore, Perry and Dockett (2007) have found that teaching and learning approaches in MST (ECP and FP) leave much to be desired. As indicated earlier research shows that a considerable number of early school teachers feel negative and anxious and lack confidence to teach early science and technology (Bosman, 2006; Gillard, 2008, Martin, 2001, 2003; Young & Elliot, 2004; Van Heerden, 2005). Some researchers (e.g. Beswick, Swabey, & Andrew, 2008; Fleer & Hardy, 2001; Keys, 2007; Watson & De Geest, 2005) have acknowledged that the beliefs of teachers about the nature of mathematics and science and how children learn mathematics and science may influence their practice. Ginsburg and Ertle (2008) as well as Cross *et al*. (2009) advocate instituting appropriate teacher education programmes that can help beginning teachers to overcome their fears and can give them a deeper understanding of MST teaching and learning in the early years.

In South Africa, current research (Bosman, 2006; Wilson-Thompson, 2005; Van Heerden, 2005) on teachers' classroom practice further indicates insufficient initial

teacher education in MST and that many teachers' understanding of MST teaching and learning is still influenced by old curriculum practice. If this is so, it may be possible that beginning teachers that are educated in programmes where the nature and understanding of learning and thinking in early MST are included, can experience serious dilemmas when they are confronted with different school and classroom contexts. This study is concerned with how beginning teachers in the ECP and FP sustain or change their professional teacher identity in the teaching of early MST. Overall, teachers' lack of sufficient pedagogical content knowledge and successful managing strategies, inadequate time allocation and learning space (Cross et *al*., 2009; Smith, 2007) for children to explore and investigate in mathematics and science lessons are said to negatively affect mathematics and science education at the ECP and FP level.

A strong relationship is said to exist between thinking and process skills in regard to teaching MST in the early grades (Bart, Yuzawa & Yuzawa, 2008; Charlesworth & Lind, 2007; Fleer & Hardy, 2001; Gallenstein, 2005; Ohana, 2007). Children in the early years of schooling use integrated content and process skills to construct MST knowledge (Charlesworth & Lind, 2007; Gillard, 2008; Makiya & Rogers, 1992). Therefore, MST activities are often presented as part of an integrated curriculum (Cross *et al.,* 2009). It is important that MST teaching and learning should focus on problem solving, reasoning and inquiry as a process and methodology (Bosman, 2006; Fleer & Hardy, 2001; Gillard, 2008, Gallenstein, 2005; Makiya & Rogers, 1992; Van Heerden, 2005). It is often said (Cantrell, Young & Moore, 2003; Eschach & Fried, 2005; Newton, 2005; Young-Loveridge, 2008) that young children benefit at this level when they are exposed to specific MST concepts, knowledge and terminology; this may result in their maintaining a lifelong interest in MST.

Ginsburg & Golbeck (2004:197) contend that 'we know little about what actually happens when teachers teach mathematics and science to young children', and that it is important to investigate and understand factors that affect the complex nature of teaching mathematics and science in the early years. They recommend that matters such as the nature and understanding of learning and thinking in mathematics and science, as well as how teachers' feelings about these learning areas influence their

teaching, should be investigated. These matters came to the fore in the voices and opinions of the six beginning teachers in this study as they express themselves.

Pedagogic content knowledge, broadly speaking, is knowledge about teaching and teaching strategies in a specific field of specialisation, topic or subject (Grossman, Schoenfeld & Lee, 2005; Smith, 2007; Zeidler, 2002). With regard to the foundation phase, pedagogic content knowledge combines and integrates content and pedagogy in the teaching and learning of MST in the early years.

This study attempted to provide insight into MST teaching and learning in the ECP and FP.

2.5.1 EARLY MATHEMATICS

Because of their individual importance, it is necessary to outline the specific values of each of the learning areas of early mathematics, science and technology.
Saracho and Spodek (2008a; 2008b) refer to an increasing awareness of the importance of mathematics to society and to children's development. This awareness has led to an increased interest in and attention to teaching mathematics to young children. If mathematics forms such an important building block in the development of young children, it is essential that mathematics content and pedagogical knowledge be included in teacher education programmes (Cross *et al*., 2009; Ginsburg & Ertle, 2008). The importance of instructional techniques and strategies (pedagogical knowledge) for advancing children's mathematical thinking should therefore be emphasised (Schmidt, 2004; Stigler & Hiebert, 2004).

Children use problem solving, the core process in mathematics, to build mathematical knowledge. Processes used in solving problems are reasoning, communication, connections and representations (Charlesworth & Lind, 2007; Yelland, Butler, & Diezmann, 1999).

In the National Curriculum, the mathematical learning area's content knowledge is indicated as (DoE, 2003):

- Number, number sense and counting and operations
- Patterns and algebra

- Shape and space
- Measurement
- Data handling

Various studies (Botha *et al*., 2005; Gibson & Ertle, 2008; Perry & Dockett, 2007) on the implementation of mathematics in the early years have established that not all teachers in the early years successfully include mathematics in their planning. Teachers need to understand the specific nature of the subject matter and the implications this has for pedagogy. Botha *et al*. (2005) in South Africa and Munn (2009) in Scotland posit that early childhood teachers often find it difficult to implement and maintain high-quality inquiry-based mathematics teaching within the existing constraints of a lack of belief and confidence.

2.5.2 EARLY SCIENCE

The Timms report and the poor secondary school results give the impression that learners in South Africa (Bosman, 2006) are insufficiently prepared in science to be successful in the modern world. Fleer and Hardy (2001), as well as Bosman (2006) and Gillard (2008) refer to the fact that many primary school teachers often lack confidence in their teaching of science as a subject, because of their pedagogic and content knowledge deficiency. Minger and Simpson (2006:49) state that 'science instruction in the elementary schools continues to be a low priority'. Sufficient reasons have, however, been provided for teachers and researchers to realise that science forms an integral part of preparing young learners for the world in which they live (Gillard, 2008; Martin, 2003). Children are naturally curious about their environment and for this reason science is frequently a part of their exploration, questioning, and experimentation (Botha & Van Heerden, 2003; Fleer, 2011; Martin, 2001; 2003). Recently, Park Rogers (2011:101) found that 'there is a need for providing classroom teachers with practical solutions for incorporating more science into their curriculum by drawing from the resources around them'.

Science education in the foundation phase is a hands-on, inquiry-based learning area and has three basic interrelated components (Bosman, 2006):

- Science content knowledge such as life science, physical science, earth and space science, health science and nutrition;

- Science process skills such as problem solving and inquiry (observing, comparing, classifying, measuring, communicating, inferring, predicting and hypothesising); and
- Scientific values and attitudes.

Because science is so important for the development of young children, it is essential that beginning teachers in the FP know and are able to apply the content knowledge and process skills of early science. However, Appleton (2008) and Gillard (2008) point out that many elementary school teachers have inadequate knowledge of science content knowledge and science pedagogy and that only a few of them are science discipline specialists. Bosman (2006) reports that teachers often lack the knowledge and skills to teach science and that very few teachers at FP level are aware of appropriate methods that can be used to teach the subject. This lack of expertise may affect the development of a positive professional teacher identity.

2.5.3 EARLY TECHNOLOGY

Technology is a new subject in many countries (Fleer & Hardy, 2001; Gibson, 2008; Mawson, 2006) and also in South Africa (Van Heerden, 2005). Because many teachers are unfamiliar with the subject in the early primary phase they are uncertain of how to plan and teach technology (Kimbell *et al*., 1996; Newton, 2005; Van Heerden, 2005). Furthermore, in South Africa Van Heerden (2005) found that teachers discourage student teachers from implementing technology activities during their school-based practice periods. Because many teachers are not familiar with technology as learning area and experience time limitations in their daily planning, they do not allow the implementation of hands-on activities.

Although technology can be linked to mathematics and science, it has certain recognised areas of conceptual knowledge that are unique to the subject, such as information about systems, materials and components. Knowledge of these areas is used in other fields, and similarly technology draws on knowledge from other learning areas (Gibson, 2008). In South Africa, according to the FP curriculum, children in the early years engage in technology activities and projects based on technological skills such as:

- Investigating
- Designing
- Making
- Evaluating

Children need to be flexible and creative when experimenting with materials and designs to identify the problem; they have to think of ways to solve the problem and to experiment with solutions. Working together to solve a problem makes learning more meaningful to learners (Makiya & Rogers, 1992; Newton, 2005) as they discover, apply logical thinking processes, imagine, plan, design and review, and make. Therefore, technology is a hands-on, inquiry-based learning area (Ter-Morshuizen, Thatcher & Thomson, 1997; Van Heerden, 2005).

Problem solving lies at the core of technology and is an exercise in high-level thinking (Makiya & Rogers, 1992; Newton, 2005). Since technology involves practical solutions to problems, it is associated with the knowledge and skills of craft and design and is closely linked to mathematics and science (Botha & Van Heerden, 2003; Tickle, 1990; Van Heerden, 2005; Webster, Campbell & Jane, 2006).

In the context of this study, many student teachers are entering the teacher education programme without any exposure to the learning area of technology at school level (Van Heerden, 2005). These beginning teachers are expected to have mastered all the aspects of technology in order to teach this learning area after completion of their teacher education programme.

This research study is about the formation of beginning teachers' professional teacher identity in early MST teaching and learning. Against this backdrop, there is clearly the need to ask why current teacher preparation programmes are failing to prepare South African foundation phase teachers who are able to and choose to implement the vision for MST education as articulated in the nation's norms and professional standards. In order to address the question, there is need for a better understanding of factors that mediate beginning teachers' identity formation in the context of implementing the new reform-based early MST curriculum knowledge and skills in the early childhood and foundation phases.

2.6 CONCEPTUAL FRAMEWORK

Research on identity, and more specifically professional teacher identity formation and the process of adjustment that beginning teachers experience, has gained prominence in the last decade (Castanheira, Green, Dixon, & Yeagerb, 2007; Onwu, 2008; Reio, 2005; Smit & Fritz, 2008; Smith, 2007; Zembylas, 2005).

To ensure a comprehensive and in-depth approach to professional teacher identity formation and to gain insight into the factors that affect beginning teachers' identity formation and teaching of early MST, it was essential to develop an appropriate conceptual framework. The process of becoming a teacher is a multifaceted and interactive process of learning that develops throughout life. To understand the process of becoming a teacher and how a professional teacher identity is created, sustained or changed, it is necessary to acknowledge the close connection between identity and learning indicated by Billett (2007; 2008) and Billett and Somerville (2004), as well as Collin, Paloniemi, Virtanen and Eteläpelto (2008). Teacher identity has become the focus of numerous studies and theoretical frameworks in teacher education (Cherubini, 2009; Day & Gu, 2010; Trent, 2010). This study has developed and used a learning identity framework to collect and analyse data.

The conceptual framework accommodates and reflects the rich complexity of the process in which the professional teacher identity of beginning teachers is created, sustained or changed.

Although a large amount of research has been done in the field of identity (Billet, 2007; Billett & Somerville, 2004; Castanheira *et al.,* 2007 Cieslik, 2006; Chronaki, 2005, 2008; Collin *et al*, 2008; Day, 2008; Forde *et al.,* 2006; Onwu, 2008; Parkison, 2008; Reio, 2005; Sachs, 2001; Smith, 2007; Søreide, 2006; Watson, 2006), the framework focussed on the learning process of six individuals and the factors that influenced their identity formation, as well as their experiences of early MST classroom practice.

This study attempted to identify factors (internal and external) that affected the professional teacher identity in early MST teaching. The learning identity framework

was used as a lens to provide clarity and information on how the six beginning teachers constructed and reconstructed their professional teacher identity.

The learning identity framework is premised on the assumption that professional identity formation and the process of learning are closely linked (Billett & Somerville, 2004; Chronaki, 2005, 2008; Cieslik, 2006). Furthermore, professional teacher identity formation is a complex process influenced by both internal and external factors (Day, 2008; Day *et al*., 2006; Watson, 2006).

Research indicates that identity and practice mirror each other, and that teachers' beliefs are linked to their practices (Billett & Somerville, 2004; Cieslik, 2006; Sachs, 2001). In this study, learning identity is thus viewed as a rich and complex construct consisting of internal and external factors that can affect professional teacher identity formation. It is also apparent that learning identity is an internal, ongoing, interrelated, reflective process (Billett & Somerville, 2004; Egan, 2004; Smith, 2007) characterised by thinking, acting and evaluating throughout the deployment of knowledge, beliefs and practices. This learning process can lead to the change of self, through internalising knowledge, beliefs, views and practices about teaching.

The concept that the learning process is a continuous cycle (adapted from Billett & Somerville, 2004) in the construction and reconstruction of a professional teacher identity forms the basis of the conceptual framework.

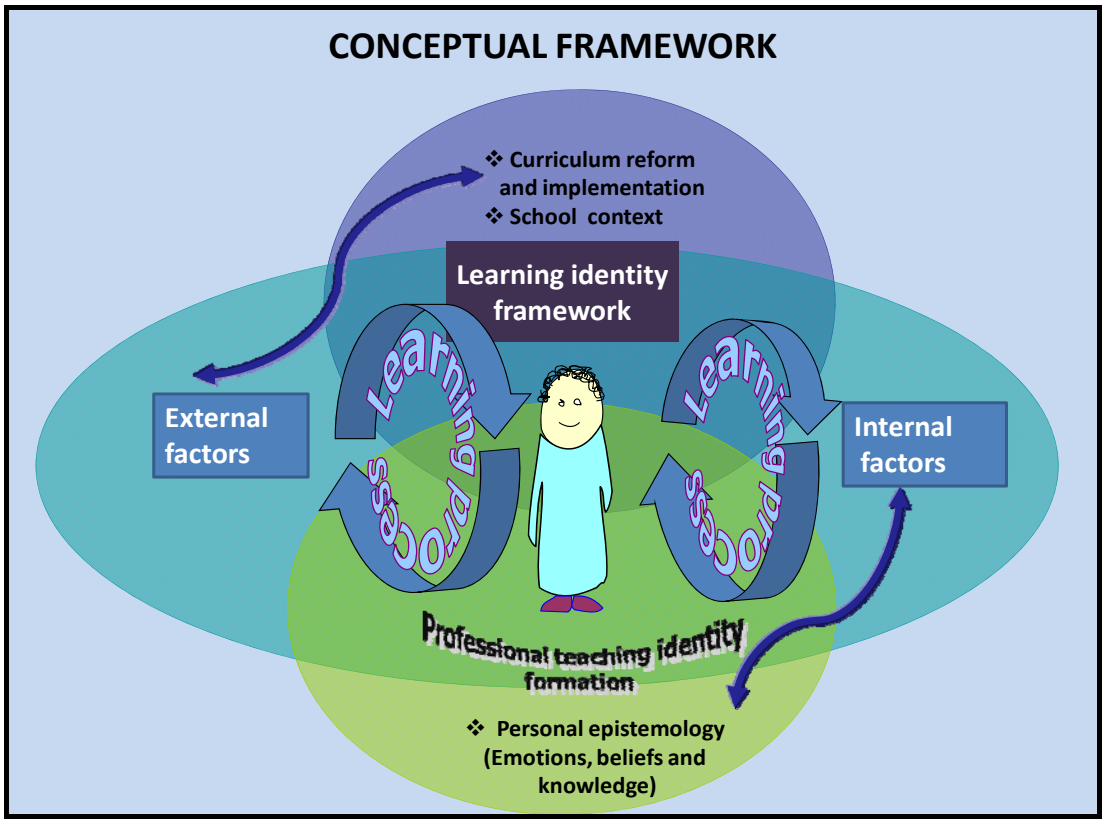

Figure 2.1: Conceptual framework (learning identity framework)

Figure 2.1 illustrates the conceptual framework regarding learning identity. Learning identity is an ongoing process of identity formation and consists of a complex personal learning process for each individual teacher. From the literature it is clear that internal and external factors can affect the process of professional teacher identity formation. The influence of internal factors (such as personal epistemology, knowledge and beliefs) and external factors (for example curriculum reform and implementation and school context) on the beginning teacher can lead to the change of self. Figure 2.1 illustrates the internal and external factors that affect the formation of professional teacher identity.

2.6.1 EXTERNAL FACTORS

External factors that can influence learning and identity in MST in the specialist field of ECP and the FP are curriculum reform and implementation (Jansen, 2003; Jita & Vandeyar, 2006; Onwu, 2008). The school context is another factor, which can include the social and cultural organisation of the school, the ethos of the school and the support that teachers receive in the teaching of MST in the classroom, directly

influences professional teacher identity. The learning process in the school context includes the self-regulating processes in a specific school context in which beginning teachers have to make their own decisions about teaching MST.

2.6.2 INTERNAL FACTORS

As indicated in Figure 2.1, internal factors such as personal biographies (Day *et al*., 2006) and personal epistemologies (personal beliefs, values, ideologies, assumptions and expectations) relating to MST teaching can influence beginning teachers' teacher identity formation (Brownlee & Berthelsen, 2006). Emotional aspects may also play their part (Day, 2008).

According to Brownlee and Berthelsen (2006) and Keys (2007), beliefs about MST knowledge and knowledge of learning are factors that may influence professional teacher identity.

The formation and reformation of a professional teacher identity should be seen as an ongoing, dynamic process that includes all the dimensions of teachers' personal histories and biographies (Watson, 2006). The learning process is revealed in actions that take place in the classroom and is strengthened or changed through critical reflection (Janssen, De Hullu & Tigelaar, 2008; Rots *et al*., 2012; Zembylas, 2005) and support (Day, 2008).

As a process, a learning identity framework is influenced by both internal and external factors, which it is assumed the new first-year teachers use to construct and reconstruct their professional teacher identity (cf. Billett, 2008; Billett & Somerville, 2004; Day, 2008; Egan, 2004; Smith, 2007; Watson, 2006). Figure 2.1 depicts the interactive factors which the literature suggests are likely to influence teacher identity formation: there are those that are external to the new teacher such as existing curriculum and educational reform publications, public expectations, experiences in particular school settings; and the internal ones which include personal background experiences, pre-teaching identity, educational background and beliefs and values about what it means to be a teacher. In this study the factors will be examined in the context of each beginning teacher's classroom teaching.

2.7 CONCLUSION

In conclusion, a review of the relevant literature indicates growing support for the idea that a strong relationship exists between the thinking and process skills related to the teaching of early MST. Mathematical concepts form the basis for the context of science and technology, although each has its own field of study (Bart *et al*., 2008; Ohana, 2007; Saracho & Spodek, 2009). It is also clear that children in the early years use integrated content and process skills to construct knowledge within MST (Charlesworth & Lind, 2007; Gallenstein, 2005).

This study tried to describe and explain how six beginning teachers in different school settings who have just completed their professional studies, form, retain, change or adapt their developing professional teacher identity in the teaching of early MST. The question was how the different school contexts of these six beginning teachers affected their professional identity formation, if at all. In this study both the internal and external factors derived from the conceptual framework were used to develop the instruments for collecting data and analysing results.

The next chapter provides a description of the research methodology of this study.

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CHAPTER THREE
RESEARCH METHODOLOGY AND PROCEDURE

> 'The subjectivity with which I dialectically relate to my world, my role in the world, is not restricted to a process of only observing what happens but it also involves my intervention as a subject of what happens in the world. My role in the world is not simply that of someone who registers what occurs, but of someone who has an input into what happens. I am equally subject and object in the historical process' – Paulo Freire (1998).

3.1 INTRODUCTION

Chapter Three discusses the research method and design used for the collection and analysis of data. It begins with a description of the research method followed by the sampling procedure and an explanation of the data collection and analysis process. The integrated process of data collection and data analysis within the interpretive paradigm is explained. The ethical considerations, validation and verification of data are set out. In conclusion, the limitations and challenges significant to this study are described.

3.2 RESEARCH METHODOLOGY

This study used a qualitative research approach involving phenomenology and the case study method within an interpretive paradigm (Cohen, Manion & Morrison, 2000; Marton, 1986) to investigate the lived experiences of six beginning teachers in their first year of teaching MST in the FP or ECP classroom (Denzin & Lincoln, 1998; Mukherji & Albon, 2010; Van Manen, 2007). The qualitative research approach was used because it would provide in-depth information and rich descriptions into the views and experiences of the beginning teachers as they attempt to make sense of their classroom practices. Casey (2007:123) describes phenomenology as the 'meaning' and descriptions people give to 'lived experiences. In this study, the lived experiences of the beginning teachers are the phenomenon of professional teacher identity formation.

The researcher tried to explore and understand the six beginning teachers' descriptions of their 'lived experience' (Casey, 2007:123) during the first year of MST teaching by listening to their voices and observing their practices, and consequently inferring how they formed their professional teacher identity in the context of teaching MST.

Phenomenology as a research approach was selected because it provided the opportunity to explore and understand the 'richness, depth, nuance, context, multi-dimensionality and complexity' (Mason, 2006:1) within which these beginning teachers formed, changed or sustained their professional teacher identity. It also helped to create an understanding of the 'meanings' (Denzin & Lincoln, 1998:3) and 'authenticity' (Mukherji & Albon, 2010:28) that the six beginning teachers brought to the formation of professional teacher identity in early MST teaching.

The six beginning teachers revealed what they believed and what they did in their MST practices through photo collages, narrative reflections and interviews. It was thus possible to gain insight into and create meaning of the identity phenomenon by considering the 'parts and whole' (Van Manen, 1990:30-31) of the varied data provided over a period of time, in this case over a period of eight months. In line with the nature of phenomenology, the multiple data collected from the beginning teachers 'subjective experiences' was used to 'create a 'description' of their professional teacher identity formation 'experiences' (Casey, 2007:123).

3.3 CASE STUDY METHOD

The case study method was used to gather and analyse the data of the participating teachers' experiences and reality (Casey, 2007:123; Creswell, 2007) in their first year of MST teaching in different ECP and FP settings. The case study method was chosen because it placed the study within a particular boundary, in a particular context and a specified time (Cohen *et al*., 2000). Furthermore, the case study method gave 'ecological validity' to the study because professional teacher identity formation in early MST teaching was a 'real life' experience for the beginning teachers (Tobin, Wu & Davidson, 1989).

The purpose of the study was to understand how beginning teachers form their professional teacher identity when teaching early MST. The case study method combined the different data collection methods used, namely photo collages, narrative reflections, semi-structured interviews and classroom observation (field notes and beginning teacher reflection) to provide descriptions (Eisenhardt, 1989) of the professional teacher identity formation of the six beginning teachers.

The multiple case study approach was selected to understand and gain insight into the dynamics, (Nieuwenhuis, 2007) similarities and differences (Mukherji & Albon, 2010; Silverman, 2005) of the professional teacher identity formation in different cases. The multiple case study approach, using the cases of six beginning teachers, provided a 'rich, thick description' (Merriam, 1998:29) and a 'fuller' (Cohen *et al*., 2000:183) and more detailed picture of the phenomenon of professional teacher identity formation of the beginning FP and ECP teachers on their MST teaching in different school settings.

3.4 SAMPLING PROCEDURE

This study employed purposive sampling to select the six beginning teachers — Bea, Riana, Lea, Gina, Jenna and Anne-marie. The beginning teachers were identified by pseudonyms and treated as cases. The cases were selected according to a purposive sampling procedure. Purposive sampling means that participants are selected according to preselected criteria relevant to the research question (Nieuwenhuis, 2007). Merriam (1988:48) explains that in purposive sampling, '…one establishes the criteria ... then finds a sample that matches these criteria'.

The following purposive sample selection criteria were applied:

(a) The sample consisted of six first-year beginning female teachers who had successfully completed the same B.Ed. Early Childhood and Foundation Phase programme the previous year and who started teaching the following year.

(b) Teachers were studied within the school context where they were appointed. They represented diverse school and teaching contexts in early childhood setting and foundation phase classrooms. They also taught in different language and cultural contexts.

(c) The beginning teachers selected had indicated that they would voluntarily participate.

The participants in this study were six first-year teachers in different school settings. The selection of six beginning teachers for the study complies with the required number of participants acceptable for phenomenological research. The six cases were chosen to maximise variance while keeping the size of the study manageable (Cresswell, 2007). This purposive sampling procedure provided the opportunity of selecting representative cases to enable the researcher to explore the phenomenon of professional teacher identity formation (Silverman, 2005). Table 3.1 provides a summary of the profile of the participants.

Table 3.1: Profile of participants

Participants	Age	Gender	School settings
Six first-year beginning teachers.	The age of participants was between 20 and 25.	Six females (only females completed the programme in 2009).	Diverse school settings: • Two teachers taught in Grade 2 classes in two different Afrikaans primary schools in Pretoria (one was permanently employed by the department of education and one was in a contract post). • One teacher taught in Tswana in a Grade 1 class at a primary school in a township near Pretoria (she was permanently employed by the department of education). • One teacher taught in a bilingual (Afrikaans and English) private Early Childhood setting in Pretoria. She taught the three and four-year-old group (she was in a contract post). • Two teachers taught in different multicultural Early Childhood settings in Pretoria. (Language of instruction: English). One taught a Grade R class and the other teacher taught a five-year-old group (both were in a contract posts).

3.5 ASSUMPTIONS OF THE STUDY

Epistemologically, the researcher accepts reality to be a subjective concept that needs to be experienced, interpreted and described. In this respect, the researcher sought to investigate the beginning teachers' reality of their MST teaching context with its variations, practices and experiences. The research approach was also

inductive, meaning that a conceptual framework on identity formation was developed based on the literature review. The assumption is therefore that professional teacher identity is a learning process that starts during the teacher education programme and is continued during the teachers' professional lives.

The researcher further proceeded from the assumption that the selected six participants had experienced the phenomenon of the formation of professional teacher identity consistent with the philosophy of their teacher education programme. It was further assumed that they could therefore express their identity through their voices (MacNaughton, Rolfe & Siraj-Blatchford, 2001) and practices (photo collages, reflective narratives interviews, observation and observational reflections). The researcher engaged in extensive data collection to understand, explore and interpret the multiple realities of the phenomenon of professional teacher identity formation.

3.6 THE RESEARCH PROCESS

The in-depth research into the research question was planned systematically. The research procedure for this study was based on an ongoing process of data collection and analysis (Nieuwenhuis, 2007). This process entailed noticing, collecting and thinking about information.

3.6.1 DATA COLLECTION INSTRUMENTS

The study used a variety of data collection instruments, namely photo collages, narrative reflections, interviews and observation. The six beginning teachers each wrote an observational reflection on their classroom practice during the observation. Although the interviews with individuals were regarded as the main source of information – which is consistent with phenomenological research – the other data collection methods such as photo collages, narrative reflections and observations provided additional data to enrich and validate the information (Cresswell, 2007).

Each of the beginning teachers was treated as an individual case (Flick, 2008) during the data collection phase. In the following section these data collection instruments are described and justified as follows:

3.6.1.1 Photo collages

The beginning teachers were asked to assemble a collage using images and photographs of their MST teaching and classroom practice from selected sets of stimuli of their choice. Each participant had to design two photo collages, one at the beginning and one towards the end of the year. The photo collages were used to express and visualise aspects of the participants' practice in MST. Guiding questions were provided to assist the participants to select and design their photo collages (see Appendix B).

Think about the way you teach mathematics, science and technology. Select any images and/or photos that represent the way you plan and teach mathematics, science and technology (MST). Design and create a photo collage.

- What do you believe/know about MST teaching (planning) in the early years?
- How do you plan and teach MST? (Explain how you plan your lessons. Give examples.)
- What do you believe/know about MST? (Nature of MST, the content and curriculum of MST.)
- What did you learn about MST teaching and learning during B.Ed. programme and internship (practice teaching)?
- What did you learn about MST teaching and learning during your first year of teaching?

Care was taken to ensure the anonymity of the children and the teachers depicted. Each participant was required to write short comments or phrases to explain or illustrate their MST teaching through the pictures/photographs used in the photo collage.

According to Banks (2009), the use of photographs or pictures of the beginning teachers' own practice and topics that matter to them is justified, as this data collection method can enrich the insight and understanding into their practice and often lead to interesting results and discoveries. The pictorial approach (Brace-Govan, 2007; Weade & Ernst, 2001) could generate rich data for triangulating data obtained from the narrative reflections, semi-structured interviews and observation and enabled the researcher to gain insight into what they believed and how they

planned and taught MST (Flick, 2008). In addition, this method (Brace-Govan, 2007; Weade & Ernst, 2001) allowed participants to tap into personal experiences, passions and beliefs and to more clearly frame and illustrate their thoughts on their teaching and practice. The photo collages also provided data on concepts and knowledge in MST teaching by illustrating real activities in the classrooms.

A limitation of this method may be the ambiguity of visual images and the possibility of 'multiple interpretations' (Banks, 2009). To counteract this possible limitation the researcher did not use the photo collages as visual photos or images on their own, but asked the beginning teacher to explain their meaning in the narrative reflections.

3.6.1.2 Narrative reflection

According to Urzúa & Vásquez (2008), the idea that teachers' written narratives of their experiences could provide insight into their professional identities is noted in the literature. Personal narratives provide written verbal information that could help to make sense of and give meaning to how beginning teachers' everyday experiences, beliefs and practices (Olshtain & Kupferberg, 1998) reflect their professional teacher identity in MST teaching. Written narrative was thus used as an appropriate and 'highly participative' (Burton & Bartlett, 2009:127) data collection method, well suited to the interpretive research paradigm. The narrative reflection also provided an opportunity for the beginning teachers to be active participants in the research process by sharing their views, knowledge, ideas and practices about MST (James & Prout, 1990).

The beginning teachers used the guiding questions (the same questions used for the photo collage) and instructions to explain their use of specific photographs or images illustrating MST teaching in the photo collages. For example, they were asked to examine the images/photos they selected, and to reflect on how these images/photos related to the questions. The triangulation of the photo collages and narrative reflections provided clarity for interpretation. The written narrative also allowed the participants to provide a 'rich account' (Burton & Bartlett, 2009:121) of their experiences, processes, beliefs and classroom practice and gave further meaning to the other data collected through semi-structured interviews and observation.

Each participant was required to write two narrative reflections (see Appendix B), one when they started teaching and one towards the end of the year.

3.6.1.3 Semi-structured individual interviews

Semi-structured interviews formed an important part of the data collection process in the study. Semi-structured individual interviews (Nieuwenhuis, 2007; Silverman, 2005) were used to further explore the research questions and to collect data on beginning teachers' MST-related experiences and practices. The main questions used in the interviews were derived from the research questions:

- How do you teach MST in your classroom?
- What did you experience during the teaching and learning of early MST?
- What influenced the way you teach MST?

A one-on-one interview format for data collection was used because it allowed the researcher to explore through questioning additional aspects of the professional teacher identity formation such as: How do you teach MST in your classroom? Why? What do you teach?

This method allowed the beginning teachers to 'talk around' (Burton & Bartlett, 2009) and explain their professional teacher identity formation. It also allowed the researcher to pick up hunches, non-verbal clues and thoughts (attitudes and beliefs) to provide rich, meaningful data (Cohen, et al., 2000).

Two semi-structured individual interview (see Appendix C) sessions of 45 minutes were conducted with each participant to triangulate the data, one at the beginning and one towards the end of the year. The first interview was done during April/May 2010, after collection and informal analysis of the first photo collages and narrative reflections.

The second interview was done during September/ November 2010, after the observation and collection of the second photo collages and narrative reflections. The flexible nature of the semi-structured interviews (Mukherji & Albon, 2010) allowed the researcher to clarify ideas, processes and practices noted in the photo collages, narrative reflections and observations (Burton & Bartlett, 2009). This

information provided opportunities for further investigation into the professional teacher identity formation of the six beginning teachers.

Administration of the interviews

The interviews with each beginning teacher were scheduled at their convenience. Each individual interview was audio-taped and written notes were taken as the interview progressed (Lincoln & Guba, 1985). The twelve interviews were transcribed and summarised for further analysis.

During the interviews, it was important for the researcher to maintain the role of good interviewer and careful listener (Creswell, 2007). I put the interviewees at ease by being friendly and considerate, but at the same time remained as neutral as possible, by not expressing my emotions, feelings and opinions in any way that was likely to influence the interviewees (Mukherji & Albon, 2010:42).

3.6.1.4 Informal observation, field notes and beginning teachers' reflections

Informal observation of the six beginning teachers in their teaching environment (classroom practice) was undertaken to see what they did in their classrooms. Observation provided an opportunity to gather 'live' data from a natural teaching situation (Cohen *et al.,* 2000:315) to understand the different contexts in which the six beginning teachers taught early MST.

The researcher took into account that observation of human actions and interactions can only be interpreted in the situational context in which they occur (Angrosino & Mays de Pèrez, 2000), therefore no structured observation schedule was used. Consequently, the researcher did informal observation and compiled field notes during May 2010. The teaching of MST was observed during scheduled observation sessions convenient to the school and the beginning teachers. The field notes comprised descriptive notes by the researcher.

The researcher expanded on the field notes that were made *in situ* at a later stage. The researcher took care to describe the school context, the number of children in the class and the activities of the teacher in detail. Notes were made of the

restrictions or otherwise of the school curriculum that affected to what extent the beginning teacher could teach MST in the way she wanted to. The context in which the observation took place, formed an important part of the data as it provided information on the situation in which the six beginning teachers formed and reformed their professional teacher identity in teaching early MST.

The researcher was constantly aware of the possibility of bias as observer but ensured objectivity through the observational reflections written by the beginning teachers at a later stage and by asking the participants to verify the information (Casey, 2007). The beginning teachers wrote reflective notes (observation reflections) on the lesson they had planned and presented. This data was given to the researcher two weeks after the informal observation visit.

Observation was an appropriate choice of data collection, because it provided the researcher with opportunities for triangulating information from other data sources. The researcher could also establish whether the beginning teachers had changed their teaching approaches due to pressure from peers or management in the various school contexts. Observation thus gave the researcher insight and understanding about how the beginning teachers planned and taught early MST (Burton & Bartlett, 2009) in their specific school settings. The researcher could see if the teachers acted as they said they had (data from first photo collage, written narrative and interviews). Another advantage was that observation included opportunities to understand the school context within which the beginning teachers planned and presented early MST activities (Cohen *et al.,* 2000). It further presented opportunities for the beginning teachers to reflect on and write an observation reflection on the MST teaching which the researcher observed (Patton, 2002).

Through the observation, field notes and participants' observational reflections, a large amount of data was gathered within a short time, which was advantageous in the sense that rich, varied and detailed information was gathered which could be sorted into topics and themes. The observation was meant to draw attention to certain practices and behaviours that would perhaps need clarification in the follow-up interview (Burton & Bartlett, 2009). The following open observation schedule (see Appendix G) was used to collect data.

Table 3.2: Open observation schedule

Observation: actions of the teacher	Reflective notes field notes
Description of the kind of mathematics, science or technology (MST) activity – Lesson planning.	
Description of the pedagogical approach (inquiry-based approach, hands on activity, workbooks, discovery learning, exploration, problem solving approach, scaffolding.	
Interaction with the children and children's MST learning.	
Interpretation and implementation of the curriculum.	
Resource and classroom environment.	
Aspects of classroom practice and management.	

Observational reflection: The six teachers wrote an individual reflection on the planning and the presentation of the observation activity(ies).

Table 3.3 provides a summary of the research sequence and the data collection instruments.

Table 3.3: Research sequence for data collection

Research sequence	Research activity	Time
Phase one	**Introduction of the study to the participants** An individual information session was conducted with each participant. The research purpose and process were discussed with each individual participant. Then the data collection method was explained (see consent letter, Appendix A). Consent letters were given to each participant. It was explained that consent was voluntary.	20 minutes meeting with each participant at the end of March 2010

Research sequence	Research activity	Time
Phase two	**First photo collage and narrative reflection** The participants were provided with the requirements and guidelines for the photo collage and narrative reflection (see Appendix B) after they had agreed to participate. The completed first photo collage and written narrative were collected from each participant a week before their scheduled first individual interview.	At the beginning of their first year of teaching after the first term (April/May 2010)
Phase three	**First semi-structured individual interviews** The first semi-structured individual interviews (Interview guidelines – see Appendix C) were conducted to establish beginning teachers' professional teacher identity in early MST teaching and the factors that influenced this identity formation. Questions dealt with: • Their background and prior experience in MST teaching and learning. • The contribution of their initial teacher education programme to the formation of their professional teacher identity in MST. • Their classroom practice during their first year of teaching.	45 minutes during May 2010
Phase four	**Observation** After consent by Gauteng Department of Education (see Appendix D), schools Appendix E) and parents (Appendix F), the informal observation and the teachers' reflection were done.	One or two negotiated school mornings convenient to the school and participant. Observation was done between April and June 2010
Phase five	**Second photo collage and narrative reflection** Handing in of the second photo collage and narrative reflection (see Appendix B) to triangulate information and gain insight into the professional teacher identity formation process during their first year of teaching.	Towards the end of their first year of teaching (September/October 2010).
Phase six	**Second semi-structured individual interviews** Second semi-structured individual interviews aimed at triangulation of information. (Interview guidelines – see Appendix C.)	45 minutes (September – November 2010)

3.6.2 Data Collection Stages and Data Analysis Processes: An Interactive Process

Based on the data collection plan, the collection of data was guided by the following research question:

How do beginning first-year early childhood and foundation phase teachers form, sustain or change their professional teacher identity in the teaching of mathematics, science and technology (MST) in the early years and in different school settings?
The sub-questions derived from the main question are:

1. What internal and external factors, if any, influence beginning teachers' professional teacher identity formation in the context of teaching MST?
2. How do the identified factors, if any, affect their teacher professional identity formation in the teaching of MST in different school settings?
3. Why do these teachers sustain, change or adapt their professional teacher identity?

All the data, including photo collages and written narratives, observations, field notes, participants' observational reflections and semi-structured interviews, were generated for triangulation purposes. The time frame for collecting the data was a period of one year starting in April 2010. The data gathering process started after ethical approval had been granted for the study.

The **first data collection stage** consisted of the first photo collage, narrative reflection and semi-structured interview with each of the six beginning teachers after they had taken up their teaching posts and settled into their respective classrooms and school settings (April/May 2010). Individual data analysis was done after each stage of data collection.

The second data collection stage (informal observation with field notes and beginning teachers' reflections) took place during May/June 2010.

The three stages of the data collection and the data collection methods were explained to the six participants during a short information session (April 2010). They were also provided with oral and written information to enable them to understand why and how to construct the photo collages (see Appendix B). During this session, the beginning teachers were asked to design the photo collages and to write a narrative refection on the photo collage. They were informed about the semi-structured individual interview and the informal observation that would take place during May 2010. A date was set for the first interview with each participant. After the

first interview session a date was scheduled for the classroom observation to take place. Similarly, the dates for the collection of the second photo collage, narrative reflection and semi-structured interview were negotiated. Some of the interviews and reflections were done in Afrikaans. These were first transcribed in Afrikaans and then translated into English. Table 3.4 summarises the data collection stages and data analysis processes.

Table 3.4: The data collection stages and data analysis processes

Stage	Data collection method	Time
Stage one	First photo collage, First narrative reflection and first round of semi-structured interviews.	April/May 2010
First data analysis process: Reading narratives. Transcribing interviews. Analysing narratives and interviews using interpretive analysis (Nieuwenhuis, 2007).		
Stage two	(4) Informal observation, field notes and beginning teachers' reflections.	May/June 2010
Second individual data analysis process: Analysing observation, teacher reflection and field notes using interpretive analysis (Nieuwenhuis, 2007).		
Stage three	(1) Second photo collage, (2) Second narrative reflection and (3) Second round of semi-structured interviews.	September to November 2010
Third individual data analysis process: Reading narratives. Transcribing interviews. Analysing narratives and interviews using interpretive analysis (Nieuwenhuis, 2007).		
Final data analysis process: Analysing and synthesising data. Writing a description of the professional identity portraits of six beginning teachers. Extracting the core elements present in all of the six cases. Presenting the essence of the phenomenon of professional teacher identity in a 'textual description' in answer to the research questions (Creswell, 2007:227).		December 2010 to October 2011

The following section will give examples of the instrument and the collected data. The examples of the collected data are from Bea case.

3.6.2.1 Photo collages

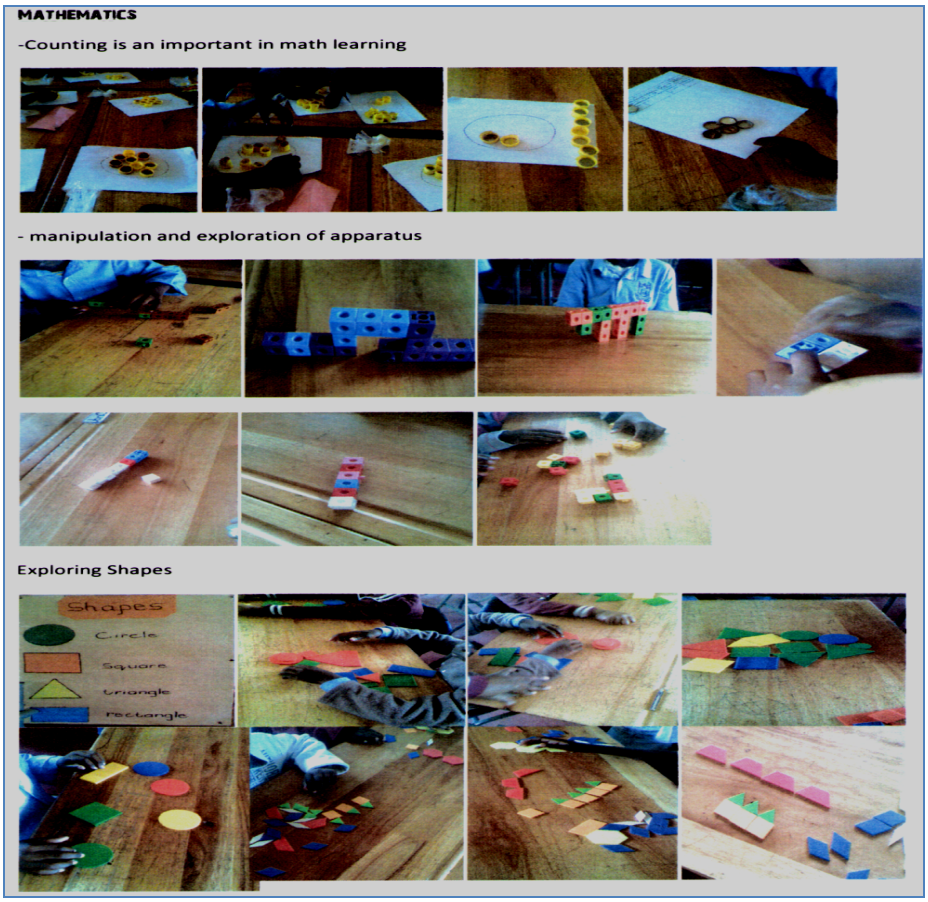

Figure 3.1: Examples of Bea's photo collages in mathematics collected during stage one

3.6.2.2 Narrative reflection

- **Narrative reflection – mathematics teaching**

Maths is a practical subject at school. Maths activities are planned well in advance and as novice teacher I have to make sure that I have all the right apparatus, the planned lesson beforehand. For example, for counters, I asked the learners to find as many bottle tops as they could find and this proceed for a few weeks until we had collected enough for each child to have about 10-15. Different approaches and strategies can be used to teach young children mathematics such as stories step-by-step instruction. Therefore how a child learn is important to me (NR1).

- **Narrative reflection – science teaching**

Science is not a focus subject/learning area in our phase. Therefore it tends to take a back seat. However, it can be incorporated in a lot of things. For example, we recently had a theme "our country" in which we talked about indigenous trees. The learners had to bring a leaf from an indigenous tree to class. The learners had to look at the leave and sort them. They then made a graph to indicate how many of each leaves they had. We also discussed that South Africa is a water scarce country and that indigenous trees use up little water and they are thus ideal for the country (NR1).

- **Narrative reflection - technology teaching**

Technology is a learning area where learners are presented with material with which they have to design and create something new or to improve something that already exists. Technology to me is about the manipulation and investigation of material and problem solving (NR1).

- **Narrative reflection - MST teaching**

I have grown in the past few months from being a 100% theoretical teacher to being one with some experience; I have seen how and what I have learnt can be implemented in the classroom. I feel that what I have learnt and seen during my four years of teacher training has helped me. I learned that teaching MST involves a lot of creativity. One can make time in the timetable to involve MST in the classroom and that it can be fun (NR2).

3.6.2.3 Semi-structured interview

- **Bea's semi-structured interviews (In1) – MST Teaching**

Maths is important to the children. It is something they must learn. They have to acquire skills so that they can love maths. I love teaching maths. Children have to practice what they learn. I need to plan carefully what I want them to do. They have to use the whole body approach. I have to plan it that I have to move from the physical to counters and then to more abstract stuff (In1).

Science is very difficult to teach. You can do it orally, and it is not taken seriously by the school. You do the maths and have to integrate the science through other subjects. This is difficult. Learners should know science and I wish I could do more. Maybe I should plan better to include science on Fridays. Make an integration day

with more practical stuff. We had no time this year. The world cup and the strike were bad (In2).

3.6.2.4 Observation

Table 3.5: The observation of Bea's lesson

Observation: actions of the teacher	Reflective field notes
Description of the mathematics, science or technology (MST) activity – Lesson planning.	
Activity 1: Counting She tells them to start counting from 0 – 100 They count in English then in Tswana She helps those who get stuck along the way. English-When the kids get to multiples of 10, there is some level of excitement and rhythm, they shout them out. The same applies in the Tswana counting, only this time it is with the numbers 7 She makes them aware of 'odd numbers' and 'even numbers'. She tells them to look at the number line and just count the odd numbers (-99). After that the children do the same with even numbers (-100)	She walks around to see if everyone is counting. When a child needs help she gives support. For example she shows them the number on the hundred chart.
Activity 2: Counting out and counting on She gives each child 20 unifix cubes (blocks). She gives them oral instructions on counting out. For example: Count out 12 blocks of one colour. Count out 2 more in another colour. Count out 12 and count on with the 2. She asks them to write the number sentence. She gives the children number sentences for example 10+3=_ They have count out the number of blocks.	Most of the children can count out and count on correctly. When children struggle she helps them by giving assistance.
Activity 3: Adding and subtraction operations The children do adding and subtraction operations in their workbooks.	Many of the children were able to use correct notations. But when children needed help she provided it by prompting, such as 'show me 10 add 2'.
Description of the pedagogical approach (inquiry-based approach, hands on activity, workbooks, discovery learning, exploration, problem solving approach, scaffolding	
She planned for hands-on activities using counters. She scaffolds learning by asking questions and helping children that need help. She also refers to resources in the classroom for example the wall frieze and number line and hundred chart.	She uses hands-on practical approaches in the planning of mathematics. She employs the problem solving approach in the questions she uses.

Observation: actions of the teacher	Reflective field notes
Interaction with the children and children's MST learning.	
She walks around in the classroom and assists the children. She repeats questions and instructions when children do not understand.	She is caring and supportive. She walks around and is aware of children that need assistance.
Interpretation and implementation of the curriculum.	
She uses: • Counting 1-100 (counting out and counting on activities on number range 1-20) • Addition and subtraction (number range)	Her interpretation of the curriculum is correct and appropriate for the grade 1 class
Resource and classroom environment.	
She uses: • unifix cubes • hundred chart • workbooks	Her classroom is a resource-rich classroom where learners work with the material shat she prepares and provides
Aspects of classroom practices and management	
The lesson she planned was well prepared and she manages the teaching and the children's learning with confidence.	The principal and H.O.D were welcoming. The H.O.D asked if she could sit in on the lesson. There seems to be a lot of support for the teachers.

3.6.2.5 Observation reflection

- **Bea's observation reflection (OR) on her planned lesson (MST teaching)**

I plan for each concept weekly with daily subheadings for each day to increase knowledge and to consolidate prior knowledge. I planned that the learners would explore the differences between odd and even numbers. The lesson was to play out so that the learners would see that odd numbers would always have one that is unpaired and that even numbers were always paired. The learners explored this by using counters to see which numbers would be paired and which would be unpaired. Planning thoroughly helps me become better at my craft than if I did not plan, and it helps me to help struggling learners.

- **I planned for children's learning by:**
    - Preparing resources *and counters or other resources to use during the lesson to encourage effective learning to foster moving from concrete to abstract concept development.*

- *I count out the resources to see if I will have enough and if not I plan how I am going to improvise and how the lesson will play out with the limited resources.*

- **Summary of my own learning process**
  - *The continuous interactions between the learners and myself in the teaching and learning situation and their reactions and mine to the daily happenings in the class help me reflect and fine tune how I teach for a better lesson the next time around.*
  - *Getting to know the learners and understanding their strengths and weaknesses also helps me reflect better on how I should do things in the future and may even teach me a new skill.*
  - *Being thoroughly planned helps me become better at my craft than if not, and helps me to be thorough at helping struggling learners (OR).*

3.6.3 DATA ANALYSIS STRATEGIES

The process of data analysis started immediately after the first data collection and transcriptions of the interviews and continued throughout. A phenomenological approach to data analysis was used to understand and to get insight into beginning teachers' professional teacher identity formation in early MST teaching and learning.

Building on the data from the photo collages, narrative reflections, observation and observational reflections, the researcher firstly used 'horisontalisation' (Moustakas, 1994) to go through all the data (e.g. photo collages, reflections and interview transcriptions). Van Manen (1990:4) describes the hermeneutical phenomenological approach to research 'oriented toward lived experience (phenomenology) and interpreting the "texts" of life (hermeneutics)'.

During this step significant statements, sentences as well as quotes were highlighted to provide an understanding of the six beginning teachers' practices and experiences in MST teaching and learning.

During the next step the researcher developed clusters of ideas (Moustakas, 1994) from the data through organising and categorising the statements, sentences and

quotes into themes. These themes were then used to write a narrative description of the participants' identity portraits (Chapter Four). During the next step the researcher focused on the common experiences of the participants (Chapter Five), giving a textual-structural description of the meanings and essences of the experiences.

The data analysis process began informally during interviews and observations and continued during transcription, when recurring themes, patterns, and categories on professional teacher identity formation became evident. The data analysis process involved the ongoing integrated process of categorisation and recategorisation of data; looking continuously for gaps, differences, similarities and connections to develop categories of description (Åkerlind, 2005) relating to professional teacher identity formation. The researcher started deductively by drawing from previous research (the literature review and conceptual framework) on topics such as beginning teachers, professional teacher identity formation, initial teacher education programmes and early MST teaching, to look for themes and to gain insight into the how beginning teachers construct their professional teacher identity.

Furthermore, Instructions, prompts and questions were generated from the literature review and conceptual framework and were used in the photo collages, narrative reflections, semi-structured interviews and observation. Because phenomenology is concerned with real-life activities and has its roots in common-sense reflections, this view was used to generate data in order to gain insight and to understand how beginning teachers formed their professional teacher identity in early MST teaching and learning (Cohen *et al*., 2000).

The data obtained from the photo collages, narrative reflections, semi-structured interviews, observation and observational reflection were analysed and interpreted for emerging themes using either phenomenological or interpretative procedures. The researcher also used inductive analysis strategies to 'reduce the data to central themes' (Casey, 2007:123). Categories of description such as teacher education programme, school context, curriculum interpretation and implementation, MST teaching, institutional support and classroom practice emerged from reading, categorising and synthesising the data. These identified themes were used to describe the phenomenon of professional teacher identity formation.

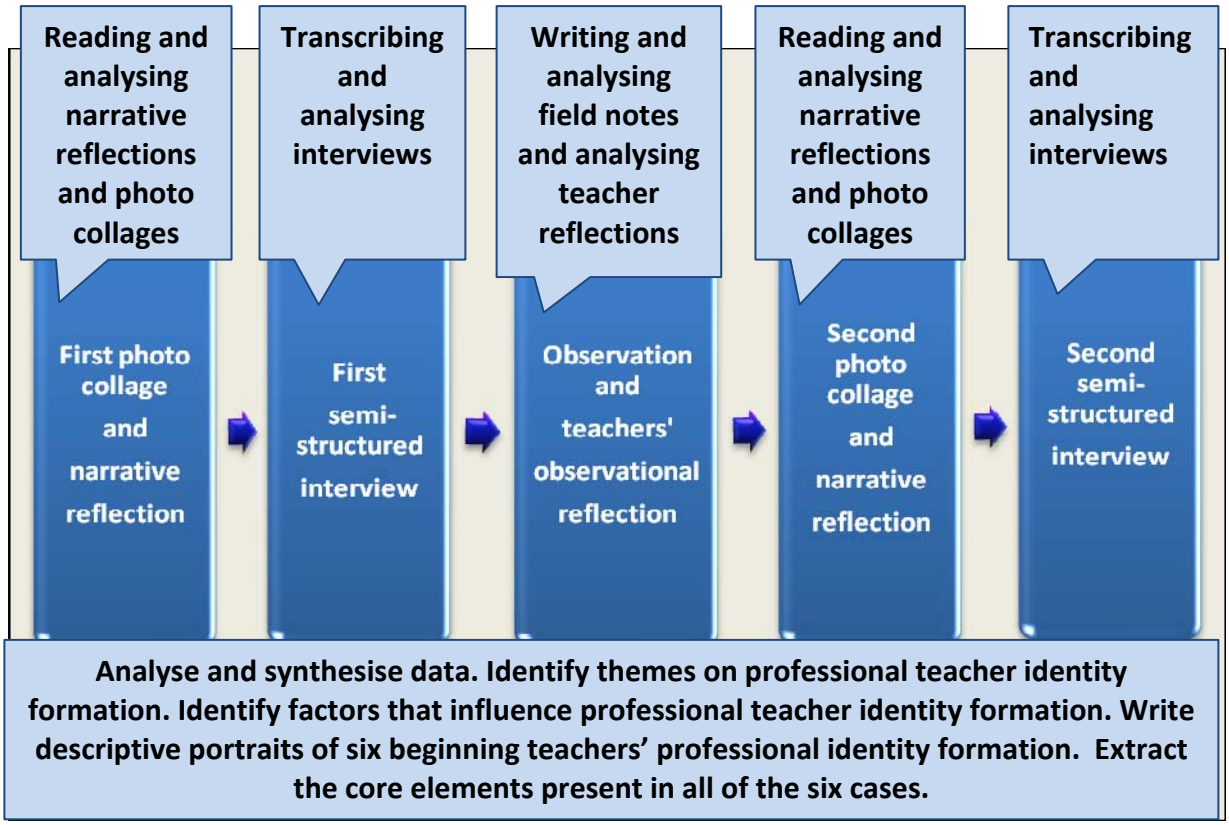

Figure 3.2: The integrated process of data collection and data analysis

During the integrated process of data collection and data analysis (Figure 3.2) the information was processed like a jigsaw puzzle and assembled into themes (Nieuwenhuis, 2007) such as beginning teachers' background in MST, the teacher education programme, school context, curriculum interpretation and implementation, teaching MST, institutional support and classroom practice. The information collected from each stage was read several times to identify and verify the themes. The common use of words, phrases, themes or patterns by the participants assisted with the interpretation and understanding of the professional teacher identity portraits of the six beginning teachers. A quality check was done by 'rechecking' and 'cross-checking' (Flick, 2008) the interview transcripts, narrative reflections and themes.

3.6.3.1 Theme construction

Themes were formulated, based on 'statements and quotes' (Creswell, 2007:227) reflecting the six beginning teachers professional teacher identity formation. To illustrate how the description of themes was constructed the theme of 'Teaching MST' is exemplified by the following extract from Bea's case:

Step one:

Statements and quotes were on the theme identified from interviews, (In1, In2) narrative reflections (NR1, NR2), and observation (O) and observation reflection (OR).

Table 3.6: Example of statements and quotes from Bea's case

Interview one (In1) 'Maths is a priority subject' (In1) 'I think my children love mathematics because they see I love it' (In1) 'Very little science and technology, if any, is taught in the foundation phase at the school. I don't see science and technology' (In1)
Interview two (In2) 'Maths is important every day (In2) 'Learners should know science and I wish I could do more. Maybe I should plan better to include science on Fridays' (In2) Science and technology are taught integrated with life skills and language (In2). The factors that caused me not to teach science and technology are because of lack of time (In2) You do the maths, and have to integrate the science through other subjects … this is difficult' (In2) I heard that science and technology are being removed from the curriculum and I am against this removal. The subjects are essential for the development of the child, and the curriculum changes every year. There is a lack of consistency (In2)
Narrative reflections one (NR1) 'I want to include science into my teaching, maybe a discovery table' (NR1)
Narrative reflections two (NR2) '…so there is very little time to teach science … However, we could plan a science project like a discovery table' (NR2)
Observation reflection (OR) 'Our science observations (about plant growth) had to be postponed and there was very little time left in the end to make a really good observation and measurement of the processes' (OR)

Step two:

The narrative portrait of each case was written to present the results of this study (see Chapter Four). Themes were used to write the narrative portraits. The following extract is from Bea's case on the theme 'teaching MST':

Mathematics was regarded as the foundational subject at the school and it had a prominent place in the curriculum. 'Maths is a priority subject' (In1) and 'Maths is important every day' (In2). She was positive about teaching mathematics to her

children and enjoyed their reaction: 'I think my children love mathematics because they see I love it' (In1).

While mathematical knowledge and skills were regarded as the main focus of teaching in the primary school, the school curriculum did not make provision for the teaching of science and technology. There was some disenchantment in the way science was taught or not taught in the school. She insisted that 'Learners should know science and I wish I could do more. Maybe I should plan better to include science on Fridays' (In2). Bea's situation was clearly expressed when she said: 'We [other staff members] plan the subjects together and science is not a priority subject because it does not count for marks' (In1) '…so there is very little time to teach science … However, we could plan a science project like a discovery table' (NR2).

She identified factors that inhibited her from fulfilling her role as an MST teacher. 'The factors that caused me not to teach science and technology are because of lack of time' (In2) and 'Very little science and technology, if any, is taught in the foundation phase at the school. I don't see science and technology' (In1).

The final stage of the data analysis process culminated in the narrative description of the professional teacher identity of the six beginning teachers (Chapter Four). The narrative descriptions explain and try to give insight into how and why six beginning teachers, in different school settings, who have just completed their professional studies, form, retain, change or adapt their professional teacher identity in the teaching of early MST. The analysis of data and discussion of results were done within the conceptual framework and the assumptions of the study. Therefore the question of how and why the different school contexts of these six beginning teachers affected their professional identity formation and in turn their MST teaching was synthesised from the collected data. In this study both the internal and external factors that derived from the conceptual framework were used as questions and guidelines in the data collection and data analysing process. The external and internal factors that influenced professional teacher identity formation were identified in a table and described in narrative form.

3.7 ETHICAL CONSIDERATIONS

To ensure ethical conduct during the research the researcher applied for ethical approval prior to data collection (Mouton, 2001). Ethical approval was granted by the Gauteng Department of Education (see Appendix D) and the University of Pretoria ethics committee. Through this process the researcher strove to assure the rights and protection of the beginning teachers and the schools that might be affected by the research (Mac Naughton *et al*., 2001).

The following principles guided the process of ensuring ethical conduct during the research:

- informed consent
- voluntary participation
- confidentiality and anonymity
- privacy
- safety
- trust.

3.7.1 INFORMED CONSENT

In order for the participants to make a decision on their willingness to participate in the study, they needed to be informed about the purpose of the research, as well as how and to whom the results would be made known (Cohen *et al.,* 2000). The researcher obtained written informed consent from the six beginning teachers. After expressing an initial interest, potential participants were provided with information about the research during an individual briefing and a consent form (see Appendix A) was made available to them. The information session outlined the research aims, research process and data collection methods and time frame of the research. Each participant was given time (one week) to think about their participation and only after they consented to their involvement, were they provided with the research timeline for the different stages of data collection and the data collection methods. Participants employed their power of choice to sign the letters of consent and a copy of the consent form was given to each beginning teacher. Dates and times were then negotiated with each participant. Consent was also sought from and granted by the Department of Education (see Appendix D) and the principals of primary schools and

owners of early childhood centres (see Appendix E). Finally, consent for the observation and photo collages was granted by the parents of the children in the different classes (see Appendix F).

3.7.2 VOLUNTARY PARTICIPATION (CONFIDENTIALITY, ANONYMITY AND SAFETY IN PARTICIPATION)

Participants were assured that participation was voluntary and that they could withdraw at any time without supplying reasons (Cohen *et al*., 2000; Mason, 2006; Mouton, 2001; Silverman, 2005). Participants signed the letter of consent prior to the commencement of data collection. The researcher was available to answer any inquiries concerning the procedure (Cohen *et al*., 2000). At each stage of data collection, anonymity was respected and applied and all the data was treated as confidential.

Because participants provided information about the formation of their professional teacher identity the researcher was constantly aware of their private space and respected this space without compromising the data. When participants felt that they did not want to reveal any private information or disclose any private domain that they felt uncomfortable with, they could withhold information or withdraw from the study at any time. The information provided in the photo collage, narrative reflection and interviews were expressions of their ideas about teaching; their own voices. Before finalising the research findings, participants had the opportunity to read and comment on the narrative descriptions of their professional teacher identity formation to ensure correctness.

3.7.3 TRUST

The principle of trust guided the process of ensuring ethical conduct during the research. Lubbe (2003:26) explains that narrative inquiry is a ‘relational inquiry’ and that trust is important in the relationship to share ‘real’ or ‘true’ stories. Beginning teachers had to trust the researcher and they had to know that the researcher respected them to be able to entrust their narrative reflections and stories to her. A relationship of trust between the researcher and the participants was very important throughout the research to obtain access to the data (Cohen *et al*., 2000). The

researcher applied the principle of fairness and trust to the participants and the schools during the data collection and during data analysis (Flick, 2008). No unexpected or ethical dilemmas arose during the study (Silverman, 2005). The beginning teachers involved in this study could have withdrawn at any time, had they wished to do so.

3.7.4 RISKS AND BENEFITS

There are no negative consequences attached to this research. This study gave beginning teachers (participants) a voice on the crucial matter of early MST teaching in the FP and ECP. The findings of the study will hopefully provide schools and teacher education institutions with information on the teaching and education of beginning teachers in early MST teaching and learning.

3.8 VALIDATION OF THIS STUDY

The 'methodological rigor' of this study was accomplished through the use of validation and verification methods (Creswell, 2007:270). The validity of this study was assured by the use of a variety of appropriate phenomenological data collection instruments, the period of time (one year) during which the data was collected and through the use of phenomenological data analysis methods. The extended time (Creswell, 2007) and engagement with the participants helped the researcher to build trust and establish credibility. The verification of this study was obtained through the repeated reading of all written narratives and transcripts to obtain a broad insight (Creswell, 2007) of how the beginning teachers' professional identity was formed. Ideas, themes, patterns and gaps emerged and crystallised from the data analysis and this led to a deeper understanding of the phenomenon (Nieuwenhuis, 2007) enabling the researcher to describe the formation of a core professional teacher identity (Casey, 2007).

The researcher's position in phenomenological methodology is 'unique' because the researcher is 'central' and 'intertwined' in the research and the research experience (Casey, 2007:125). The researcher is a lecturer at the teacher education institution where the beginning teachers completed their studies. This position placed the researcher in an 'insider' situation, which meant that in a phenomenological research

approach the researcher had to discard 'prejudgement' (Creswell, 2007:237) about the formation of professional teacher identity. The nature of phenomenology further added to the possibility of subjectivity. Therefore the researcher had to be aware (as far as possible) of preconceived notions and subjectivities (Creswell, 2007) because 'the researcher and the research are intertwined' (Casey, 2007:125). This was done through triangulation of the different data sources. Furthermore, the researcher used the technique of member checking (Casey, 2007:126) and communicative validation (Flick, 2008:115) by asking the participants to read and verify their professional teacher identity portraits. This enabled her to hear the 'voices' of the beginning teachers on their professional teacher identity (Casey, 2007). However, the 'insider' position of the researcher also had the advantage of providing the possibility of deeper insight and understanding of the aspects of MST teaching and learning. A further advantage of this situation was that the rich background of experience has hopefully led to a better understanding of the phenomenon.

3.9 CHALLENGES AND STRENGTH OF THE STUDY

This study explored the experiences of beginning teachers during their first year of teaching early MST. A phenomenologically orientated research approach limited the potential for generalisation in this study, but combined with a multiple case study method (Silverman, 2005), it allowed the researcher to explore the 'richness, depth, nuance, context, multi-dimensionality and complexity' of the phenomenon of professional teacher identity formation (Mason, 2006:1).

The advantages of the multiple case study design lay in comparing similarities and differences of identity formation and MST teaching between cases and identifying themes, also called 'clusters of meaning' (Creswell, 2007:61). The case study revealed the real-life teaching situation in which each beginning teacher found herself, when she described in her own words what happened, allowing for a 'close-up reality and thick description of participants' lived experience' (Cohen *et al*., 2000:182).

The multiple case study approach also had disadvantages. It was time-consuming, due to the extended data collection period. The large amount of data collected necessitated systematic data reduction into more manageable topics and themes

(Cohen *et al*., 2000; Miles, 1979; Mouton, 2001). Also, the researcher had to guard against the ever-present possibility of researcher bias and subjectivity (Cohen *et al*., 2000).

The possible challenges of the study were minimised by the use of a variety of data collection methods, the triangulation of data and the extended period of time (one year) during which the data was collected and verified (Creswell, 2007). The limitations of the data collection methods and the enrichment of validation of these methods have been summarised in Table 3.7.

Table 3.7: Data collection methods, limitations and enrichment of validation

Data collection methods	Limitations	Enrichment of validation
Photo collages	The ambiguity of visual and the possibility of 'multiple interpretations' (Banks, 2009).	The use of a variety of data collection methods (triangulation), member checking (Casey, 2007) to verify interpretation of photos and images.
Narrative reflections	Limited views, knowledge, ideas and practices about MST teaching may inhibit the information on professional teacher identity formation.	• The use of a variety of data collection methods (triangulation) • Communicative validation (Flick, 2008). • Highly participative data collection method (Burton & Bartlett, 2009). Open questions were formulated to guide the beginning teachers in their writing.
Semi-structured individual interviews	• Power relationship because the researcher was known to the beginning teachers. • Insider role of the researcher meant that the researcher had to guard against pre-judgement.	• The use of a variety of data collection methods (triangulation). • The researcher had to build in a relationship of trust. • 'Communicative validation' (Flick, 2008) and • Member checking (Casey, 2007) were done with the beginning teachers on the transcribed interviews.
Informal observation and field notes	• Researcher's own views • Time constraints, only one observation in each school. • School context may inhibit the teaching of science and technology.	• The use of a variety of data collection methods (triangulation). • The researcher had to build in a relationship of trust. • Member checking (Casey, 2007) on the field notes. • Communicative validation (Flick, 2008) through their observational reflections.

Data collection methods	Limitations	Enrichment of validation
Observational reflections	Limited views, knowledge, ideas and practices about MST teaching and may inhibit the information on professional teacher identity formation.	• The use of a variety of data collection methods (triangulation). • The researcher ensured a relationship of trust.

3.10 CONCLUSION

In this chapter the research approach and the sample selection were described. A detailed account of the data collection and analysis techniques, the stages of data collection as well as the strengths and weaknesses of these techniques were provided. The chosen research methods were justified in line with the research questions and the purpose of the research. The ethical considerations, as well as the limitations and challenges of the study were explained.

In Chapter Four the results will be presented.

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CHAPTER FOUR
REPORTING THE RESULTS OF SIX CASES: THE NARRATIVE PORTRAITS OF BEGINNING TEACHERS' PROFESSIONAL TEACHER IDENTITY FORMATION IN EARLY MATHEMATICS, SCIENCE AND TECHNOLOGY

'… people construct narratives and narratives construct people, and our identities emerge through these processes' – Watson (2006).

4.1 INTRODUCTION

In Chapter Four the results of the study are presented. The data was analysed against the background of the main research question of how first-year ECP and FP teachers form and sustain or change their professional teacher identity in the teaching of mathematics, science and technology (MST) in the early years. Subsidiary questions of what internal and external factors, if any, influenced their professional identity were addressed. The question of how the identified factors, if any, affected their professional identity formation in different school settings, therefore guided the presentation of the results. The results are presented in six cases describing each individual beginning teacher's professional identity in the context of teaching MST in different school contexts.

4.2 NARRATIVE DESCRIPTIONS: SIX BEGINNING TEACHERS' PROFESSIONAL IDENTITY PORTRAITS

In this section the narrative descriptions of the six cases are presented. These narrative descriptions and the photo collages describe representative selected practices and experiences of the case teachers' realities in their different school settings. The voice of each beginning teacher helps to explain the specific lived experiences in MST teaching, extracted from 'statements and quotes' (Creswell, 2007:227). The abbreviations used with the quotes identify the data collection methods as follows: Narrative reflection one (NR1); Narrative reflection two (NR2); Interview one (In1); Interview two (In2); Observational reflection (OR).

The results of the identity portrait of each case are further summarised in Table 4.1 according to three selected identity categories namely; (i) prior experiences in MST; (ii) initial teacher education programme; (iii) school experience as a first-year MST teacher.

4.2.1 THE CASE OF BEA

Bea taught a Grade 1 class of 42 learners in their local mother tongue, Tswana. Most children came from single parent households where parental support and involvement were low. There was high unemployment and the school implemented a feeding scheme. Learner absenteeism was rife. Although the school was situated in a high-poverty area, the school environment was very neat, organised and safe.

Personal history in MST: Bea entered university with negative attitudes, limited knowledge and uninformed beliefs about MST that had been shaped by previous experiences. She said that she 'did science and maths in matric, I did not enjoy the subjects at school' (In1).

Teacher education programme and MST education: Bea described her process of becoming a FP MST teacher as that of a person whose *'emotions went from feeling like I was thrown into the deep end … and that I had to sink or swim'* toward *'feeling more confident'* (In1) and positive. She attributed this transformation to her university education experiences, explaining that *'University learning helps you know that you can be confident to innovate your teaching style'* and to *'apply new ways of teaching'* and you then *'adapt your techniques to grow as a teacher'* (NR1).

According to her, her teacher education programme and internship were important positive learning experiences that were instrumental in helping her to develop her professional teacher identity in the teaching of MST, as she '*changed the way I* [she] *used to think about maths, science and technology … During my years at university I realised that maths can be made interesting and can be learnt and taught in a different way'* (In1). Bea did her first internship period in a Grade 2 class at an English primary school (diverse multi-cultural context) and her second internship period at an English early childhood setting (diverse multi- cultural context). During this period she could apply her theoretical knowledge of MST in practice.

Her thinking about the nature of science and technology also changed from when she commenced her studies to her present situation *'At university I learnt that science can be approached in different ways … teacher can use lots of different environments as areas for discovery and for exploring and investigating and thinking in scientific terms – the teacher has to allow children to think and allow time to discover and explore'* (In1). She explained that *'I used to think that science is about test tubes and such, but science is all around us, technology is the same'* (In1). She wanted her learners to discover things on their own because *'science at foundation phase level is about investigating and that is our primary focus in this phase'* (NR1).

Furthermore she explained that she used the content and pedagogical knowledge, skills and resources she had acquired during her teacher education programme as a *'form of referral to remind you of strategies to use when teaching a certain aspect – using what was learnt as a basis for more reflective teaching'* (NR1). She specifically applied elements of the constructivist theory (Vygotsky) that she had encountered during her studies, *'using what was learnt as a basis for observation such as knowing the learner's "zone of proximal development"* and moving him/her from *"the known to the unknown"'* (NR1).

Becoming a professional FP MST teacher was for Bea a process of interaction between personal perceptions and specific aspects of one's professional training in a particular context. That implied a process of growth stimulated by learning from classroom experiences and also engaging in dialogue with her colleagues in her peer support group at school. As would be noted later there were also issues of disagreement (see Teaching MST) among colleagues that led to growth and resourcefulness.

School context: During her first year of teaching Bea felt that moving from being a university student teacher to the reality of her own classroom was a shock because *'My emotions went from feeling like I was thrown into the deep end ... towards working hard to make schooling a meaningful experience for each learner'* (In1).

She taught in a school that challenged her adaptive and decision-making capabilities due to the existing realities of the learning environment. The school situation was

characterised by the poverty she observed and children's learning difficulties, which were further exacerbated by a high rate of absenteeism. All of those factors and conditions posed veritable obstacles to effective teaching and learning. *'Learners are from a poor socio-economic background. They sometimes miss a few days of school. This influences their progress. So the learner ends up not knowing the subject. That is a huge problem for us'* (In2).

Curriculum interpretation and implementation: Bea initially found the curriculum difficult to follow, especially with regard to the recommended protocols and procedures specified in the Foundations for Learning document. She found the documents unhelpful: *'We have been using The Foundations for Learning Campaign files as directed by the DoE and this I found very confusing'* (NR1), because *'The curriculum changes every year. This is disconcerting. You find something that works and the next year you are made to readjust because of something else'* (In2). Bea's resistance to the change reflected a loss of a sense of herself as a teacher, because curriculum change required new approaches and attitudes. The reluctance to use the documents or to entertain the curriculum changes might also reflect the effort that she needed to make to adjust to a new direction contrary to what she had been exposed to at the university. It required an effort to justify herself as a teacher.

Teaching MST: Mathematics was regarded as the foundational subject at the school and it had a prominent place in the curriculum. *'Maths is a priority subject'* (In1) and *'Maths is important every day'* (In2). She was positive about teaching mathematics to her children and enjoyed their reaction: *'I think my children love mathematics because they see I love it'* (In1).

While mathematical knowledge and skills were regarded as the main focus of teaching in the primary school, the school curriculum did not make provision for the teaching of science and technology. There was some disenchantment in the way science was taught or not taught in the school. She insisted that *'Learners should know science and I wish I could do more. Maybe I should plan better to include science on Fridays'* (In2). Bea's situation was clearly expressed when she said: '*We* [other staff members] *plan the subjects together and science is not a priority subject because it does not count for marks*' (In1) *'…so there is very little time to teach*

science … However, we could plan a science project like a discovery table' (NR2) she posited.

She identified factors that inhibited her from fulfilling her role as an MST teacher. *'The factors that caused me not to teach science and technology are because of lack of time'* (In2) and *'Very little science and technology, if any, is taught in the foundation phase at the school. I don't see science and technology'* (In1).

This hidden uneasiness about the school's (and colleagues') position on science and technology teaching led to growth as a teacher. She revealed her creative ability by adapting the curriculum to integrate science and technology with other lessons, consistent with the intentions of the FP curriculum. She explained that *'Science and technology are taught integrated with life skills and language'* (In2). When the teachers' strike interrupted her science lessons over an extended period of time, she felt frustrated because *'Our science observations (about plant growth) had to be postponed and there was very little time left in the end to make a really good observation and measurement of the processes'* (OR). She also wanted to start a science corner and *'to include science into my teaching, maybe a discovery table'* (NR1). However, she did not find the integration of science and technology into the programme easy. With mathematics it was a little more straightforward: *'You do the maths, and have to integrate the science through other subjects … this is difficult'* (In2). What motivated Bea was clearly a love for MST. She appeared to lose a sense of herself as an MST teacher when she learnt that the curriculum was about to change: '*I heard that science and technology are being removed from the curriculum and I am against this removal. The subjects are essential for the development of the child'*, and *'The curriculum changes every year. There is a lack of consistency'* (In2). Curriculum change was likely to affect her professional teacher identity formation, because curriculum change was likely to result in new stories and new situations to live by; new interpretations and re-interpretations of experiences. Thus, teacher identity formation is invariably an ongoing process of construction and reconstruction of identity.

Institutional support: Since professional identity implies both person and context, Bea's dilemmas and emotional conflicts were alleviated by the support she received

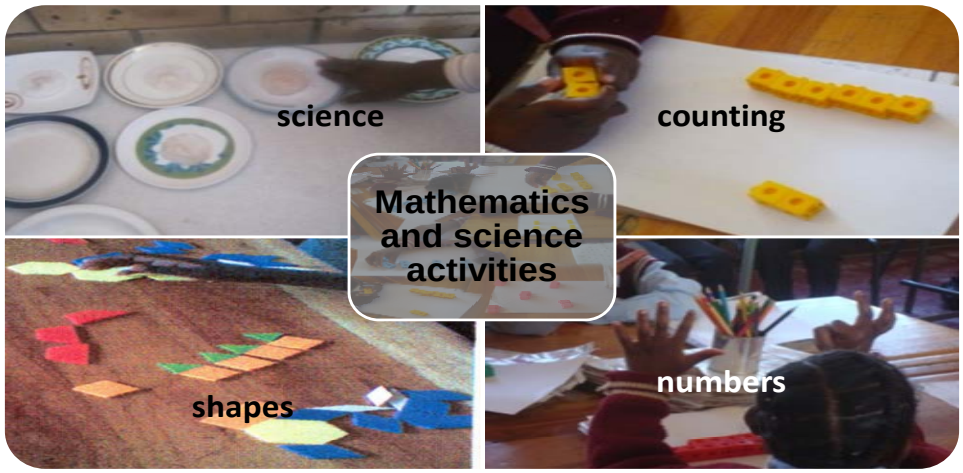
from her colleagues at school. She approached them for help and she received the assistance she sought: *'I experienced a lot of support from my fellow teachers and my senior'* (OR). Institutional support from her peers created positive emotions and feelings of self-worth and self-confidence, to the extent that she was able to win the confidence of her colleagues, because, as she put it *'I convinced the team through my enthusiasm and they know I am able to do things because they ask me for my ideas and input'* (NR1). She felt that she had *'grown in the past few months from being a 100% theoretical teacher to being one with some experience; I have seen how what I have learnt can be implemented in the classroom'* (In2).

Classroom practice: She adapted the curriculum in a way that suited her own beliefs about the nature of mathematics (science and technology not as prominently) and how it should be taught at that level. She positioned herself alongside the children in her class in a somewhat symmetrical relationship as co-inquirer in which all the children explored concepts through guided discovery. Pondering on her classroom practice she stated that the *'continuous interactions between the learners and myself in the teaching and learning situation and their reactions and mine to the daily happenings in the class help me reflect and fine-tune how I teach for a better lesson the next time around'* (OR).

Although she had to change and adjust her pedagogy to the reality of her classroom, her positive beliefs about her teaching ability consistent with the inquiry-based approach strengthened. She said *'I am positive about my teaching. I feel that I am making a difference'* (In1) and *'I believe that my identity is strong enough for me to be successful and to become an even better teacher. I want more knowledge; I have a passion for children and I want to be there for them'* (In2). She adapted to the poverty and absenteeism of the children in her classroom by: *'I adjusted my teaching approach to the practical situation at school. I still have the same attitude and beliefs about the subjects. But I have learnt specific information about the school, who my learners are and how to teach them'* (In2).

She regarded herself as a 'hands-on' teacher who tried to use creative means (as part of her identity formation) to teach her children: *'I believe children need to manipulate resources in order to learn better ... I always use counters so that the*

child can move smoothly from the concrete to the abstract' (In1) and she created 'an atmosphere of discovery and one that fosters learning...' (NR2). For example, *'With each planned lesson, using a weekly planner, I write how each aspect of say a given concept is going to be dealt with and then I play it out in my head. At the time of execution I observe how the learners react ... and this reaction sometimes indicates to me what I should do in a different way and how differently'* (NR1).



Bea created a resource-rich classroom where learners were engaged in hands-on activities (for example counters, shapes and growing seeds). She planned mathematics and science problem-solving activities.

Figure 4.1: Bea's classroom practice (observation and photo collages)

For Bea the process of becoming an FP teacher started when she entered the teacher education programme. Her MST professional teacher identity formation was an ongoing process of interaction between her personal perceptions and the professional training she received. She overcame an initial period of uncertainty during which the reality of her demanding teaching situation required dedication to her task as teacher. Her desire to teach and to make a difference in the lives of children, combined with encouragement and support from her principal and colleagues, were aspects that enabled her to sustain and grow her professional teacher identity in the teaching of MST.

4.2.2 THE CASE OF RIANA

Riana's first year teaching experience was in a Grade 2 Afrikaans class with 25 children at a primary school situated in the east of Pretoria. Although most learners came from middle-to high-income homes, there was a support group that assisted the increasing number of learners that needed food and clothing. This school endeavoured to employ educators that make a difference and Riana was employed in a permanent post.

Personal history in MST: Riana had *'science and maths in matric, but did not like it…'* (In1) and consequently did not feel positive or confident about teaching mathematics and science. Riana elaborates that *'I used to be negative about science, because I did not understand it and did not like it'* (In1). Riana admitted that she had no knowledge of technology when she entered her teacher education programme, as she had *'no technology*.' (In1) exposure at high school level and therefore *'technology … was an … unknown learning area'* (NR1).

Teacher education programme and MST education: Riana entered her teacher education programme with negative feelings about mathematics and science and limited knowledge about technology. There were indications that at the beginning of her first year of teaching her feelings had changed as she explained *'My training at university helped me to recognise that MST are important'* (In2) and she also at that point felt that *'science is part of our lives'* (NR1). Riana explained that her experiences as student teacher at university prepared her for her task as a teacher and formed a *'good foundation'*, and she had *'learnt* [the] *most in maths, … and … technology, but not much in science'* and that she had *'the latest information and I have something to contribute'* (In1). For Riana, her professional teacher identity had been formed through the interaction between her own background and the influence of her university training as her *'thinking skills and other skills were developed. This was meaningful'* (In2) and therefore *'My training taught me to think independently'* (In2).

Although her teacher education programme and internship provided important information, she felt that she was not yet adequately prepared to teach technology,

because *'At first when I thought of teaching a technology lesson during my teaching practice, I felt insecure as this was an unknown learning area to me'* (NR1).

Riana did her first internship period in a Grade 1 class at an Afrikaans primary school and her second internship period in a Grade R classroom at an inner-city English primary school (diverse multi-cultural context). In spite of her initial insecurity about technology, she had had positive teaching experiences in technology and science involving the children and her mentor teacher. She explained that *'During practice teaching my teacher was open to discussion on teaching technology and we gave a combined technology lesson that worked'* (In1) and *'I teach science based on the interest that children show'* (In1); *'They* [learners] *were building volcanoes in the sandpit*' (NR1); '*They asked about volcanoes, so I did a science lesson on volcanoes. The reaction was exciting'* (In1).

School context: After a positive teaching experience during the internship period, working with the established teachers and groups within the school was an enormous shock to Riana*. 'Now that I have my own classroom it is difficult to teach the way I want to, because I have to fit in with what the other teachers do. During the first meeting I was told that what one does, everybody does. This makes teaching very difficult'* (In1).

Riana had developed specific beliefs, feelings and opinions about MST teaching during her teacher education programme and she felt that teaching MST was important. Instead of just following suit and doing what the other teachers did, she had her *'own ideas and think for myself'* (In2). When she entered the new school context she realised that her beliefs, feelings and thinking about MST were different from those of the teachers at the school. She stressed that she felt *'frustrated because in the primary school I cannot teach the way I would like to. I cannot teach like this for a whole year'* (In1).

Riana was also under pressure from parents as they were *'very involved in their children's progress and this creates pressure'* and the parents *'compare books* [from the different Grade 2 classes] *and complain if the books are not the same'*. In spite of this difficulty she found innovative ways to maintain her beliefs about MST teaching *'if*

I do something original, I do it on a loose sheet so that the parents cannot pick it up' (In2).

Riana's experiences during her first year of teaching put pressure on her teacher identity. She realised that she had to survive and consequently conformed to the politics and culture of the school, saying that *'I did things their way to know I was safe, and not to have pressure from the parents'* (In2).

Riana had undergone an array of emotional experiences as a beginning teacher, and the story of her professional experiences raised interesting questions about the emotional dimension of teachers' work. These emotional experiences resulted in an identity conflict and as first-year beginning teacher she became uncertain about her knowledge and ability. She said: *'I feel that I don't have all the knowledge, and I am inclined to rather do what the others do in case I don't have the right idea'* (In2). Riana's feeling of insecurity continued throughout the first year. She was severely restricted and frustrated by the teachers' inflexible ways but she tried to maintain her positive attitude and beliefs about teaching. She felt that her learning curve had been restricted by the school situation but she maintained that the *'university gave me skills that assist me to cope'* (In2).

After an initial period of negativity she devised solutions to reduce her frustration. The *'solution for me is that I must convince the team through my enthusiasm; it all depends on my enthusiasm'* (NR1). She planned alternatives to teach her way and therefore *'I am going to negotiate, which will be difficult but worthwhile; let's see what happens'* (In1). She also tried to plan new approaches with the support of the other like-minded young teacher, but she knew that it *'depends on the time we have and how flexible I'm allowed to be within my prescribed work schedule'* (NR1). To a certain extent she felt that she had made progress. *'Now, after almost a year, they are more inclined to listen to my ideas than at the beginning. They think I am more realistic now, after a year'* (In2).

In spite of her initial feelings of frustration and disappointment about asserting herself as a professional teacher, Riana tried to maintain her positive attitude towards the school, her colleagues and MST teaching. She devised an approach to try and solve

the difficult context in which she found herself while maintaining her professional teacher identity. She recognised her first year of teaching as a year of learning new skills and indicated that *'I have learnt to work with other people. I have sharpened up my negotiating and social skills because I have learnt to work with others. I have also learnt how to manage time effectively'* (In2).

Curriculum interpretation and implementation: Compounding Riana's challenges were the cumbersome curriculum demands: *'The curriculum requirements and goals set to achieve by the end of the term create pressure'* (In2). Moreover, the challenge of navigating and gaining familiarity with the curriculum requirements made it difficult to support the special needs of some learners in her class: *'The negative effect is that the weaker children cannot keep up and once they fall behind, they cannot catch up. Some children are disadvantaged because of the pace required'* (In2). Riana admitted, however, that *'The curriculum requirements and goals set to achieve by the end of the term create pressure'* (In2).

For her the reality of curriculum implementation comprised adapting her aspirations and convictions as a teacher with a positive teacher identity to the reality of the curriculum in that *'Technology as a learning area gets little attention in the curriculum of my school. Many teachers see technology as a waste of time'* (NR2). She also *'noticed that the school curriculum does not allow much time for science, I would like to make my own time for science. I also want to try and inspire the other teachers to do more science activities in their classes'* (NR1).

Teaching MST: Teaching mathematical knowledge and skills is a very important focal point of teaching in the primary school. Riana felt comfortable with the teaching insights she had received during her training: *'Much of the material we received is valuable'* (In1). She was *'positive about teaching maths'* and more important, she wanted to *'ensure that children feel positive towards maths'* because for her mathematics was *'one of the learning areas that children can feel enthusiastic about and they can do well'* (In1).

She believed that *'maths is important, but children have to be taught the concepts; they cannot learn them by themselves. The work should be enriched'* (In2). Riana

revealed the underlying strength of her teacher identity when she accepted the challenge of balancing the workbook with hands-on activities. *'In working with both, I have experienced that the hands-on activity carries much more value'* (NR1). She expressed her concern about the use of workbooks in mathematics: *'During my teaching practice I experienced that most schools have a set of workbooks which they follow when it comes to mathematics. The problem with this is that when you extend the lesson beyond the workbook, you lose time and you get stressed'* (In1).

During October of Riana's first year of teaching, she still struggled to find a compromise to the conflict between the school culture and her beliefs. She tried to construct a sense of herself in relation to the challenging teaching context in which she found herself. She maintained that: *'I also like to use counters when introducing a new number'* (NR1) because *'I like to make my numeracy lessons more hands-on, but I have time constraints'* (NR2). Riana felt that her more concrete and creative approach to teaching mathematics *'brings me into conflict with my fellow teachers, because they want to do the same as last year. They are unwilling to try new stuff'* (In2).

Throughout the observation lesson it was evident that Riana tried to implement her beliefs about MST; for example, during her reflection on the lesson she pointed out: *'I believe that children should first do maths practically. I did not use the workbook in my lesson because the children would not have understood the concept. They learn more if they write the work themselves. They enjoyed the lesson'* (In2).

As the year progressed, she found it easier to assert herself and to implement her mathematical pedagogical epistemology by utilising blocks and other physical teaching aids in group work. She contended that *'Learners understand concepts more quickly when I use three-dimensional materials. I am also more relaxed and better prepared because I have grown used to the pace of the daily programme'* (NR2).

Although she was positive about science and technology she expressed concern that very little time was available for those two subjects. She pointed out that *'unless the curriculum provides more time and attention to science and technology, these two*

subjects will be sidelined as less important. There is no time to teach these two learning areas' (In2). For her *'technology and science are important because children learn valuable concepts and they also enjoy them'* (In2).

Additional pressure was exerted on Riana's professional teacher identity because the school curriculum did not provide for the teaching of science and technology. Therefore, implementing science and technology into Riana's Grade 2 class posed some difficulties at first, as she explained: *'I don't have time for technology lessons, but I am going to do technology during the art class'* (In1) and *'I cannot teach a science lesson only in my classroom. All the classes must do the same work. Secondly I have to teach the three learning areas that are important to the school, literacy, numeracy and life skills (movement)'* (In2).

Although it was difficult, Riana planned to teach science and technology by *'changing some of my time allocation of life skills to provide time for science and technology lessons'* (In1). Riana believed that *'if you do not make time to teach science and technology, there will never be time to teach them. You have to prioritise the teaching of science and technology'* (NR2). She found practical solutions and declared that she had *'learnt to accommodate science and technology in the last half an hour of the day'* (In2).

Riana believed that science could be taught *'through discovery and experimenting. At this level science is about everyday things'* (In2). She would have liked to teach science and technology *'based on the interest that children show'* and she would *'start with the project approach to make them used to thinking about things, and then tackle a science lesson'* (In1). One example of Riana's approach to science teaching was when she used the theme *'animals'* in a science lesson. *'We discussed the different kinds of animals and their characteristics. Then learners collected pictures of animals and sorted them into categories and as a summary of the week's work they had to draw a brain map of the different mammals'* (NR2).

Institutional support: Reflecting on her first year of teaching, Riana recalled feelings of exclusion by the more experienced teachers for her ideas about MST teaching. Her story provided insight into the challenges facing her as beginning teacher with

regard to how she perceived judgement from the older, more experienced teachers, who instead of respecting her knowledge as beginning teacher, regarded her as inexperienced. The group of more experienced teachers at this school provided support on condition of compliance. As a new teacher in a school with its own political culture where a *'first-year teacher is not recognised by the older teachers who feel that you have book knowledge, but you don't have teaching experience'* (In2), she felt that she had no support. *'The older teachers have their ways of teaching and if you do not fit in with them, they are negative against you'* (In1).

Riana indicated that she valued the assistance of experienced teachers when teaching specific mathematical concepts. She explained that they *'helped me when I went to them for assistance. They would advise me on how to teach a specific concept if I was uncertain'* (In2). However, she experienced this assistance as *'negative in the sense that teachers would indicate how they would do something, indicating that any other approach would not work'* (In2). The negative influence that she experienced from the older teachers was counteracted by the support of another beginning teacher who also believed in hands-on teaching methods. *'Fortunately we are two new teachers out of a group of five who teach Grade 2 and we have decided that we will push our ideas'* (In1).

Riana's professional teacher identity withstood different feelings of isolation, disagreement and discouragement at the beginning of her teaching career. She experienced a school culture that contradicted her teaching beliefs and her vision of the profession that formed the foundation of her experience as a new teacher. She commented that *'The situation at school was not what I expected. The school prescribes methods and approaches and this has a negative effect on me. During my interview the principal asked me what I could contribute to the school and I felt that I had a lot to contribute, such as my way of teaching and my insights into methodology. I was excited to teach, but the situation at school disappointed me and I thought: is this what teaching is about?'* (In2).

Riana's negative experiences in her first year of teaching infused many aspects of her teacher identity. She felt that *'The biggest influence on my teaching was the school situation. I think I would have had a totally different learning process if I had*

been at a different school. I wanted to teach in a particular way, but the workbooks and the way that the teachers work together had an influence' (In2). This had not been the teaching experience she had envisioned; it was therefore not surprising that she left this school at the end of her first year of teaching to go to another school where she might get a chance to employ her beliefs and knowledge.

Classroom practice: Riana felt challenged by the administrative duties that took her away from her teaching MST. *'I am out of my classroom to do other things, not teaching all the time.'* (In1). The numerous administrative tasks frustrated her because they affected the children's MST learning, and in order to cope she had to compromise with the use of *'worksheets'*, a pedagogical approach she did not agree with, because she believed in *'working creatively and three-dimensionally with the children before going to the abstract. Workbooks are difficult and ineffective because of the way they are constructed and used. I am not positive about workbooks because I think there are more effective ways of teaching'* (In1).

Another frustrating interruption to her classroom practice was the intrusive use of the intercom system for announcement and administrative purposes. She said: *'One of the factors that had a detrimental influence was the intercom system that interrupts my lessons and most of the time the announcement had no bearing on us. This is a major interruption and distraction for the learners'* (In2). During the observation of an activity where the children were actively involved in counting money the intercom came on seven times and interrupted Riana's teaching and the children's learning. Riana refocused the children after each interruption and completed the lesson.

When Riana entered the school as first-year beginning teacher, she was eager to make a difference and to be accepted as an equal with something to offer. She wanted to be a good MST teacher and to teach creatively. Although she was challenged by time and institutional restrictions that at times prevented her from teaching MST according to her beliefs, Riana developed a more flexible practical approach to teaching that provided time for both hands-on activities and the workbook. She was convinced that through hands-on, three-dimensional activities, the *'learners don't experience the three-dimensional work as maths and think they are playing'* (In2).

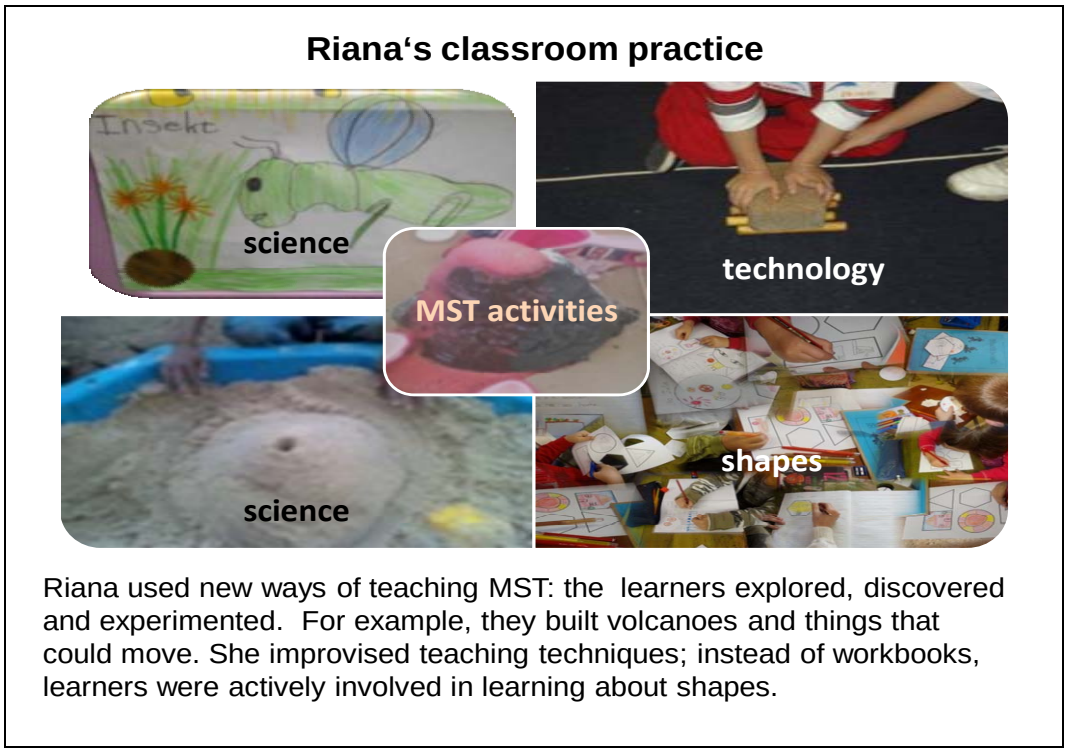


Figure 4.2: Riana’s classroom practice (observation and photo collages)

Riana entered her teacher training programme with a background of mathematics and science, but she was not confident about teaching the subjects. After positive experiences during the teacher education programme which formed her professional teacher identity in the teaching of MST, she started her first year of teaching feeling enthusiastic about teaching the subjects at FP level. Riana’s positive approach to teaching was stifled because of the conflict between the school culture and her beliefs. She found it difficult to sustain her professional teacher identity in the face of opposition to her convictions on MST teaching at that particular school. During the first year she struggled to find a compromise between the school culture and her beliefs as an MST teacher. At the end of the year she left the school to teach in an environment that would hopefully accept her ideas on MST teaching. Taking this step indicates that Riana sustained her MST professional teacher identity.

4.2.3 THE CASE OF LEA

Lea’s first teaching post was at a rapidly expanding Afrikaans primary school in a northern suburb of Pretoria. As one of six Grade 2 teachers, she had 36 learners in her class. Although most of the learners came from middle-class income homes, a

few children required financial support and there was a growing number of children from single-parent families.

Personal history in MST: Prior to entering the teacher education programme, Lea recalled her negative feelings about the rigid approach to teaching mathematics and science at school level *'I remember the structured nature of mathematics and science teaching and we did not have the opportunity to learn (creatively) what learners have now'* she *'did not have technology at school'* and she only *'did science up to grade nine level'* (In1).

Teacher education programme and MST education: Lea entered her teacher education studies at university with what may be described as negative feelings towards MST. *'When I started with the mathematics modules I was negative because I did not like mathematics'* (OR). *'I did not know much about MST'* (In1). However, she later acknowledges that her four years at university had broadened her outlook and changed her perceptions about MST '*the methodologies of MST have made me change my perceptions about these subjects'* (In1). She has become 'aware of many aspects and possibilities to teach mathematics' (NR1) She has now realised that *'children like maths'* (In1) and she now feels *'differently about maths'* (OR).

Lea did her first internship in a Grade 1 class and her second internship period was completed in an English early childhood setting with a diverse multi-cultural context. Lea's experiences during her internship and the research project during her final year helped to shape her attitude towards teaching MST. She would often refer *'back to my experience during training'* (In1). Although she at first did not understand *'what it means to think mathematically, ... after completion of my internship I was thinking mathematically, scientifically and technologically'* (NR1).

Although her internship period changed her perceptions, she observed some realities about MST teaching in schools. She came to the conclusion that *'maths was only taught at two-dimensional level, especially in the primary school. I also noted that very little science and technology is taught in the primary school'* (In1). Lea completed her teacher training programme with a firm resolve to include learner-centred, creative approaches in her teaching of MST. Her approach to teaching was

confirmed during observation when the children designed milk bottles during an integrated MST lesson.

School context: Lea entered her first year of teaching feeling positive about teaching MST as she was appointed by the school where she had completed her internship. Although she valued her internship period at a time which she termed to be *'a make or break year'* (In2), the reality of the school culture was not in sync with her ideal vision of the profession. Very soon she was made to realise that *'A new teacher cannot think that she can come into her classroom and do what she wants; ... there are too many restrictions and rules'* (In2). Here Lea refers to the workbooks that had to be completed and that all the classes had to do the same work. She described her first year of teaching as *'not easy'* because when *'you stand in front of your own class for the first time you are uncertain'* (In2). She was torn between what she wanted to do and what she was expected to do with regard to teaching methodology. She stated that for a teacher *'being in your own classroom is vastly different. As student teacher you are unaware of what really happens at school. The pressure in your own classroom is tremendous, as other tasks intrude on your teaching and everything has to be completed'* (In1). The situation that she describes pressurised the formation of her professional teacher identity, but at the same time strengthened her resolve to carry on.

Lea found that the older teachers at school did not support her belief that science and technology are important learning areas. She realised that the *'older teachers have never done science and technology and therefore have no interest to teach the subjects'.* She was *'careful not to attract too much attention with new approaches and teaching methods. I keep a low profile not to attract attention'* (In2). She tried to keep a low profile and explained that *'I conform because I do not want conflict'* (In1).

The other teachers at the school mainly used workbooks when teaching mathematics and did not always allow learners time to do hands-on experimentation and discovery. She experienced conflict because *'Some days I do not want to use the workbook, but I must keep up with the other five teachers. Everybody does the same'* (In1), and her *'colleagues have been teaching for a long time and are not open to new ideas'* (In2). While teaching the way the other teachers do may be regarded as a

coping strategy for survival on her part, this approach pressurised her professional teacher identity as she wanted to teach differently.

Lea acknowledged that she did not have enough time to teach the way she wanted to. Time constraints were a constant challenge that permeated her professional life. She acknowledged that during *'practice teaching I could negotiate with the teacher to do something new, but there is no time at school. The workbook must be completed in a hurry, and that is all that is possible in the available time … time is a factor that has to be kept in mind when teaching'* (In1). A further complication was the fact that *'many admin tasks make it difficult to plan my teaching day'* (NR2).

The school employed a team approach to lesson planning. During these team meetings she used the opportunity to share her pedagogical knowledge from her teacher education programme. She explained that *'I still make use of my books from university when planning my lessons. At school we do team planning, and when I do the preparation for everybody for the week, I use what I have learnt, especially the maths and science handbook that we used at university'.* However, sadly the reality was that her *'new ideas are not accepted'* (In2) and this feeling of frustration and rejection of her ideas exerted pressure on her developing teacher identity, as agent of change and transformation.

The challenges that Lea experienced at that school were compounded by the pressure from parents who wanted all the classes to do exactly the same work *'parents talk to one another and apply pressure'* (In2). She also felt that coping with the children's poor socio-economic background complicated teaching and added that *'some children are from poor socio-economic homes and do not have food. Some children come from broken homes, with resulting problems'* (In2). However, in spite of these challenges she *'had positive feedback from (some) parents who write encouraging comments in the children's books that I send home and at feedback meetings'* (In2).

Lea's story sheds light on how the school situation, institutional support or otherwise affect professional teacher identity formation for a beginner teacher. The many challenges and how they go about resolving those professional dilemmas exert

pressure on the developing professional teacher identity. For Lea, the challenges were met with a resolve to keep on planning to convince the other teachers of her viewpoint.

Curriculum interpretation and implementation: Lea realised that mathematics was the foundation subject in the numeracy programme. However, the challenge of navigating and gaining familiarity with the FP curriculum translated into the difficulty of teaching science and technology, as no specific time was allocated to the teaching of these two subjects. *'The tempo of learning at school is high, as are the standards. Children have to achieve specific assessment standards and milestones. This makes the teaching of science and technology very difficult'* (NR2).

South African curriculum documents recommend cross-curricular integration of learning areas. However, these suggestions were difficult to implement as *'I still try to integrate technology into art or maths in my own class. I try to do the same with science, although it is more difficult with science'* (In1).

The announcement by the department of education that *'technology is going to be removed from the curriculum from 2011'* (In2) brought the realisation that the curriculum would be much poorer for its removal and that the children would suffer: *'we are moving backwards to the old ways of teaching that are less learner-centred and children cannot learn effectively'* (In2). Lea felt apprehensive about that curriculum change, as she felt that MST concepts should be taught to prepare children for the more advanced classes. She felt that with the impending removal of technology from the curriculum and with science not receiving adequate attention, it was difficult to teach science and technology. The change affected her pedagogical beliefs that children learn through *'discovery and experimentation'* (NR1) and her epistemological beliefs: *'I feel that science and technology will die out unless I do something about it. They [children] will lose out unless I introduce them to the children'* (In1). The situation described here put pressure on Lea's professional teacher identity as she felt that she could not teach her children the way she believed she should.

Teaching MST: Teaching mathematical knowledge and skills is a very important focal point of teaching in the primary school. Lea felt comfortable with the teaching insights she had received during her training. She felt that *'mathematics is a foundation subject'* (In1) and it *'is the focal point, science and technology are subsidiaries'* (In2). She also believed that *'MST form the basis for learning in other learning areas'* and that *'MST provide important knowledge and skills to learners that they will be able to use for the rest of their lives'* (NR1). For Lea, planning her lessons was most important, as *'without planning and preparation, lessons tend to be reduced to talking and workbooks and the children don't benefit'*. Lea wanted the children to *'become skilled at problem-solving'* (In2). Therefore, the acquisition of inquiry skills was an important focus in her MST teaching and she planned to develop these skills by allowing the children to talk about what they had done and learnt *'I often do the reflection informally'* (In2).

Lea's attempts to teach science and technology were severely restricted by the curriculum guidelines that required the integration of science and technology into the other learning areas. *'I try to teach science and technology but this does not often happen'* (NR2) and *'There is really very limited time to teach science and technology in the foundation phase'* (NR1).

Lea's vision of teaching creatively was stultified by the rigid, prescriptive school structure that required the completion of workbooks. Consequently she could not let the children use counters and other manipulatives. She felt that her teacher identity was negatively affected by her inability to teach creatively and that she was *'stagnating as a teacher. I find that the reality in school is different'* (NR2).

During a visit to her classroom, Lea demonstrated that in spite of the various challenges she encountered, she had a well-constructed teacher identity in MST. She integrated the three MST learning areas in her teaching to accommodate science and technology. For example, she planned an integrated MST lesson around a real-life problem *'the children had to design their own milk container that did not need a fridge'* (OR). The lesson included mathematical measurement concepts – the children experimented with hands-on activities measuring different volumes (millilitres and litres). Science concepts came into play when children observed what *'happens*

to milk when left in the sun' (OR). In technology the children had to design a milk container that would help to keep the milk fresh. During this visit it was evident that her philosophy of teaching was an integrated MST approach where problem-solving was an important component of her planning. Lea's approach to pedagogy was hands-on and interactive, as she believed that *'learners react more positively when they are actively involved in their own learning process and I plan the activities in such a way that learners can be hands-on'* (NR1). She experienced the integrated curriculum as a reality in her day-to-day practice. She observed that *'I integrate and apply MST concepts in structured lessons'* (In1).

Lea's professional teacher identity in teaching MST seems to be based on a positive approach to learner-centred inquiry-based teaching. She believes that MST should be taught as an integrated whole, for the benefit of the children *'They enjoy active participation much more than sitting passively'* (NR1).

Institutional support: Lea's experience provides some insight into the challenges that beginning teachers face and the pressure exerted on their developing teacher identity if they feel they are not supported by more experienced staff members, who instead of guiding them, do not regard their ideas, content knowledge and pedagogical knowledge as valuable. Lea *'felt that I did not have support, except from the other young teacher'* (In1); furthermore, *'new ideas were not accepted'*; the *'situation at present makes me [her] feel like a failure, as if I am a bad teacher'* (In2). As a result she *'find*(s) *teaching difficult because it feels as if I am stagnating because I cannot think creatively. There is no time for learner-centred activities and when I suggest something my idea is turned down'* (NR2). The *'school where I am does not allow me to teach anything outside of their usual programme. My head of department is not open to new ideas'* (In2).

Furthermore she felt that the *'more experienced staff members' do not have the background in science and technology. There is also the fact that the other teachers do not want to spend time to plan the new lessons'* (In2). In the beginning Lea admitted that she found it difficult to implement her MST beliefs, new ideas and knowledge and it was difficult for her to assert herself confidently in her teaching role without the support of management and experienced teachers. The school culture

invariably affected her teacher identity formation negatively and this resulted in an identity crisis. She felt that she was compelled to adapt *'I will have to adapt to a degree to avoid conflict'* but towards the end of the year she declared that *'I shall not become like them, I shall keep on teaching the way I want t*o' (In2). She announced that she did not want to *'follow the rules'* (In2) of the school culture, she wanted to prove herself and act decisively, thus asserting her identity by taking on the challenging school context and teaching MST the way she believed would benefit the children in her class. Lea fell back on the conviction that MST had to be taught and learnt according to how she had been taught at university, namely in an inquiry-based manner.

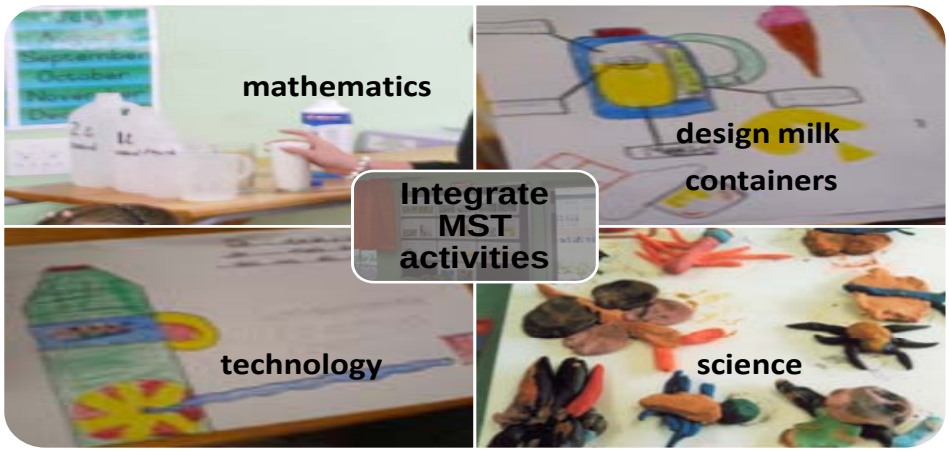
Classroom practice: Lea had to find a way to cope as a new teacher within a school culture that did not support her positive beliefs about MST teaching. In addition, she struggled with not having enough time to attend to and adequately prepare MST lessons using appropriate pedagogical knowledge and resources. She found that familiarising herself with the curriculum and the *'specific assessment standards and milestones was time-consuming'* (NR1). Lea further experienced conflict as her *'opinion has changed about the teaching of MST. There is not as much time as I originally thought when I was a student. I want to teach maths the right way. The old way of teaching is not learner-centred, which is bad because children cannot think for themselves. Keeping the different learning styles in mind, the workbooks are not the answer. I am behind with my workbooks because I am doing practical work'* (In1). Lea reacted emotionally as the *'situation at present makes me feel like a failure'* (In2).

Practical experience in the classroom resulted in increased insight and awareness of how children learn and what should be taught. She taught *'maths differently from the other teachers. I use counters and Unifix blocks with counting to reinforce the concepts'* (In1).

Her colleagues were *'not open to new ideas'* (NR2) and they turned down her ideas. She had to change and adjust her pedagogy to the challenges of the school context and the reality of her classroom in order to survive. Although at first she reacted emotionally to the dilemmas in which she found herself and *'feel*(s) *like a failure'*

(In2), she gradually strengthened her positive beliefs about her teaching ability, which is consistent with the inquiry-based and hands-on learner-centred approach. She felt that *'children do not learn better with the workbooks, they learn better if they can experiment and explore'* (In2). Consequently she planned *'for the children to experience learning material'* and to *'learn from one another. I team up a strong learner with a weaker one, and they learn from each other. I go back to my experience during training'* (In1).

Lea's classroom practice



Lea used creative techniques to integrate MST activities. She often replaced workbook activities with exploration. During the classroom visit the learners worked in pairs to design milk containers to keep milk chilled.

Figure 4.3: Lea's classroom practice (observation and photo collages)

Lea entered the teacher training programme with a limited background in science and technology. In spite of this, she entered the school environment with a positive MST professional teacher identity, largely due to the influence of the teacher education programme and specifically the research project. Her professional teacher identity was immediately under pressure due to the demands of the school culture, lack of support and conflicting ideas on MST pedagogical approaches. She partly conformed to pressure and used pedagogical approaches contrary to her beliefs. In spite of this, she used innovative integrated approaches without attracting attention, thus sustaining and even strengthening her MST professional teacher identity.

4.2.4 THE CASE OF GINA

Gina had a class of 22 three-year-old children in a well-resourced private early childhood school in a south-eastern suburb of Pretoria. Most children came from high to middle socio-economic income homes. The languages of instruction were Afrikaans and English. Gina had a teaching assistant who helped with cleaning and assisted with some activities. The formal programme ran from 08:30 until 12:00, when the children had lunch (the school provided the food).

Personal history in MST: Gina was exposed to MST knowledge at school, as she *'took maths, science and technology in matric'* (In1). At school she was *'positive about maths and science'* but she 'did not like technology' because *'we were the first OBE [outcomes-based education] learners and the learning material was very confusing'* (In1).

Teacher education programme and MST education: When Gina entered her teaching education programme she was positive about mathematics and science but did not like technology; she said that '*it was badly taught ... I did not enjoy it at school'* (In1). After studying technology at university, she changed her mind. She was more positive and wanted to teach the subject and she wanted children to feel positive about it. She explained that *'I feel that I know what technology is and that I don't want children to feel towards the subject what I felt'* (In1).

Gina's love for science was evident when she chose *'general science as a three-year elective in her teacher training programme'* (in1). She further said that the *'science pedagogy we studied was not as comprehensive as the maths pedagogy, it was very basic. I had to find out later exactly how the information fitted into my teaching of the subject*' (In1).

For Gina, becoming a professional early childhood MST teacher was a process of interaction between personal perceptions and specific aspects of her professional training. The learning process implied growth stimulated by theoretical knowledge (MST modules in the programme) and learning from classroom experiences (internship period). Her experiences during the internship programme were *'definitely*

influenced by what I had learnt from the modules during my teacher training programme' (NR1).

She confirmed that the MST knowledge she acquired during her studies provided her with a platform to expand from, but it also made her question the position and value of science and technology teaching within the FP. She found it difficult to accommodate science and technology: *'The reality about science and technology is that teaching science does not exist where I am.'* (In1) and *'teaching technology takes too much time'* (In1). Furthermore, Gina found technology *'a very difficult subject to teach when children do not have the basic skills required to carry out technology activities'* (NR2).

Although Gina had prior exposure to MST at school and in her teacher education programme, she had limited practical exposure to the teaching of science and technology during the internship. She said *'I did not experience a whole lot of science or any technology during my internship in the Grade 1 classroom*' (NR1) and she did not have enough time to teach science and technology: ' (NR1). She further felt that *'if you want to fill the gap of science and technology, you have to think differently'* (In1). Gina demonstrated her developing teacher identity in science by devising strategies such as planning activities in the vegetable garden and including insects and animals themes to her the classroom practice.

School context: Gina entered her own classroom with confidence, but her concept of self as a teacher was challenged when she was faced with unforeseen complexities. Gina found teaching in her own classroom difficult due to time constraints and the young age of the children in her class. She elaborated thus: *'Constraints are placed on the kind of activities I can plan because of the age of the children, the time available for work in the daily programme as well as the expectation from the principal and parents to produce a minimum number of lasting products (mostly pictures) in a week (it is expected that each child should create two products during a week)'* (NR1). As lack of time was the problem, she needed to improve her time management skills and *'adapt from the time when I was a student on practice teaching and had much time, to the present where time is of the essence'* (In1).

Her notion of self as a teacher was apparent from her ability to adapt to the situation of dealing with parents and administrative duties and her mastery of coping mechanisms. For example, she survived by planning her teaching to accommodate the different influences and challenges she encountered. She stated that she *'found doing things in class difficult at first, but* (they) *became easier as I taught more. Things that take time are the everyday admin tasks or consoling young children when their parents bring them to school'* (In2). She also experimented with different teaching techniques because *'master*[ing] *teaching techniques on my own'* helped her to *'understood them better'* (In1).

She managed her feelings of initial frustration by planning her daily programme to include what she wanted, while at the same time adhering to the requirements of the school such as the paper trail evidence for the principal and parents. Gina attributed much of her ability to adapt to *'the situation at school'* (In1) to personal experience and mastering teaching techniques.

Gina felt confident about teaching MST because she realised that she could accomplish more in her early childhood classroom than elsewhere: *'The pre-primary school situation is much less rigid than primary school ... the teacher has more freedom to attend to children who need help. Also the pre-primary class has an assistant who can help'* (In1). In this specific setting an assistant was provided, which might not always be the case in all situations.

Curriculum interpretation and implementation: Gina realised that she had more freedom to teach in the early childhood setting than teachers in the primary school, in spite of the expectations from the principal and parents that contradicted her pedagogical beliefs. During observation it was evident that Gina was given the opportunity to make her own decisions on content and pedagogical approaches. Gina believed that children should *'learn about maths, science and technology using physical objects, as far as possible. I incorporate the maths/science activity into an art activity'* (NR2). Training as a teacher made Gina realise *'the importance of science and technology, it should be an important part of any curriculum, instead of a part that is left behind when other things seem more important'* (NR1). Gina accordingly integrated science into her art classes and she selected learning material

that was *both 'developmentally appropriate and challenging. It is no use to only keep them where they are, but you need to push them a little further to be effective'* (In1).

Teaching MST: Apart from some constraints and rules at the beginning of the year, Gina enjoyed teaching in the less formal surroundings of a group of children between two and three years old. She succeeded in initiating age-appropriate activities within the time available. *'Developmental appropriateness should always be the first consideration'* (NR1).

Gina's understanding of how mathematics should be taught at their level was reflected in her conviction that *'Teaching maths means acquiring basic skills like number concept in a concrete manner'* (In1), and *'I think it is about laying the foundations for the development of basic mathematical skills.'* (In1). She believed that *'Young learners need to experience mathematics for themselves. They need to see, for example, 'what concepts such as heavy and light mean'* (NR1). Mathematics should be taught informally and *'learning mathematical concepts and skills should be an enjoyable experience for all learners. When a child enjoys something, he or she is more likely to give participation and therefore gain something from the experience'* (NR1). During observation it was clear that children were actively involved in experimentation through activities like gardening and observing the growth of plants and observing animals.

She believed that MST learning areas were important for the development of concept formation of the children in her class. Gina added: *'Mathematics, science and technology should form part of every early childhood programme. It is in the early years that children learn the foundation skills they will need and use to succeed in these subject areas later in their schooling'* (NR2). During observation children used blocks to build constructions and used three-dimensional Unifix blocks to make patterns.

Although she found mathematics easier to teach than science and technology, she also felt *'comfortable in teaching science because I know what I am doing'* (In1). She planned her lessons but was always on the lookout for opportunities to integrate relevant aspects from science and technology during her lessons. Gina felt that

'technology should be hands-on' (In1) and she taught *'technology through art, and [tries] to create situations where they may choose colours or what things must look like'* (In2). During observation of her integrated lesson she combined art, science and technology by letting the children create patterns and also by working in the garden. Integration of learning areas allowed her the opportunity to teach more work in the limited time at her disposal.

Gina considered the pedagogical knowledge she acquired during her university studies to be *'important for providing insight, because without it one does not understand the process of what is happening'* (In1) and *'Teaching maths is much more specific, while science and technology teaching is more general in nature'* (In1). Her teacher training background influenced her teaching approach and she stated that she *'always teach[es] MST in a concrete manner. I start three-dimensionally and then move to two-dimensional. I stick to basic stuff and keep things as simple as possible. I take a small group of three and work individually with each child'* (In2). This teaching approach was demonstrated during the observed lesson.

She planned to include MST in her daily programme, but she was also *'constantly subconsciously ... on the lookout for situations where knowledge and skills regarding these learning areas can be incorporated'* (NR2). One such situation was *'a pasting activity simply as part of an art project, but it turned out the children needed to apply mathematical skills to complete the task successfully, since the activity involved copying a pattern. Once I had realised this, I focused the children's attention on the pattern (a fence) and asked them to copy it'* (NR2) and *'the three little pigs story was the perfect opportunity to bring maths into art'* (OR). Gina's developing professional teacher identity is illustrated in her confident approach to situations in her class, as was observed during her observation lesson.

Institutional Support: Gina received quality support from the principal and did not lack teaching resources. She felt confident and in control of her situation as a teacher, with a strong sense of self as a teacher who could negotiate with her principal. She stated that *'the principal supported me in providing materials that I required. I would just write a note and she would order the material'* (In2).

Gina also enjoyed the benefit of having an assistant whose services were provided by the principal *'an assistant who can help.'* (In1). Her situation at school strengthened her developing professional teacher identity.

Classroom practice: Gina felt secure in her classroom and there was evidence of planning for intentional mathematics and science teaching in the specific integrated lessons she prepared. She explained that *'once a week I set aside the time allocated to the main activity for a maths or science activity'* (NR1); and *'every Wednesday I do either a maths or science activity. Sometimes it is a separate activity, but I try to incorporate it into an art activity'* (OR). Another example was that *'when the theme allows, I include discussions about MST in the theme discussion and language development. When I plan a theme, I try to look for ways in which these learning areas can be included'* (In2). During the observed lesson on insects she combined maths and language by telling the children about insects and classifying them according to their features.

She had become confident, flexible and adaptable in her ability as a teacher and she found *'it is easier to decide on approaches in class, because my theoretical and practical experience confirm my beliefs'* and she *'manage[s] my time better'* (In1). Her *'biggest change during the first year is that I have found more confidence in my teaching. I have also learnt to think on my feet, especially when an activity does not quite work, I then adapt'* (In1). She was able to teach with confidence because her dedication to her task and the support she received from the school management reinforced her developing teacher identity.

Gina valued and applied the knowledge she had acquired during her teacher education programme and had not changed her opinion with regard to the 'how and what' should be taught and 'why' mathematics was important. She adapted her acquired knowledge to the classroom context and *'refer to my notes and handbooks in maths when in doubt about what to do'* (In2).

She demonstrated a practical and flexible approach to teaching as observed, and said that *'I learnt through trial and error, for instance I immediately simplify material when I realise the material is too complex'* (In2). She further relied on her classroom

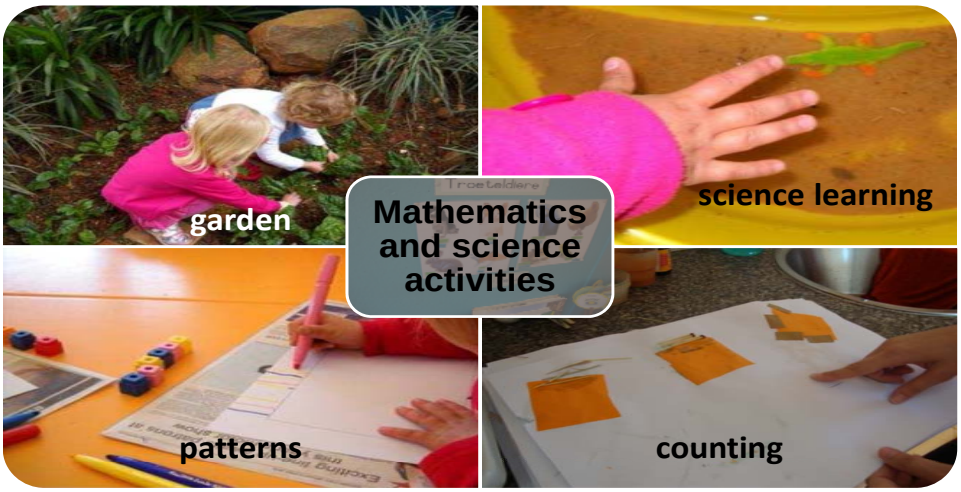
experience *'science activities … have taught me – less is indeed more. The simpler the activity, the more children gain from the experience'* (NR2).

Gina constantly worked at improving her teaching skills; proof of this was found in her statement: *'The reflection I wrote made me think about my teaching and encouraged me to improve my teaching'* (In2). Reflective practice had improved her teaching ability as well as her insight into her task as a teacher.

Gina was comfortable with the requirements of the school and accommodated her own beliefs within the school's contextual framework or ethos. She was convinced of her ability as a teacher and of the quality of her contribution to the development of the children in her class; therefore it appeared as if Gina in her first year of teaching was constructing a positive and stable professional teacher identity in MST, as she explained: *'without a doubt, although influenced by multiple sources, my beliefs about MST correlate to the way in which I plan and teach these learning areas'* (NR1).

Gina's self-identity as an MST teacher was further revealed through her personal and emotional involvement with the children in her classroom. She cared about their wellbeing and development. She had this to say: *'children should learn mathematical concepts from a very young age. Children should be challenged to expand their knowledge and skills, but should be assisted along the way so that they experience success as they are learning. I believe that each activity should be adapted to the level of each child'* (OR).

Gina‘s classroom practice



The children in Gina’s class were actively involved in mathematical and science learning. In a resource-rich environment, they explored, experimented and discovered (planting vegetables and creating patterns).

Figure 4.4: Gina’s classroom practice (observation and photo collages)

With her background in mathematics, science and technology at matric level, Gina selected science as her main subject for degree purposes. She regarded the teacher education programme as important in the formation of her MST professional teacher identity. She felt, however, that she had received little practical exposure to science and technology during her fourth-year internship period. Although she experienced the same reality shock as the three FP teachers, she regained her equilibrium quickly because of her personal commitment to teaching and the support she received from colleagues at the early childhood centre. In the process of professional teacher identity formation, Gina not only sustained and strengthened her MST professional teacher identity, but she also adapted to the particular situation in which she found herself. Her first year of teaching was a year of growth and development in the practical aspects of teaching.

4.2.5 CASE OF JENNA

Jenna taught a group of 20 children of four and five years old from diverse socio-economic and cultural backgrounds in a privately owned early childhood school. The owners were very involved and they had been running the school for approximately

20 years. Although there was a rich diversity of multilingual children in her class, the language of instruction was English. At the time of observation the school was without a principal, as the previous one had left.

Background: Jenna, who did *'mathematics at matric'* level, had a *'positive view about mathematics'* (In1). She always thought that she *'was going to be a foundation phase teacher'* and therefore she *'did not see the need to do science' at school.* She also *'did not do technology'* (In1) at school.

Teacher education programme: Jenna entered university with a positive attitude towards mathematics. Her liking for the subject was enhanced during her teacher education programme and the practical internship period: *'Personally, mathematics had the biggest influence and impact on me and I feel this is the learning area that I am most competent to teach'* (NR1). The programme at university *'prepared me for teaching maths. We did lots of practical exercises to illustrate mathematical theory at primary level'* (In1). Jenna felt that she did not have the same grounding in science and technology and she was still uncertain about specific aspects in those two subjects, notably *'as I do not know what the learning outcomes are and have to look them up. I do not have the same experience (of maths) with science and technology. I also did not see many lessons on science and technology during practice teaching'* (In1).

She stated that she had learnt very little about science and technology from her mentor teachers: *'science was taught in a less practical manner and hence this is the learning area I tend to neglect as I am to this day unsure of exactly what is expected and how it can be implemented effectively'* (NR1). She also recalled that *'during practice teaching teachers did not really give attention to science and technology'* (In1). Jenna was aware that her years of teacher training had influenced her teacher identity: *'I feel that the knowledge that I acquired during my years of study and my mentor lecturer are factors that shaped and assisted me in my development'* (In2).

School context: From the outset Jenna felt optimistic in the school where she was and this tended to strengthen her notion of becoming a successful MST teacher in FP. She said she *'can teach positively in an early childhood setting. There is enough*

time ... in comparison with the primary school, where things are more formal and structured' (In1). She felt in control of her situation, knew her children well and experienced those factors as *'positives in my teaching situation' and 'everything is easier than when I did practice teaching'* (In2).

Pondering her experiences as a new teacher, Jenna commented that *'being a first-year teacher, I do believe that every lesson is a learning opportunity'* (OR).

Jenna expressed her positive teacher identity through her actions. *'You follow the examples taught at university and that is what you believe in. Then suddenly you are at a school that wants you to do otherwise and the danger is that you conform. Your mind knows that you should do what you believe. I do think that given time to adjust and find your feet, you will express your own opinion and teach the way you feel you should'* (In2). Jenna's remarks were due to the experience she had had in a Grade 1 FP classroom during her practice teaching. The situation in which she found herself during her first year of teaching was different, as she had support for her ideas and the freedom to apply them. During observation it was evident that she planned an interactive number concept development lesson where children had to count out and identify numbers. Although she facilitated number concept development for the second language learners, she also made provision for exploration and discovery. She used the memory of her past experiences to express her thoughts about a conforming and changing professional teacher identity in the light of a possible difficult situation in the future. In doing so, she displays insight and a sound, well-established professional teacher identity.

Curriculum interpretation and implementation: Jenna explained that the dilemma of teaching MST to children of four and five years old was that there was no curriculum in MST for this age group and consequently *'no assessment standards for children younger than grade R, but with a bit of innovation one can work out lessons that help the children to reach the grade R outcomes with ease'* (NR1). Because there were no clear curriculum guidelines for MST except for the FP curriculum, Jenna adapted the Grade R curriculum to suit the developmental needs of her class. During observation she used number concept development principles in an activity. The children had to count out objects from one to five, draw the amount and match it

to the symbol. The children were actively involved, using manipulatives to represent the number value and helping one another in the process.

For Jenna, *'MST are all integrated and can be integrated into the other learning areas as well'* (NR1) and *'integration of learning materials in MST has become a reality for me'* (In2). During observation she displayed a science theme table where the children could explore the theme of winter. She integrated the theme by counting how many children were wearing scarves during the introduction and identifying the different kinds of warm clothing the children were wearing.

Knowing the curriculum guidelines for grade R mathematics, she *'divide*[d] *numeracy into the five learning outcomes and each day of the week after outside play time we do some form of fun concrete activity that aims at achieving the specific learning outcomes'* (NR2) and *'When I plan for maths I consult my outcomes and plan what they must know. I often adjust the lesson to the children's needs and achieve my outcomes along a different route'* (In2).

Teaching MST: As a beginning teacher, Jenna wanted to teach the children in her class MST. She wanted them to feel positive about MST; therefore for her *'the teaching of MST is important in the early years. A great deal of planning needs to go into the teaching of these three learning areas'* (In1). She used situations that arise in the classroom as *'opportunities of incidental learning on a daily basis with regards to MST'* (NR2).

Jenna felt confident about her pedagogical and mathematical knowledge; she believed that *'maths is important in the development of children's thinking processes'* (In1). She often *'integrate*[s*] maths with other subjects'* (In1). Jenna tried to teach lessons in all three learning areas *'to make sure the children reap the true benefits of education'* (NR1) She stated that she *'strongly feel(s) that these three learning areas need to be taught in a very concrete manner in order to make abstract thinking in the future easier for the child'* (In2). Therefore, she planned lessons in a *'fun and interactive manner, having no correct or incorrect way of doing things but rather leaving the creativity and problem-solving in the hands of the learners'* (NR1). For example, *'If we count out stuff in class, I allow the children to help. They learn the*

basics in an informal, playful manner' (In1). She also acknowledged that the *'children made me aware of possibilities in maths'* (In2). During observation it was evident that she used questioning techniques to prompt reactions from her second-language learners. She involved the children in questioning and answering activities that led to higher-order thinking and problem-solving.

Jenna's identity of self as a teacher was illustrated in her explanation of herself in her teaching philosophy as a *'big supporter of the constructivist approach'*; she *'firmly believes that learners need to be active agents in the construction of their own knowledge'* (OR).

During classroom observation it was evident that she applied the constructivist approach in her teaching. For example, she presented an activity of number concept development where the children first used objects to count out from one to five. Then they had to arrange the groups of objects from one to five. The third step was that the children had to draw each set of numbers (symbolic representation of number) in the correct sequence. (See Jenna's photo collage on classroom practice).

Reflecting on that activity, Jenna explained that *'I feel that my method of teaching is effective and that there are learners who really benefited and were given the opportunity to do a challenging yet exciting activity that tested their own limits ... the sense of accomplishment that the learners experience is indescribable'* (OR)

Jenna remarked that *'science is all around us, but we take what happens around us for granted and do not open our eyes to the possibilities that present themselves. Technology is the same'* (In2). The reality of her teaching situation in the school was that *'science and technology were neglected'*, and that it was *'difficult to teach science and technology because I do not have enough pedagogical knowledge; I am uncertain of how to teach science and technology'* (In1).

Jenna came to the conclusion that in the teaching of MST she had to *'accommodate all different levels of learners, which is challenging'* and *'one needs to think on one's feet, and be two steps ahead of the learners. It is essential that one has a backup plan to fall back on'* (OR). She had also *'learnt that there are daily situations where one can promote MST. Learners enjoy MST and have a thirst for knowledge, children*

just needs to be stimulated by the teacher' (NR2). It was evident through the activities observed that Jenna's mathematics professional teacher identity was well established and sustained and that she could teach mathematics with confidence.

Institutional Support: At the beginning of the year, Jenna voiced her frustration as *'The owner of the school will not provide resources and I do not have the means to buy them, so at the moment they are unobtainable'* (In1). Then, later in the year, the situation at the school changed when she *'was made responsible for finances and we [all the teachers] collected funds for MST apparatus. The parents contribute an amount every term and we allocate funds where needed'* (In2).

Institutional support by the other teachers and her feeling of accomplishment observed during her lesson strengthened Jenna's view of herself as a teacher. The reaction of the children to her pedagogical approaches she employed, gave her the confidence to teach and develop a feeling of self-worth: *'I feel that my method of teaching is effective'* (OR). Jenna valued the institutional support: *'The most important aspect at school was the support I received from the teachers during lesson planning and that helped me a lot'* (In2). She found colleagues, and fellow graduates of her teacher education programme to be a great source of informal support. She acknowledged that *'my principal supports me and listens to what I have to say'* (In1); *'my principal is positive and provides assistance and positive input'*; (In1) and *'The principal provides me with ideas for lessons and has an open door policy, I am able to ask for advice if I feel I need it'* (OR).

The school context and institutional support that Jenna experienced in that early childhood setting promoted a feeling of security and emotional closeness that seemed to strengthen her professional teacher identity and beliefs about teaching. Being able to teach in a school culture that promoted collaborative and effective support during the first year of teaching helped Jenna to cope and to feel positive and confident about her teaching.

Classroom practice: Jenna valued the teacher education programme that informed her perceptions and beliefs about teaching in the FP. She felt that a teacher should be innovative and creative. *'I believe that learners need to be taught through*

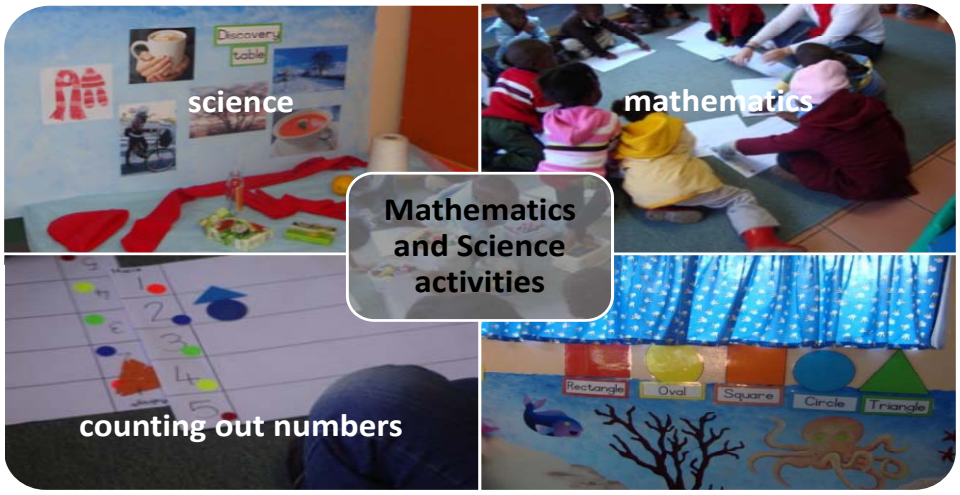
discovery and scaffolding and not by rote learning' (OR). *'Because I do not like technology I would rather spend the time I have on teaching what I am passionate about, which is maths'* (In1). She favoured 'child-initiated teaching where the teacher acts as facilitator' and she believed *'in applying Vygotsky's scaffolding and the zone of proximal development'* (In2). Jenna's developing MST professional teacher identity is clearly illustrated in her comments and her actions as observed. She applied Vygotsky's notion of scaffolding children's learning and asking challenging questions during the observed lesson.

Her comments on her classroom practice and the different responses of her learners brought her to the conclusion that children are unique and individual and that different learning and teaching approaches should be investigated and applied. She therefore *'plan*(s) *multi-level lessons and can adjust to the situation that develops'* (In2). She also realised that 'learners who cannot work independently and do not benefit from peer teaching need intervention; *'she always 'asked questions'* and *encouraged 'learners to become critical thinkers'* (OR).

During observation the children reacted in ways that allowed Jenna to open new areas or activities and she was constantly on the lookout for these opportunities *'I have children in front of me that learn in different ways and have multiple intelligences that have to be developed'* (In2).

Jenna regarded her first year of teaching as an important period of growth for shaping her beliefs and knowledge about MST. She realised that as a beginning teacher she was involved in a learning process, which she described as follows*: 'I feel that I have grown as a teacher and that I am in my own class and in control of what happens. Although it is a great responsibility I feel comfortable because I have more experience and I can do a more integrated programme with the children'* (In2). She consequently felt that *'experiences during this year have made me positive about my teaching'* (In2).

Jenna's classroom practice



In Jenna's classroom the children were actively involved counting out objects and placing them in order. The children worked together helping each other while Jenna mediated the learning activity by asking questions and scaffolding children's learning

Figure 4.5: Jenna's classroom practice (observation and photo collages)

Reflecting on her growth from student teacher to beginning teacher, it was clear that she developed and sustained a positive MST professional teacher identity. It was evident from her classroom practice during observation that she taught MST with confidence and insight. The formation and continuous development of her MST professional teacher identity was confirmed in her explanation that *'I have grown within myself and as a teacher. I believe it is necessary to be a lifelong learner'* (OR). She defined herself as a *'successful teacher'* (In2) and it seemed that her professional teacher identity reflected positive qualities and beliefs about mathematics teaching.

4.2.6 THE CASE OF ANNE-MARIE

Anne-marie taught a reception year (Grade R) class of 33 children in a privately owned early childhood setting with many children from countries all over Africa. The language of instruction was English, although the children were from diverse cultural and language backgrounds. The school had a morning programme and used the National Curriculum Grade R curriculum guidelines.

Background: Anne-marie had had some exposure to mathematics and science, but did not have technology at school. Her experience of mathematics and science at school had not been particularly positive, so she ended up *'not liking maths at school, because the teacher could not make it attractive for me. I found mathematics and science boring'* (In1). That early experience did not necessarily impact negatively on her notion of self as an MST teacher in the FP. Her idea of developing to become a successful teacher was always seen as a lifelong learning process.

Teacher education programme: Her perception of mathematics and science gradually changed during her university studies, when she *'realised that mathematics and science can be interesting'* (In1). Anne-marie admitted that during her extended teaching practice she *'unfortunately … learnt very little about science and technology from my mentor teachers'* (NR 1). However, she insisted that the practical knowledge acquired from her training programme was important: *'I have learnt so much during my four years at university'* (OR); *'the knowledge acquired during my studies provides me with the background knowledge to my lessons'* (In1). She wondered, however, *'if all the theory we learnt will work in practice'* (In1). She was of the opinion that *'theory provides a necessary foundation for what lies ahead'* (In2) and therefore she would have liked to try *'new things with my children to see what can work, and what not, but also to see where I can adjust activities'* (OR). This element of professional identity formation corresponded with a constructivist learning paradigm.

School context: Anne-marie entered her first teaching position with *'creative energy and enthusiasm … excited to teach'* (In1). For Anne-marie, becoming a professional MST teacher meant following a developmental path with many unknown challenges. Moving from being a student teacher to the reality of a classroom was a rude shock for Anne-marie, especially since *'you only realise what happens in a classroom when you stand alone on your own'* (In2). At the end of her first year of teaching she still sometimes felt that *'every day brings a new challenge that I can learn from'* (NR2).

The situation at school was difficult at first, as *'the principal opposed everything I* (she) *proposed'* and *'this had a devastating effect on me'; 'one can only stand up for oneself up to a point, especially if she is the principal as well'* (In2). When *'she* [the principal] *left the school'*, the situation changed. *'I was lucky enough not to have a*

whole year of this'. When the principal left the school, Anne-marie was left to her own devices and had more freedom: *'I have much more freedom and can set the classroom the way I want to'* (In2). Anne-marie's initial sense of developing a new identity as a successful teacher was a struggle within the context of her practice, partly because she had to make sense of opposing perspectives from the principal, and partly because of the way she wanted to teach and what she hoped to become as a reform-minded MST teacher. From a professional development perspective, her development was much more than an answer to the question 'Who am I now after my teacher education and training?' She also wanted to know who she wanted to become as an FP MST teacher. Professional teacher identity formation for her was a dynamic, ongoing process relating to her context and relationships. During observation she demonstrated her positive MST professional teacher identity by integrating MST with an art lesson where the children had to apply maths, science and technology to create design using patterning, burning the design into a styrofoam tile (combining science and technology) and making a symmetric print in different colours.

Curriculum interpretation and implementation: Because of the *'freedom' that she gained as a result of the principal's leaving the school, Anne-marie freely interpreted and implemented the curriculum in line with her teaching philosophy.* She could *'think of creative activities in which to get the children actively involved and interested'* (OR). During a visit to her classroom she presented an art activity integrated with MST. Each child designed and engraved his or her own pattern on a styrofoam tile, and printed four images using the concept of symmetry. With this activity she successfully integrated art, maths, science and technology.

Teaching MST: Anne-marie regarded mathematical knowledge and science and technology inquiry skills acquisition as an important focal point in her teaching. She stated that *'mathematics is the foundation subject'* for her and *'I integrate and apply mathematics, science and technology concepts in structured lessons'* (In1). She described the following learning activities after *'a parent brought a box full of silk worms'* to her class*: 'A while ago I let the children design and build a house as part of my own research. I started the project with a story about Sally Silkworm who lost her house in a fire. Learners were then divided into groups and they could choose*

materials with which to build the house' (NR 2). She planned an integrated MST lesson around a real-life problem (the loss of habitat) where the children had to plan and design an appropriate habitat for a silkworm. She and the children also *'had to identify the right leaves (mulberry) to feed the worms'* (In2). To continue the real-life theme she *'started a small garden'* and *'a wormery'* she asked the children to bring *'potato peels and other material for the worm garden'* (NR2). For her the transition from theory to practice occurred through her teaching and classroom experimentation with imaginative activities. For instance, she encouraged children to learn experientially through discovery. *'I have a nature corner in my classroom where silkworms spin cocoons and shapes. We have birds, fish and a vegetable garden'* (NR2). During observation there was evidence of the implementation of exploration and discovery, as a nature corner displayed silkworms and bird nests. She proudly pointed out the vegetable garden and asked the children to tell about how they planned and planted the vegetables in the garden.

Her voice, her stories and the way she explained and enthused about providing imaginative hands-on inquiry-based MST activities for her learners, in essence constituted her 'core' identity, which at the same time was formed and informed by the classroom context. Her identity formation was a process of building practical knowledge in line with what she knew and viewed as relevant for inquiry-based ECE MST teaching.

Institutional support: Anne-marie found support for her ideas and worked closely with other teachers who held similar views about MST teaching at pre-primary level. She explained that she and her *'colleagues plan and work together ... One of my colleagues is an experienced teacher and she supports me very well'* (In2) and *'I have support for my ideas on teaching at pre-primary school because my colleagues feel exactly the same'* (In1). The centrality of her professional identity as pre-primary school MST teacher and one who wanted to become a successful teacher was further emphasised in what she believed and practised in the classroom.

Classroom practice: She explained that *'MST are important and I try to make the subjects interesting so that my children will realise the subjects are worthwhile and important'* (In1). She was convinced that *'one should have a passion for teaching'*

(In1) and *'I have a passion for children'* (In2); *'my identity is strong enough for me to be successful and to become a better teacher'* (In2). She valued her teaching experience and teaching culture and insisted that *'Experience means more than theory'* (OR) and *'I would not change my work or my school for anything. Many children in my class come from all over Africa and others even from abroad ...which makes my work interesting and enjoyable'* (NR1). Her working environment had confirmed her initial ideas about teaching. She truly believed that she was *'… a good teacher because my children are happy, I am happy and we enjoy learning together'* (OR).

Anne-marie as observed, used hands-on, practical approaches and field trips to teach. She explained why, with reference to an observed science lesson. *'Not only did I enjoy the lesson ... my children enjoyed the lesson'* and *'The children enjoy science because they think it is magic and they are fascinated and they think and wonder about what they experience. When we went to the Willem Prinsloo Museum they observed candle making, which is a scientific process, and they learnt something more!'* (NR2). The more central an identity is, the more difficult it is to change or lose that identity; this would appear to be true in Anne-marie's case.

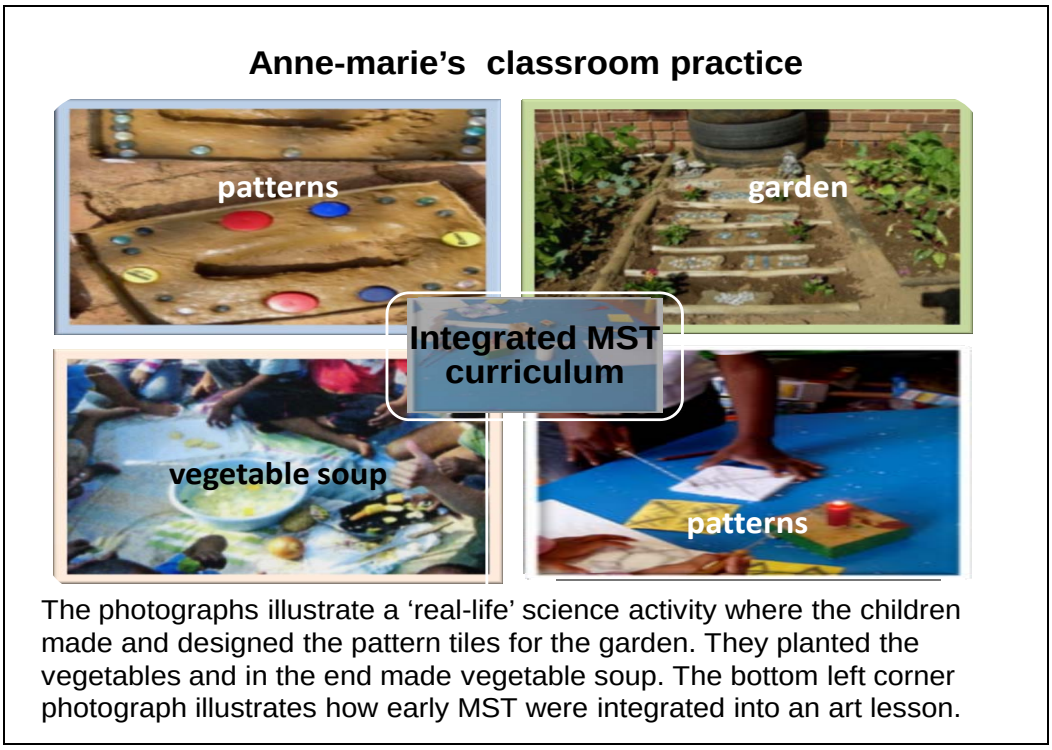


Figure 4.6: Anne-marie's classroom practice (observation and photo collages)

Although for Anne-marie the transition from student teacher to beginning teacher was initially an unstable period of coping and surviving the unpredictable realities of the new workplace, it was mostly a positive experience. Developing and sustaining her professional teacher identity was an ongoing process of integrating personal and professional issues of institutional support. She demonstrated the ongoing process of her professional teacher identity formation and growth through creative integrated MST teaching activities.

4.3 SUMMARY OF IDENTITY PORTRAITS OF BEGINNING TEACHERS IN EARLY MST TEACHING AND LEARNING

The main results of the six identity portraits are summarised in Table 4.1 (p.120) according to the identified main influences that affected the professional teacher identity formation of the beginning teachers. The main influences were (i) background or prior experiences, (ii) initial teacher education programme and (iii) MST classroom and school experiences as a first-year teacher. The MST classroom and school experience as a first-year teacher is presented according to:

- School context
- Institutional support
- Curriculum implementation and interpretation
- Teaching MST
- Classroom practice

Tabel 4.1: Summary of six beginning teachers' professional teacher identity in MST teaching and learning

Beginning teachers' professional teacher identity in MST teaching and learning (foundation phase and early childhood education)					
Bea Grade 1 class in township primary school (permanent post)	**Riana** Grade 2 class in city primary school (permanent post)	**Lea** Grade 2 class in city primary school (contract post)	**Gina** Class: 3-4 years in early childhood setting (contract post)	**Jenna** Class: 5 years in early childhood setting (contract post)	**Anne-Marie** Reception year class in early childhood setting (contract post)
Prior experiences in MST					
◈ Mathematics at matric level. ◈ Little background in science and technology. ◈ Negative feelings towards mathematics.	◈ Mathematics and science at matric level. ◈ Technology is an unknown learning area. ◈ Negative feelings towards science.	◈ Mathematics at matric level. ◈ Little background in science – only up to Grade 9 level and none in technology. ◈ Negative feelings towards MST.	◈ MST at matric level. ◈ Negative feelings towards technology.	◈ Mathematics at matric level. ◈ Little background in science and none in technology. ◈ Negative feelings towards science and technology.	◈ Mathematics at matric level. ◈ Little background in science and none in technology. ◈ Negative feelings towards mathematics.
Initial teacher education programme					
◈ Developed MST knowledge, skills and pedagogic content knowledge. ◈ Exposure to MST teaching during internship. ◈ Changed MST beliefs and attitude from negative to positive. ◈ Views MST teaching as important.	◈ Learnt the most about content and pedagogical knowledge in mathematics and technology, but not much in science. ◈ Positive exposure to MST teaching during internship. ◈ Changed MST beliefs from negative to positive. ◈ Views MST teaching as important.	◈ Increased MST knowledge, skills and developed pedagogic content knowledge. ◈ Programme modules and 4th-year research project broadened her insight and changed her MST perceptions to positive. ◈ Very little exposure to science and technology during the internship in the foundation phase. ◈ Views MST teaching and learning as important.	◈ Increased MST knowledge, skills and developed pedagogic content knowledge. ◈ Positive about science, she chooses 'life sciences' as a three-year elective. ◈ Programme module broadened her knowledge and insight in mathematics but science and technology had been inadequately dealt with. ◈ Very little exposure to science and technology during the internship. ◈ Views MST teaching and learning as important.	◈ Learnt the most about c ◈ Positive attitude towards mathematics. Her affinity for the subject is enhanced during her teacher education programme. ◈ The MST modules provide grounding for teaching. ◈ Very little exposure to science and technology during the internship. ◈ Views MST teaching and learning as important.	◈ Increased MST knowledge, skills and developed pedagogic content knowledge. ◈ Changed MST beliefs and attitude from negative to positive. ◈ Little exposure in science and technology during internship – negotiated teaching opportunities with mentor teachers. ◈ Views MST teaching and learning as important

Beginning teachers' professional teacher identity in MST teaching and learning (foundation phase and early childhood education)					
Bea Grade 1 class in township primary school (permanent post)	**Riana** Grade 2 class in city primary school (permanent post)	**Lea** Grade 2 class in city primary school (contract post)	**Gina** Class: 3-4 years in early childhood setting (contract post)	**Jenna** Class: 5 years in early childhood setting (contract post)	**Anne-Marie** Reception year class in early childhood setting (contract post)
MST classroom and school experience as a first year teacher					
School context ◈ Reality shock – work is emotionally demanding and complex. ◈ Socio-economic factors like poverty, absenteeism affect MST teaching. **Institutional support** ◈ Support and working environment at school have a positive influence. ◈ Initial problems with mathematics curriculum implementation. **Curriculum interpretation and implementation** ◈ Experiences time constraints – tries to find time to teach science and technology. Science and technology not part of the school curriculum. **Teaching MST** ◈ Regards mathematics as focus point. Numeracy programme is important as foundational knowledge. ◈ The fixed school culture in science and technology results in lack of teaching and learning opportunities	**School context** ◈ Reality shock – work is emotionally demanding and complex. ◈ Negative experiences with older colleagues pressure on MST teaching. ◈ Under pressure from parents to conform to pedagogical approaches and the school culture requirements. **Institutional support** ◈ Lack of support from experienced colleagues results in negative emotions and frustration. **Curriculum interpretation and implementation** ◈ Experiences time constraints – Tries to find time to teach science and technology. **Teaching MST** ◈ Regards mathematics as focus point. Numeracy programme is important as foundational knowledge.	**School context** ◈ Reality shock – work is emotionally demanding and complex. ◈ Negative experiences with older colleagues. They did not value her ideas and pedagogical knowledge and approaches. She partially conforms and uses some pedagogical approaches that contradict her beliefs. She tries not to attract attention with innovative approaches. ◈ Parents apply some pressure on her. ◈ Negative experiences with older colleagues put pressure on MST teaching. **Institutional support** ◈ Lack of support from experienced colleagues results in negative emotions and feelings of failure. **Curriculum interpretation and implementation** ◈ Experiences time constraints – tries to find time to teach MST in an integrated way. Science and technology not part of the school curriculum.	**School context** ◈ Reality shock – work is emotionally demanding and complex. **Institutional support** ◈ Support and working environment at school have a positive influence. **Curriculum interpretation and implementation** ◈ Science and technology not part of the school curriculum. **Teaching MST** ◈ Regards MST as important for young children's development. ◈ Found teaching science and technology difficult at first; became easier later. ◈ Challenges were due to time constraints and the age of the children in her class, as well as the requirements of the school (principal, the parents and the age of the children). ◈ Experiences time constraints – tries to find time to teach MST in an integrated way.	**School context** ◈ Reality shock – work is emotionally demanding and complex. **Institutional support** ◈ Support and working environment at school have a positive influence on MST teaching. **Curriculum interpretation and implementation** ◈ Finds it difficult at times to teach science and technology because she feels she does not always have enough knowledge. **Teaching MST** ◈ Regards mathematics as important and as focus point for young children's development. ◈ Experiences time constraints – tries to find time to teach MST in an integrated way. **Classroom practice** ◈ Uses hands-on, practical inquiry-based approaches in MST.	**School context** ◈ Reality shock – work is emotionally demanding and complex. ◈ Initial negative experience with principal influences MST teaching and learning. This was solved when principal left. **Institutional support** ◈ Finds support from like-minded colleagues. Negotiates and collaborates with other teachers. **Curriculum interpretation and implementation** ◈ Curriculum: Integrates MST with art and language. **Teaching MST** ◈ Regards MST as important. ◈ Mathematical knowledge and skills acquisition form the main focus of her teaching. **Classroom practice** ◈ Positive and passionate MST teacher. ◈ Uses creative and research skills to plan and teach MST. Applies hands-on, practical approaches and field trips.

Beginning teachers' professional teacher identity in MST teaching and learning (foundation phase and early childhood education)					
Bea Grade 1 class in township primary school (permanent post)	**Riana** Grade 2 class in city primary school (permanent post)	**Lea** Grade 2 class in city primary school (contract post)	**Gina** Class: 3-4 years in early childhood setting (contract post)	**Jenna** Class: 5 years in early childhood setting (contract post)	**Anne-Marie** Reception year class in early childhood setting (contract post)
causing negative emotional effect and frustration. ◈ Integrates science and technology into other subjects. ◈ Positive and confident as MST teacher. **Classroom practice** ◈ Uses hands-on, practical inquiry-based approaches in MST. Applies elements of the constructivist theory (Vygotsky). ◈ Caring and committed to children, MST teaching and learning.	◈ Feeling of insecurity – the school culture frustrates her because she cannot teach MST as she wants to. ◈ Integrates science and technology into other subjects. **Classroom practice** ◈ Uses hands-on, practical inquiry-based approaches in MST. ◈ Caring and committed to children's MST teaching and learning.	**Teaching MST** ◈ Regards mathematics as focus point. Numeracy programme is important as foundational knowledge. **Classroom practice** ◈ Uses hands-on, practical inquiry-based approaches in MST. ◈ Caring and committed to children, MST teaching and learning.	**Classroom practice** ◈ Uses hands-on, practical inquiry-based approaches in MST. ◈ Caring and committed to children, MST teaching and learning.	◈ Caring and committed to children, MST teaching and learning. ◈ Positive and confident MST teacher.	◈ Caring and committed to children, MST teaching and learning.

4.4 CONCLUDING REMARKS

In this chapter the data collected from the six beginning teachers were presented as results through individual narrative portraits. The six cases of professional teacher identity portraits were described according to the identified main influences that affected the six beginning teachers' professional teacher identity formation. The different influences crystallised through the data analysis process. In conclusion the results of the different cases were summarised in Table 4.1 according to these main influences.

In Chapter Five, the findings of the study are presented and discussed. These findings will be presented and positioned against existing literature and the conceptual framework. Finally the new insights that emerged from this study are presented.

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CHAPTER FIVE
DISCUSSION OF RESULTS OF SIX BEGINNING TEACHERS' PROFESSIONAL TEACHER IDENTITY FORMATION IN EARLY MATHEMATICS, SCIENCE AND TECHNOLOGY TO EXISTING LITERATUR

> 'Research on teachers' professional identity formation also contributes to our understanding and acknowledgment of what it feels like to be a teacher in today's schools, where many things are changing rapidly, and how teachers cope with these changes' – Beijaard, Meijer and Verloop (2004).

5.1 INTRODUCTION

In Chapter Four the results of the six cases were presented through individual narrative portraits. The six cases of professional teacher identity portraits were described through themes illustrating the nature of each individual beginning teacher's professional teacher identity formation. The different themes crystallised through the data analysis process. In conclusion the different cases were summarised in Table 4.1.

In Chapter Five the findings of the study are presented and discussed. The results from the case study summary (Table 4.1) as well as the information in the narrative portraits were used to present, describe and finalise the findings. The analytical strategy was a cross-case comparison to firstly determine which aspects of professional teacher identity formation influenced the process and how they did so. Secondly, factors were identified that are external and internal to the teacher. This chapter explains how and why these factors affected beginning teachers' professional teacher identity formation. Furthermore, the supportive or contradictive evidence in the findings, amongst other things, are discussed with regard to the literature and the conceptual framework. Finally, the new insights that emerged from this study are presented.

5.2 FINDINGS OF THE STUDY

In this section the findings as they derived from the results in Chapter Four (in the narrative portraits) are discussed. The findings were guided by the research questions of how and why professional teacher identity was formed, changed or sustained during the first year of MST teaching. Furthermore, the findings give insight into what factors affect professional teacher identity formation and in addition refine these factors by trying to differentiate between what external and internal factors influenced professional teacher identity formation and how they affected this process.

5.2.1 PROFESSIONAL TEACHER IDENTITY FORMATION OF BEGINNING TEACHERS IN MATHEMATICS, SCIENCE AND TECHNOLOGY

In this study professional teacher identity was important because it reflected how six beginning teachers viewed themselves as teachers (Flores & Day, 2006; Fleer, 2011, Samuel, 2008).

Of particular importance was how the six beginning teachers' prior or background experiences in MST teaching, their initial teacher education programme and their first year of classroom and school experience influenced the process of their becoming MST teachers at foundation phase level.

All six beginning teachers had mathematics at matric level. Of the six participants in the study, only Gina and Jenna were positive about mathematics when they entered university to commence their studies. Riana had science at matric level but said that *'technology'* was an *'unknown learning area'* (NR1). Bea had some experience at high school level, saying she *'did science and maths in matric, I did not enjoy the subjects at school'* (In1).

Only Gina *'took maths, science and technology in matric'* (In1). She was *'positive about maths and science'* but she *'did not like technology'* (In1). Gina was also the only beginning teacher that had positive feelings about science, while all five the others were negative or did not like the subject. The prior experience and background of MST was different for each beginning teacher. Although all six beginning teachers had mathematics at matric level, only two were positive about the

subject. Five of them were negative towards science and only one was familiar with technology when they entered the initial teacher training programme. These beginning teachers entered their initial teacher education programme with a mixture of positive and negative feelings towards MST teaching and learning, influenced by their personal histories, attitudes and beliefs. This finding corroborates the work of Cherubini (2009) and Day and Gu (2010) that emphasises that beginning teachers enter their professional education programme with personal histories, attitudes and beliefs that may influence their MST learning and teaching.

5.2.1.1 Initial teacher education programme

According to the findings, the initial teacher education programme is fundamental in the process of acquiring professional knowledge about teaching. As student teachers the six participants entered the teacher education programme with a wide variety of preconceptions and ideas about MST that affected their attitude toward these subjects and also towards learning and teaching. The B.Ed. FP and ECP teacher education programme that shaped the beginning teachers' professional teacher identity and attitudes towards teaching MST consisted of theoretical modules in MST as well as practice teaching experiences (18-week internship period).

The six beginning teachers reported that they had acquired MST pedagogical and content knowledge during their initial teacher education programme. Anne-marie says *'I have learned so much during my four years at university'* (OR) and *'the knowledge acquired during my studies provides me with the background knowledge to my lessons'* (In1). Lea explained that in her first year of teaching *'I still make use of my books from university when planning my lessons. At school we do team planning, and when I do the preparation for everybody for the week, I use what I have learnt, especially the maths and science handbook that we used at university'* (In2). Bea stated that *'At university I learned that science can be approached in different ways … teacher can use lots of different environments as areas for discovery and for exploring and investigating and thinking in scientific terms – the teacher has to allow children to think and allow time to discover and explore'* (In1).

Riana and Jenna, however, would have liked to increase their content knowledge in science. Jenna stated that *'science was taught in a less practical manner and hence this is the learning area I tend to neglect'* (NR1).

With regard to their feelings and attitudes towards MST, although five of the beginning teachers had negative feelings towards MST when they entered the teacher education programme, most of them were more positive after completing their initial teacher education and internship programme. With increased knowledge and insight Bea, Riana, Lea, Gina and Anne-marie said that they changed their ideas about MST from negative to positive during their studies and consequently viewed MST teaching as important. For example, Anne-marie *'realised that mathematics and science can be interesting'* (In1). Bea *'changed the way I (she) used to think about maths, science and technology During my years at university I realised that maths can be made interesting and can be learnt and taught in a different way'* (In1). Jenna stated that the programme prepared her for teaching mathematics. She said, *'Personally, mathematics had the biggest influence and impact on me and I feel this is the learning area that I am most competent to teach* (NR1)'.

Clearly, the initial teacher education programme provided the six beginning teachers with MST knowledge, pedagogical content knowledge and skills. The initial teacher education programme positively influenced their MST knowledge, pedagogical content knowledge and skills, and consequently their attitude towards teaching MST.

This finding corresponds with findings in the literature. Fleer and Hardy (2001), Korthagen *et al.* (2006) and Saracho and Spodek (2008) concur that initial teacher education programmes provide experiences that improve early school teachers' MST knowledge.

Research confirms that beliefs about MST knowledge and knowledge of learning are factors that influence professional teacher identity (Brownlee & Berthelsen, 2006; Egan, 2004; Stronach *et al.,* 2002).

With regard to their practice teaching and especially the internship period, the group had mixed experiences. Jenna's love of mathematics was enhanced during her

teacher education programme and the internship period: She was still unsure about science and technology *'I do not have the same experience with science and technology. I also did not see many lessons on science and technology during practice teaching' (*In1). Jenna was aware that her years of teacher training influenced her: *'I feel that the knowledge that I acquired during my years of study and my mentor lecturer are factors that shaped and assisted me in my development'* (In2).

Most beginning teachers seemed to have had exposure to mathematics during practice teaching, but this was not necessarily the case with science and technology. Lea said *'after completion of my internship I was thinking mathematically, scientifically and technologically'* (NR1) but she *'noted that very little science and technology is taught in the primary school'* (In1). Riana explained that *'During practice teaching my teacher was open to discussion on teaching technology and we gave a combined technology lesson that worked'* (In1). Gina had limited exposure to science and technology during this period. For example, Gina stated that: *'I did not experience a whole lot of science or any technology during my internship in the grade one classroom'* (NR1). Anne-marie reported that during her extended practice teaching she *'unfortunately learnt very little about science and technology from my mentor teachers'* (NR 1).

The six beginning teachers reported that they had received insufficient exposure to pedagogical content knowledge for science and technology and practical pedagogy in these areas during the internship period at foundation level (school-based practical learning). The literature substantiates this situation, as according to Bosman (2006) and Van Heerden (2005), old or new teachers enter a period of uncertainty about the place of science and technology at FP level. Also in other countries the research of Gillard (2008), Martin (2001) and Young and Elliot (2004) shows that many school teachers who teach at the early stages feel negative and anxious and lack confidence for teaching science and technology.

More importantly, Davis (2008) and Korthagen *et al*. (2006) argue that student teachers need opportunities during school-based practical learning to develop and expand their professional knowledge. However, in this case the six teachers did not

have the opportunity to experience much science and technology teaching in the classrooms where they were placed and they had to negotiate with their mentor teacher to find time to teach these subjects. Consequently, they were left to their own initiatives in science and technology and could not fully apply their theoretical knowledge in practice. Because they did not have the same grounding in science and technology during teaching practice, Jenna for example felt uncertain about specific aspects of teaching science and technology.

Through the teacher education programme the six beginning teachers acquired reflective practice and cognitive skills. The value of acquiring cognitive and practical skills such as reflective practice, thinking skills, creativity, and the ability to integrate theory and practice through the teacher education programme is illustrated by the following remarks from the participating first-year teachers: According to Bea, '*University learning helps you know that you can be confident to innovate your teaching style'* and to ' *apply new ways of teaching'* [and you then] *'adapt your techniques to grow as a teacher'* (NR1). She felt that she has *'grown in the past few months from being a 100% theoretical teacher to being one with some experience; I have seen how what I have learnt can be implemented in the classroom'* (In2). The beginning teachers were introduced to the use of reflection in their teacher education programme. Speaking on the value of reflective practice as an important tool to make the connections between practice and theory, Bea comments: *'The daily happenings in the class help me reflect and fine tune how I teach for a better lesson the next time around'* (OR).

Riana said that her training provided her with: *'the latest information'* (In1), and *'university gave me skills that assist me to cope'* (In2), *'thinking skills and other skills were developed. This was meaningful'* (In2). Lea explained that *'I still make use of my books from university when planning my lessons. At school we do team planning, and when I do the preparation for everybody for the week, I use what I have learnt, especially the maths and science handbook that we used at university'*. Gina adapted her acquired knowledge to the classroom context and *'I refer to my [her] notes and handbooks in maths when in doubt about what to do'* (In2). Gina constantly worked at improving her teaching skills; proof of this is found in her statement 'The reflection I

wrote made me think about my teaching and encouraged me to improve my teaching' (In2).

Anne-marie insisted that the practical knowledge acquired from her training programme was important because *'Theory provides a necessary foundation for what lies ahead'* (In2) and therefore she would like to try *'new things with my [her] children to see what can work, and what not, but also to see where I can adjust activities'* (OR). Anne-marie also said that: *'I have learned so much during my four years at university'* (OR), while Jenna revealed that she favoured *'child-initiated teaching where the teacher acts as facilitator'* and she believed in *'applying Vygotsky's scaffolding and the zone of proximal development'* (In2), as she was a *'big supporter of the constructivist approach'* (OR).

The initial teacher education programme seemed to have contained elements that equipped the six beginning teachers with skills that helped them to plan, to reflect, to apply creative teaching approaches and to cope with some difficult situations.

Not only is this outcome stated as a prerequisite for teacher training by the Council on Higher Education (2010), but there is also general consensus in the literature that initial teacher education programmes should equip student teachers with knowledge and a critically reflective attitude towards their own teaching and development as teachers (Davis, 2008; Green, 2008; Korthagen *et al.,* 2006; Lunenburg & Korthagen, 2009).

5.2.1.2 School context

The first-year beginning teachers were placed in different schools and were confronted with vastly different situations. Bea, Riana and Lea taught in FP classrooms in three different primary schools. Bea taught in a Grade 1 Tswana-speaking classroom, while both Riana and Lea taught in Grade 2 classrooms where the language of instruction was Afrikaans. Gina, Jenna and Anne-marie taught different age group classes in different ECP settings. Anne-marie taught in a grade R classroom in a multi-cultural private school where the language of instruction was English. Gina taught in a dual-medium (Afrikaans and English) private school, while

Jenna taught five-year-old children from rich, diverse multicultural and language backgrounds in an English-medium private school.

Although the six beginning teachers were situated at different schools, they all experienced a sense of reality shock when they started teaching in their own classrooms. For instance, Bea described this feeling of shock as follows: *'My emotions went from feeling like I was thrown into the deep end towards working hard to make schooling a meaningful experience for each learner'* (In 1). Lea explained that her first year of teaching as *'not easy'* because when *'you stand in front of your own class for the first time you are uncertain'* (In2) and the first year of teaching *'is a make or break year'* (In2). Moving from being a student teacher to the reality of a classroom was a rude shock for Anne- marie especially since *'you only realise what happens in a classroom when you stand alone on your own'* (In 2). Reality shock for the beginning teachers is caused by the sometimes painful transition from student teacher to beginning teacher, when the new teachers are confronted with uncomfortable situations they have to cope with. In spite of initial difficulties they developed coping mechanisms such as negotiation and creative approaches to survive. Exposure to and coping with difficult situations helped them develop a stronger sense of self and therefore strengthened their professional teacher identity.

Recognition as a colleague and fellow teacher came in varying degrees for the six beginning teachers. Riana and Lea had negative experiences with colleagues who did not value their ideas and pedagogical approaches. Riana contended that a *'first-year teacher is not recognised by the older teachers who feel that you have book knowledge, but you don't have teaching experience'* (In2), while Lea said that her *'new ideas are not accepted'*; the *'situation at present makes me* [her] *feel like a failure, as if I am a bad teacher'* (In2). For Anne-marie the situation at school was difficult at first, as *'the principal opposed everything I proposed'* and *'this had a devastating effect on me'*. Anne-marie felt that *'one can only stand up for oneself to a point, especially if she is the principal as well'* (In2). Bea was fortunate in that she was accepted as a colleague who had a contribution to make: *'I convinced the team through my enthusiasm and they know I am able to do things because they ask me for my ideas and input'* (NR1). Jenna initially had a problem that caused frustration because *'The owner of the school will not provide resources and I do not have the*

means to buy them, so at the moment they are unobtainable' (In1). Fortunately this problem was solved later in the year. Jenna, however, felt that she was developing into a teacher who would be able to teach the way she wanted to. Jenna enthused that *'given time to adjust and find your feet, you will express your own opinion and teach the way you feel you should'* (In2). Gina was recognised as a colleague and received full support *'The principal supported me in providing the materials I required. I would just write a note and she would order the material'* (In2).

The beginning teachers experienced a variety of discrete problems that differed from school to school and challenged their organisational and adaptive capabilities. For Bea the school situation was characterised by the poverty she observed and the children's learning difficulties, further exacerbated by a high rate of absenteeism. All of those factors and conditions posed obstacles to effective teaching and learning and forced Bea to find solutions if she could. *'Learners are from a poor socio-economic background. They sometimes miss a few days of school. This influences their progress. So the learner ends up not knowing the subject. That is a huge problem for us'* (In2).

Gina experienced pressure in her teaching because of the age of her children, time constraints and parent pressure. *'Constraints are placed on the kind of activities I can plan because of the age of the children, the time available for work in the daily programme as well as the expectation from the principal and parents to produce a minimum number of lasting products (mostly pictures) in a week (it is expected that each child should create two products during a week)'* (NR1). Gina adapted to the situation and maintained her professional teacher identity.

Riana found parent pressure difficult to accommodate. She stated that parents were '*very involved in their children's progress and this creates pressure and the parents compare books* [from the different grade 2 classes] *and complain if the books are not the same'*. She also said that *'I did things their way to know I was safe, and not to have pressure from the parents'* (In2). In spite of this difficulty she found innovative ways to maintain her beliefs about MST teaching*: 'if I do something original, I do it on a loose sheet so that the parents cannot pick it up'* (In2). She also found the inconsiderate use of the school intercom disruptive: *'One of the factors that had a*

detrimental influence was the intercom system that interrupts my lessons and most of the time the announcement had no bearing on us. This is a major interruption and distraction for the learners' (In2). In spite of the interruptions she carried on with her lesson and refocused the children's attention.

Lea and Riana found administrative and other duties a time-consuming burden that intruded on teaching time and caused frustration: Lea said that *'The pressure in your own classroom is tremendous, as other tasks intrude on your teaching and everything has to be complete'* (In1), while Riana felt challenged by the administrative duties that took her away from teaching MST. *'I am out of my classroom to do other things, not teaching all the time'* (In1).

The numerous administration tasks frustrated her and in order to cope she had to compromise with the use of *'worksheets'*, a pedagogical approach she did not agree with, as *'I am not positive about workbooks because I think there are more effective ways of teaching'* (In1). In her opinion, hands-on activities are a more appropriate pedagogical approach for inquiry-based teaching.

Anne-marie, however did not experience the problems mentioned above. She said, *'I would not change my work or my school for anything. Many children in my class come from all over Africa and others even from abroad which makes my work interesting and enjoyable'* (NR1). In the end, Jenna shared those sentiments when she commented that *'Being a first-year teacher I do believe that every lesson is a learning opportunity'* (OR).

First, the transition from student teacher to beginning teacher required new roles and responsibilities from the beginning teachers. The new conditions caused stress which was experienced as a reality shock with accompanying conflicting emotions in the beginning teachers. This reality shock is corroborated by the literature (Cherian & Daniel, 2008; Day & Gu, 2010; Cherubini, 2009; Pillen *et al.,* 2009; Rizza, 2011; Whitelaw, 2007). The beginning teachers found creative and innovative ways to adapt to their new circumstances while at the same time maintaining their professional teacher identity.

Second, recognition as a colleague and fellow teacher with a contribution to make is important for the beginning teacher, who wants to be accepted and not treated as an outsider. In this respect the literature (Cherian & Daniel, 2008; Rippon & Martin, 2006) mentions that the school hierarchy or veteran-orientated professional culture of a school may prevent the new teacher from being recognised and acknowledged as a skilled colleague. The six beginning teachers felt that they had specific MST pedagogic and content knowledge to contribute and that they should therefore be respected as colleagues with expertise. They applied their creative and negotiating skills to maintaining their developed professional teacher identity.

Thirdly, each school seems to have a distinct character that beginning teachers have to cope with and adapt to and that puts pressure on the professional teacher identity development of the beginning teacher. In the literature, Egan (2004) corroborates this assertion by finding that beginning teachers sometimes have to work within intrinsic constraints in order to establish their professional teacher identity. They often have to conform to the specific requirements of a school culture. This pressure may sometimes isolate the beginning teacher from the broader school setting and cause tension because of their conflicting beliefs about teaching (Day & Gu, 2010; Pakison, 2008; Whitelaw, 2007). The beginning teacher is faced with the dilemma of emotional conflict between personal beliefs and the reality on the ground (Billet & Somerville, 2004; Day, 2008; Keys, 2007; Parkison, 2008). In this study, the teachers coped by adapting to each individual situation. Bea adapted well and was respected for the knowledge she brought to the school. Riana was pressurised by the school culture. She tried to negotiate, bolstered by her strong professional teacher identity. She refused to conform to a school culture that contradicted her teaching beliefs and she indicated that she would rather leave the school for another, than to conform. She went to another school where she could teach according to her beliefs. Lea found it difficult to assert herself and she had to adapt to avoid conflict. She refused to change her beliefs and to conform to the school culture. She adapted by not attracting attention and keeping a low profile, but maintained her professional teacher identity. Gina flourished and felt confident enough to teach MST creatively. She accepted the challenge of teaching younger children. She exhibited a stable professional identity in teaching MST. Jenna was confident in her pedagogical and mathematical knowledge and portrayed a strong professional teacher identity. She

felt that she had grown within herself as a teacher. The centrality of Anne-marie's professional teacher identity as a pre-primary MST teacher was illustrated by her classroom teaching.

5.2.1.3 Institutional support

Institutional support may be described as the process of welcoming and acknowledging a beginning teacher as a colleague with professional knowledge and skills in teaching MST. In this study, the six beginning teachers experienced varying degrees of support.

Bea felt that *'I experienced a lot of support from my fellow teachers and my senior'* (OR). Similarly, Gina received quality support from the principal and did not lack teaching resources. She felt confident and in control of her situation as a teacher with a strong professional identity who could negotiate with her principal. She stated that *'The principal supported me in providing materials that I required. I would just write a note and she would order the material'* (In2). It seems as if these two beginning teachers felt confident that they were accepted as teachers and colleagues.

Riana felt that she had no support, 'except from the other young teacher' She said that *'older teachers have their ways of teaching and if you do not fit in with them, they are negative against you'* (In1). However, she explained that they *'helped me when I went to them for assistance. They would advise me on how to teach a specific concept if I was uncertain'* (In2). She sometimes also experienced that assistance as *'negative in the sense that teachers would indicate how they would do something, and implying that any other approach would not work'* (In2). Lea was negatively affected by the lack of support, as she said that the *'situation at present makes me [her] feel like a failure, as if I am a bad teacher'* (In2). As a result she 'find(s) teaching difficult because it feels as if I am stagnating because I cannot think creatively'. In spite of this, during observation she demonstrated a positive and creative approach towards teaching science and technology.

Jenna's experiences were both negative and positive. In the beginning of the year Jenna voiced her frustration as follows: *'The owner of the school will not provide resources and I do not have the means to buy them, so at the moment they are*

unobtainable' (In1). Then, later in the year, the situation at the school changed when she *'was made responsible for finances and we [all the teachers] collected funds for MST apparatus. The parents contribute an amount every term and we allocate funds where needed'* (In2).

Anne-marie found support for her ideas and worked closely with other teachers who held similar views about MST teaching at pre-primary level. She explained that she and her *'colleagues plan and work together'* and *'One of my colleagues is an experienced teacher and she supports me very well'* (In2) and *'I have support for my ideas on teaching at pre-primary school because my colleagues feel exactly the same'* (In 1). Anne-marie felt positive in her professional identity development as pre-primary school MST teacher because what she believed and practised in the classroom was supported by others.

It seems as if the support that they received from their school situations affected the six beginning teachers positively or negatively and reflected in their feelings about teaching MST. The literature reflects the importance of acceptance for beginning teachers at the commencement of their careers. They should feel valued as colleagues and be welcomed into the profession as teachers who know what they are doing (Davis & Higdon, 2008; Day, 2008; Day & Key, 2010; Egan, 2004; Rizza, 2011). This feeling of being accepted and appreciated is most often achieved through collaboration with colleagues and a supportive school principal (Cherian & Daniel, 2008; Rippon & Martin, 2006; Whitelaw, 2007). Collegial acceptance and support by colleagues and more experienced teachers enables a beginning teacher to develop her own professional teacher identity through positive reinforcement and acceptance of ideas (Flores & Day, 2006; Walkington, 2005).

5.2.1.4 MST Curriculum

Some aspects regarding MST curriculum were found to be important in the professional teacher identity formation process of the beginning teachers. The following aspects in this regard are explained, namely, curriculum interpretation and implementation, the learning areas of science and technology as well as pedagogical approaches that was employed to teach MST.

- **Curriculum interpretation and implementation**

Foundation phase curriculum interpretation and implementation was problematic for the six beginning teachers. All six teachers accepted mathematics as the core subject, but they experienced problems with interpretation of the curriculum. For example, Lea realised that mathematics was the foundation subject; however, the challenge of navigating and gaining familiarity with the curriculum, translated into the difficulty of teaching science and technology. *'The tempo of learning at school is high, as are the standards. Children have to achieve specific assessment standards and milestones. This makes the teaching of science and technology very difficult'* (NR2). Lea's efforts to teach science and technology were severely restricted by the guidelines of the curriculum and therefore the reality was that she tried *'to teach science and technology but this does not often happen'* (NR2) and *'There is really very limited time to teach science and technology in the foundation phase'* (NR1).

Bea stated that 'We have been using The Foundations for Learning Campaign files as directed by the DoE and this I found very confusing' (NR1). Riana was more concerned with the time allowed for teaching technology and science, as: *'Technology as a learning area gets little attention in the curriculum of my school. Many teachers see technology as a waste of time'* (NR2). She also *'noticed that the school curriculum does not allow much time for science, I would like to make my own time for science. I also want to try and inspire the other teachers to do more science activities in their classes'* (NR1).

The situation was very different in the early childhood settings, where Anne-marie freely interpreted and implemented the curriculum in line with her teaching philosophy. She could 'think of creative activities in which to get the children actively involved and interested' (OR). For Jenna, *'MST are all integrated and can be integrated into the other learning areas as well' (NR1), and 'Integration of learning materials in MST has become a reality for me.'* (In2).

Gina believed that children should *'learn about maths, science and technology using physical objects, as far as possible. I incorporate the maths and science activity into an art activity'* (NR2).

The three beginning teachers placed in the early grades of the primary schools (FP) experienced difficulty at first in interpreting and implementing the curriculum. They felt restricted and did not know how to accommodate everything they had to accomplish in the time available. Researchers (Cherubini, 2009; Day & Gu, 2010) identified challenges that relate to curriculum demands, such as implementing subject matter knowledge and work overload due to time management constraints. In spite of the difficulties encountered and the feeling of vulnerability they experienced (Flores & Day, 2006), the beginning teachers adapted to the various challenges and maintained a strong sense of self belief and identity as teachers.

By way of contrast, the beginning teachers in the ECP felt they had more freedom to teach the way they wanted to. The freedom they had to implement an integrated MST curriculum gave them a feeling of self-confidence to establish their MST professional teacher identity freely to the benefit of the children. The literature confirms that children in the early years use integrated content and process skills to construct MST knowledge (Charlesworth & Lind, 2007; Gillard, 2008).

A second finding was that established teachers were opposed to teaching science and technology and regarded teaching technology as a waste of time. The literature indicates that the implementation of the National Curriculum required that teachers adapt to a whole new range of teaching strategies and roles to implement the curriculum (DoE, 1998, 2000, 2003; Wilson-Thompson, 2005). Consequently, research indicates that teachers often find it difficult to teach science and technology and therefore neglect the subjects (Bosman, 2006; Van Heerden, 2005). In spite of this, the six beginning teachers maintained their positive approach to teaching science and technology by creating opportunities to teach these subjects through an inquiry-based approach.

The six beginning teachers found the new curriculum reform difficult to adapt to. In this respect, Bea was disconcerted because *'The curriculum changes every year. This is disconcerting. You find something that works and the next year you are made to readjust because of something else'* (In2). She complained that 'There is a lack of consistency' (In 2). Keeping in mind that Bea devised strategies to integrate the teaching of science and technology, she reacted to the impending curriculum

change: *'I heard that science and technology are being removed from the curriculum and I am against this removal. The subjects are essential for the development of the child'* (In2).

The announcement by the department of education that *'technology is going to be removed from the curriculum from 2011'* (In2) brought Lea to the realisation that *'we are moving backwards to the old ways of teaching that are less learner-centred and children cannot learn effectively'* (In2). Lea felt apprehensive about that curriculum change, as it was already difficult to teach science and technology. The change further impacted on her pedagogical beliefs that children learn through *'discovery and experimentation'* (NR1) and her epistemological beliefs: *'I feel that science and technology will die out unless I do something about it. They* [children] *will lose out unless I introduce them to it'* (In1). Curriculum change caused feelings of frustration for the beginning teachers, especially Bea and Lea.

The literature (Bosman, 2006; Van Heerden, 2005; Thompson, 2005) indicates that when teachers are confronted with curriculum change in schools where the interpretation and implementation of curriculum differ from their own, serious dilemmas arise (Day & Gu, 2010; Rippon & Martin, 2006; Rizza, 2011). With the implementation of the National Curriculum many teachers had to adapt to a whole new range of teaching strategies and roles (DoE, 1998, 2000, 2003; Wilson-Thompson, 2005) to effectively implement it. The recommended teaching approach was sometimes difficult to implement in the classroom (Howie *et al*., 2003; Maree & Erasmus, 2006; Reddy, 2006; Wilson-Thompson, 2005), as little support for the inquiry-based approach was provided and the National Curriculum lacked adequate specification of content knowledge in the eight learning areas (Hoadley *et al*., 2010). Carlone *et al.* (2010) and Day and Gu (2010) suggest that the development of a positive professional teacher identity can help beginning teachers to accommodate and respond to curriculum reform and change. On the whole, the professional teacher identity of the six beginning teachers was not seriously affected by curriculum change, as they adapted to the new situation. The only aspect that perturbed them was the news of the impending removal of science and technology from the curriculum.

The learning area of mathematics forms the core of the numeracy programme, while science and technology learning areas are integrated into all three learning programmes (DoE, 2003).

In her Grade 1 class, Bea employed an integrated curriculum to teach. She adapted the curriculum in a way that suited her own beliefs about the nature of mathematics (science and technology not as prominently) *'Science and technology are taught integrated with life skills and language'* (In2). However, she found the documents unhelpful and 'very confusing' (NR1).

Teaching Grade 2 children, Riana felt that she was also pressurised by the curriculum requirements: *'The curriculum requirements and goals set to achieve by the end of the term create pressure'* (In2). She pointed out that *'Unless the curriculum provides more time and attention to science and technology, these two subjects will be sidelined as less important. There is no time to teach these two learning areas'* (In2)

Lea realised that mathematics was the foundation subject. However, the challenge of navigating and becoming familiar with the curriculum translated into the difficulty of teaching science and technology, as she was severely restricted by the guidelines of the curriculum at school. The reality was therefore was that *'I try to teach science and technology but this does not often happen'* (NR2) and *'There is really very limited time to teach science and technology in the foundation phase'* (NR1).

Anne-marie in her Grade R class freely interpreted and implemented the FP National curriculum guidelines and adapted them in line with her teaching philosophy. She could *'think of creative activities in which to get the children actively involved and interested'* (OR).

The beginning teachers in FP classrooms in the primary schools experienced difficulty in teaching MST creatively. For example, Lea's efforts to teach science and technology were severely restricted by the guidelines of the curriculum and therefore the reality was that *'I try to teach science and technology but this does not often*

happen' (NR2) and *'There is really very limited time to teach science and technology in the foundation phase'* (NR1).

Jenna and Gina were in ECP settings where they were confronted with a lack of clear curriculum guidelines for the age group they were teaching. Jenna explained that the dilemma of teaching MST to children of four and five years old with no curriculum guidelines and consequently *'no assessment standards for children younger than grade R, but with a bit of initiative one can work out lessons that help the children to reach the grade R outcomes with ease'* (NR1). Jenna used knowledge from the FP curriculum acquired during her studies to adapt and plan her MST teaching. For her *'Integration of learning materials in MST has become a reality'* (In2).

Gina realised that she had more freedom to teach in the early childhood setting than teachers in the primary school. Gina believed that children should *'learn about maths, science and technology using physical objects, as far as possible. I incorporate the maths/science activity into an art activity'* (NR2).

The mathematics learning area forms the core of the numeracy programme in the FP. The teaching of science and technology does not receive the attention that the beginning teachers feel it should because of restrictions by the curriculum guidelines. Bea, Riana and Lea tried to integrate science and technology into all three learning programmes but felt that they did not have sufficient time to do so. Anne-marie, who could use the National Curriculum guidelines for her Grade R class, had the freedom to implement the guidelines and was the exception. She could teach more freely and without restriction and could adopt the curriculum to inquiry-based learning. The literature (DoE, 2003) corroborates that mathematics forms the core of the numeracy programme. Research also indicates that implementing the National Curriculum is regarded as a challenge to the beginning teacher (Bosman, 2006; Hoadley *et al.,* 2010; Van Heerden, 2005). Furthermore, there is some uncertainty about the place and amount of science and technology that should be included in FP classrooms where the time allocation is insufficient for inquiry-based learning. Teachers often find it difficult to teach science and technology in the FP classroom and tend to neglect the subjects (Bosman, 2006; Van Heerden, 2005).

Secondly, the integration of early MST seemed to be more easily accomplished in the ECP than in the FP, as evidenced in the study. Cross *et al*. (2009) and Van Heerden (2011) confirm that MST activities are often presented as part of an integrated curriculum in early childhood classrooms and form part of the pedagogical approaches employed.

Bea expressed a love for mathematics and tried to instil that love in the children she taught*: 'I think my children love mathematics because they see I love it'* (In1). Riana said that she was *'positive about teaching maths'* and more important, she wanted to *'ensure that children feel positive towards maths'.* For Riana, mathematics was *'one of the learning areas that children can feel enthusiastic about and they can do well* (in)' (In1), she added that *'maths is important, but children have to be taught the concepts; they cannot learn them by themselves. The work should be enriched'* (In2).

Lea felt that *'mathematics is a foundation subject'* (In1). Gina was convinced that mathematics as the foundation subject should be taught informally and *'learning mathematical concepts and skills should be an enjoyable experience for all learners.'* (NR1). She added that 'Teaching maths means acquiring basic skills like number concept in a concrete manner' (In1). She believed that *'Young learners need to experience mathematics for themselves. They need to see what concepts such as "heavy and light" mean'* (NR1).

Jenna believed that *'maths is important in the development of children's thinking processes'* (In1). She planned lessons in *'a fun and interactive manner, having no correct or incorrect way of doing things but rather leaving the creativity and problem solving in the hands of the learners'* (NR1). For example *'If we count out stuff in class, I allow the children to help. They learn the basics in an informal playful manner'* (In1). She acknowledged that the *'children made me aware of possibilities in maths'* (In2). Anne-marie stated that *'mathematics is the foundation subject'* (In1).

The six beginning teachers regarded mathematics as important for the conceptual development of young children and that mathematics teaching should be both enjoyable and meaningful. This positive approach to mathematics teaching applied to all the teachers in the study. This finding seems to contradict findings in other studies

where early childhood teachers did not always include mathematics in their classroom practice (Botha *et al.,* 2005*;* Ginsburg & Ertle, 2008). The six beginning teachers' positive attitude towards teaching mathematics corresponds with what research says, namely that teachers who are positive and confident about teaching mathematics show an understanding of the nature of the subject and the implications this has for classroom practice (Cross *et al.,* 2009; Ginsburg & Ertle, 2008; Saracho & Spodek, 2008).

- **Science and Technology**

Most of the beginning teachers mentioned that it was difficult to teach science and technology. Because they felt that the science and technology were important, they nevertheless devised ways to teach these subjects.

Bea explained that *'We (other staff members) plan the subjects together and science is not a priority subject because it does not count for marks'* (In1). But she planned alternative approaches for teaching science and technology: *'so there is very little time to teach science. But we could plan a science project like a discovery table'* (NR2). She added that *'Learners should know science and I wish I could do more. Maybe I should plan better to include science on Fridays'* (In2).

In Riana's Grade 2 class planning science and technology posed some difficulties at first, as she explains*: 'I don't have time for technology lessons, but I am going to do technology during the art class'* (In1) and *'I cannot teach a science lesson only in my classroom. All the classes must do the same work. Secondly I have to teach the three learning areas that are important to the school, literacy, numeracy and life skills (movement)'* (In 2). But Riana also knew that *'if you do not make time to teach science and technology, there will never be time to teach them. You have to prioritise the teaching of science and technology'* (NR2). For her *'technology and science are important because children learn valuable concepts and they also enjoy them'* (In2). She found practical solutions and declared that she had *'learnt to accommodate science and technology in the last half an hour of the day'* (In2). Riana added that: *'I teach science based on the interest that children show' and 'I usually base science lessons on practical, everyday things'* (In1).

Lea's efforts to teach science and technology in her Grade 2 class were severely restricted by the guidelines of the curriculum. Lea stated that *'There is really very limited time to teach science and technology in the foundation phase'* (NR1). The reality was that she tried *'to teach science and technology but this does not often happen'* (NR2). In spite of the difficulties she mentioned, Lea presented an integrated MST lesson during the observation. One of the difficulties that Lea experienced was that the *'older teachers have never done science and technology and therefore have no interest to teach the subjects' and that 'science and technology are subsidiaries'* (In2).

Jenna stated that she *'strongly feel[s] that these three learning areas need to be taught in a very concrete manner in order to make abstract thinking in the future easier for the child'* (In2). Gina employed a different strategy with her three-year-old group: *'Every Wednesday I do either a maths or science activity. Sometimes it is a separate activity, but I try to incorporate it into an art activity'* (OR). Another example she gave was: *'When the theme allows, I include discussions about MST in the theme discussion and language development. When I plan a theme, I try to look for ways in which these learning areas can be included'* (In2). In Anne-marie's grade R classroom in an early childhood setting, she encouraged children to learn experientially through discovery. *'I have a nature corner in my classroom where beans sprout and silkworms spin cocoons and shapes. We have birds, fish and a vegetable garden. The children enjoy science because they think it is magic and they are fascinated and they think and wonder about what they experience.'* (NR2).

In summary, the six beginning teachers regarded science and technology as important for the development of the children in their care. This represents an important component of their professional teacher identity. They planned and strategised to teach science and technology in spite of impediments such as time constraints and restrictions for inquiry-based science and technology teaching.

Secondly, they implemented an inquiry-based pedagogical approach for teaching MST because they believed that this approach would benefit the children by developing exploration, discovery and problem-solving skills. Research indicates that

teachers have to believe in an inquiry-based approach to implement this approach (Furtak, 2006).

Anne-marie integrated and *'applies mathematics, science and technology concepts in planned lessons'* (In1). Gina stated that *'Mathematics, science and technology should form part of every early childhood programme. It is in the early years that children learn the foundation skills they will need and use to succeed in these subject areas later in their schooling'* (NR2). Jenna felt confident about her pedagogical and mathematical knowledge; she believed that *'maths is important in the development of children's thinking processes'* (In1). In her early childhood class she often integrated *'maths with other subjects'* (In1) and tried to teach lessons in all three learning areas *'to make sure the children reap the true benefits of education'* (NR1).

Lea believed that 'MST form the basis for learning in other learning areas' and that *'MST provide important knowledge and skills to learners that they will be able to use for the rest of their lives'* (NR1). For her *'planning is the most important aspect of teaching MST, as without planning and preparation, lessons tend to be reduced to talking and workbooks and the children don't benefit' because they need to become skilled at problem solving'* (In2).

Bea did not find the integration of science and technology into the programme easy. '*You do the maths, and have to integrate the science through other subjects this is difficult'* (In 2).

Integrating MST in FP and ECP classes is possible with careful planning and with the conviction of the teacher that such integration is beneficial to the children with regard to problem solving, reasoning and enquiry as a process. The literature advocates that MST teaching should focus on problem solving, reasoning and enquiry as a process and methodology (Bosman, 2006; Charlesworth & Lind, 2007; Gillard, 2008)

All the beginning teachers expressed themselves as being positive about teaching MST and committed to making a difference. Bea said *'I am positive about my teaching. I feel that I am making a difference'* (In1). Similarly Anne-marie said that she was convinced that 'one should have a passion for teaching' (In 1). She entered

her first teaching position with *'creative energy and enthusiasm ... excited to teach'* (In1). She also stated that she *'would not change my work or my school for anything. Many children in my class come from all over Africa and others even from abroad which makes my work interesting and enjoyable'* (NR1).. Jenna defined herself as a 'successful teacher' (In2). Gina felt *'comfortable in teaching science because I know what I am doing'* (In1), while Riana mentioned that she had *'the latest information and (I) have something to contribute'* (In1).

The six beginning teachers entered their first classrooms with a positive attitude that appears to have prevailed. They felt that they had much to contribute and were excited to be part of the teaching profession. This positive attitude from beginning teachers is substantiated in research. Nias (1989) says that the majority of beginning teachers have a sense of purpose and are idealistic about their work. Day (2008), Day *et al*. (2006a) and Rippon and Martin (2006) found that teachers want to be satisfied with the results of their work. Research further indicates that a positive approach to teaching MST may help beginning teachers to construct and sustain a positive professional teacher identity (Flores & Day, 2006; Forde *et al*., 2006; Vaillant, 2007; Walkington, 2005). This positive teacher identity enables them to be confident and flexible and to participate in ongoing change. They will also be able to make decisions and to 'take risks' (Samuel, 2008; Walkington, 2005).

The six beginning teachers demonstrated their caring nature towards the children in their classes as part of their professional teacher identity construct.

Anne-marie felt:' a passion for children' (In 2). Jenna realised that *'learners who cannot work independently and do not benefit from peer teaching need intervention'* (OR). Bea felt that she was *'making a difference'* (In1) in her situation. Riana wanted to *'ensure that children feel positive towards maths' because for her mathematics* was *'one of the learning areas that children can feel enthusiastic about and they can do well'* (In1). Lea wanted *'to accommodate all learners as every learner is unique and has to be considered'* (NR1). Gina's caring nature was evident when she explained that *'learning mathematical concepts and skills should be an enjoyable experience'* (NR1) for all learners.

The six beginning teachers indicated through their actions and statements that they were compassionate and caring towards the children in their care and felt that they were successful if they made a difference. Research (Rots *et al*., 2011) indicates that teachers who felt that they made a difference in children's performance, were convinced that they were successful teachers.

- **Pedagogical approaches**

The pedagogical approach of the six beginning teachers indicated clearly that they favoured creative instructional techniques and strategies to encourage concept formation and develop problem solving capacity in their children.

Bea's pedagogy was that of a 'hands-on' teacher who tried to use creative means (as part of her identity formation) to teach her children: *'I believe children need to manipulate resources in order to learn better. I always use counters so that the child can move smoothly from the concrete to the abstract'* (In1) and she created *'an atmosphere of discovery and one that fosters learning'* (NR2).

Riana's pedagogy was apparent in her actions *'I also like to use counters when introducing a new number'* (NR1) because *'I like to make my numeracy lessons more hands on'* (NR2). Riana said that *'Learners understand concepts more quickly when I use three dimensional materials.'* (NR2) She preferred *'working creatively and three-dimensionally with the children before going to the abstract'*. She added that ' workbooks were difficult and ineffective because of the way they were constructed and used. *'I am not positive about workbooks because I think there are more effective ways of teaching'* (In1).

For Lea *'planning is the most important aspect of teaching MST, as without planning and preparation, lessons tend to be reduced to talking and workbooks and the children don't benefit'* because they needed to *'become skilled at problem solving'* (In2). In her classroom Lea taught *'maths differently from the other teachers. I use counters and unifix blocks with counting to reinforce the concepts'* (In1). *'I am behind with my workbooks because I am doing practical work'* (In1). She felt that her teacher identity was negatively affected by her inability to teach creatively and that she was *'stagnating as a teacher. I find that the reality in school is different'* (NR2). Lea

reacted emotionally because *'Now that I am teaching, I find it difficult to teach creatively because the school is more structured' She said that the 'situation at present makes me feel like a failure'* (In2). '

Because of her situation in the ECP, Anne-marie could plan constructively and *'think of creative activities in which to get the children actively involved and interested'* (OR).

Jenna believed that *'learners needed to be taught through discovery and scaffolding and not by rote learning'* (OR) and she *'strongly feel(s) that these three learning areas need to be taught in a very concrete manner in order to make abstract thinking in the future easier for the child'* (In2).

Gina's attitude was made clear when she stated that she '*always teach*(es) *MST in a concrete manner. I start three-dimensionally and then move to two dimensional. I stick to basic stuff and keep things as simple as possible. I take a small group of three and work individually with each child*' (In2). Her opinion was that *'children should learn mathematical concepts from a very young age. Children should be challenged to expand their knowledge and skills, but should be assisted along the way so that they experience success as they are learning. I believe that each activity should be adapted for the level of each child'* (OR).

First, the six beginning teachers started their first year of teaching early MST using hands-on, creative inquiry-based teaching strategies which they felt would advantage the children in their care. They formed an emotional bond with their children and were committed to the task of teaching. Research (Charlesworth & Lind, 2007; Schmidt, 2004; Stigler & Hiebert, 2004) indicates the value of using pedagogical strategies that develop children's mathematical thinking in early childhood settings.

Secondly, some of the beginning teachers in the FP classrooms felt that they could not be as creative as they wanted to be because of time constraints and the use of workbooks. It is evident from the literature that the lack of adequate time and space allocated for exploration and investigation during learner-centred activities have had a negative impact on the teaching and learning of MST in South Africa and has led to

worksheet-dominated classrooms (Bosman, 2006; Botha *et al*., 2005; Van Heerden, 2005). Pedagogical approaches where worksheets and workbooks dominate are fundamentally different from inquiry-based pedagogy (Carruthers & Worthington, 2006; Fisher, 1996; Pound,1998).

5.2.1.5 Professional teacher identity

Judging from their remarks, the participating teachers' identity in the context of teaching MST seems to have been well formed as a result of the four-year teacher education programme which sought to produce reform-minded FP teachers.

Bea said that she believed: *'that my identity is strong enough for me to be successful and to become an even better teacher'* (In1). She added later that *'I want more knowledge; I have a passion for children and I want to be there for them'* (In2).

Riana's professional teacher identity withstood different feelings of isolation, disagreement and discouragement at the beginning of her teaching career. She experienced a school culture that contradicted her teaching beliefs and her vision of the profession that formed the foundation of her experience as a new teacher. She commented that *'The situation at school was not what I expected. The school prescribes methods and approaches and this has a negative effect on me. During my interview the principal asked me what I could contribute to the school and I felt that I had a lot to contribute, such as my way of teaching and my insights into methodology. I was excited to teach, but the situation at school disappointed me and I thought: is this what teaching is about?'* (In2)

Lea's identity as a teacher was initially inspired by her own experiences in the classroom during the internship and her transformed belief that MST were important learning areas. However, during her first year of teaching she placed emphasis on maintaining a 'distance' between her and the older teachers. She realised that the *'older teachers have never done science and technology and therefore have no interest to teach the subjects'.* She tried to keep a low profile and explained that *'I conform because I do not want conflict'* (In1). The other teachers at the school made use of mainly workbooks and did not always allow learners time to do *'hands-on'* experimentation and discovery. She experienced conflict because *'Some days I do*

not want to use the workbook, but I must keep up with the other five teachers. Everybody does the same' (In1), and her *'colleagues have been teaching for a long time and are not open to new ideas'* (In2).

In her ECP setting, Gina became confident, flexible and adaptable in her ability as a teacher and she found that *'it is easier to decide on approaches in class, because my theoretical and practical experience confirm my beliefs'* and she '*manage*[s] *my* [her] *time better'* (In1). Gina confirmed that the '*biggest change during the first year is that I have found more confidence in my teaching. I have also learnt to think on my feet, especially when an activity does not quite work, I then adapt'* (In1).

Jenna described herself as follows: '*I feel that I have grown as a teacher and that I am in my own class and in control of what happens. Although it is a great responsibility I feel comfortable because I have more experience and I can do a more integrated programme with the children'* (In2). Her experiences '*during the year' had 'made me positive about my teaching*' (In2). She explained that '*I have grown within myself and as a teacher. I believe it is necessary to be a lifelong learner*' (OR) and she defined herself as a '*successful teacher'* (In2).

Anne-marie was convinced that '*my identity is strong enough for me to be successful and to become a better teacher*' (In 2). She valued her teaching experience and teaching culture and insisted that '*Experience means more than theory'* (OR) and '*I would not change my work or my school for anything. Many children in my class come from all over Africa and others even from abroad, which makes my work interesting and enjoyable*' (NR1). Her working environment had confirmed her initial ideas about teaching. She truly believed that she was '*a good teacher because my children are happy, I am happy and we enjoy learning together*' (OR).

5.2.1.6 To summarise

With regard to the professional MST teacher identity formation, the six beginning teachers were found to be positive about their roles as teachers. It seems as if their professional teacher identity developed and was sustained through the rich complexity of the experiences they had had during the year. Research indicates that the first year of teaching is complex and variable and requires that beginning

teachers experience this rich complexity in the process of creating, sustaining or changing their professional teacher identity (Billet, 2007; Billet & Somerville, 2004; Brownlee & Berthelsen, 2006). The six beginning teachers developed a professional teacher identity with a cognitive dimension of self-understanding, reflective practice and creative thinking.

5.2.2 Factors Affecting Beginning Teachers' Professional Teacher Identity Formation in Early MST

The internal and external factors that influenced the six beginning teachers' professional teacher identity formation in early MST were identified. The narrative descriptions of the six beginning teachers were used to arrive at findings on how these factors influenced their professional teacher identity.

5.2.2.1 Internal factors that influenced beginning teachers' professional teacher identity in early MST

Internal factors are those factors that encompass and influence the personal beliefs, values, ideologies, assumptions and expectations relating to MST teaching and which may influence professional teacher identity formation (Brownlee & Berthelsen, 2006). Secondly, beliefs about MST knowledge and knowledge about learning are internal factors that may influence professional teacher identity (Brownlee & Berthelsen, 2006; Bleicher, 2006; Keys, 2007).

Personal biographies and epistemologies

The theme of personal biographies and epistemologies are discussed under MST beliefs and MST knowledge.

- **MST beliefs**

Although most of the six beginning teachers entered their teacher education programme with negative feelings towards maths, science and technology, all of them mentioned a degree of positive change in their MST beliefs during and after their studies and internship period. They all entered their first year of teaching with a positive MST professional teacher identity.

Jenna commented that '*You follow the examples taught at university and that is what you believe in. Then suddenly you are at a school that wants you to do otherwise and the danger is that you conform. Your mind knows that you should do what you believe. I do think that given time to adjust and find your feet, you will express your own opinion and teach the way you feel you should*' (In2).

Bea, Riana and Lea had to adapt their MST teaching techniques to conform to the requirements of their respective school cultures, although they did not change their beliefs. Their beliefs about MST pedagogy are exemplified in their reactions to adverse situations as they attempted to avoid conflict by conforming to school context requirements, while at the same time planning to teach creatively and applying hands-on, inquiry-based pedagogical approaches and trying to convince colleagues to do the same. In this respect Bea succeeded more easily in gaining the support of her colleagues because of her specific situation. For Riana and Lea the process was slower, but they managed to gradually strengthen their beliefs in their pedagogic approaches and to preserve their professional teacher identity by adapting their teaching techniques.

Unencumbered by the restrictions of the primary school, Gina, Jenna and Anne-marie found that they could confirm their pedagogic beliefs and knowledge. They employed hands-on, inquiry-based pedagogical approaches in their classrooms, further strengthening their positive teacher identity. The six beginning teachers indicated that they did not change their convictions and beliefs about MST teaching, although there were instances where some had to conform to some extent to avoid conflict. Nevertheless, there were indications through their teaching practice during the first year that all of them retained their beliefs about inquiry-based MST teaching. In the literature Mayer (1999) supports the idea that beginning teachers' core beliefs about teaching and being a teacher are important to adapt, strengthen and sustain their professional identity.

- **MST knowledge**

MST knowledge includes the general knowledge of how to teach and the specific pedagogical content knowledge of how to teach MST.

Bea's confidence in her ability to teach MST received a reality shock when she became aware of the school context. Her '*emotions went from feeling like I was thrown into the deep end and that I had to sink or swim' toward 'feeling more confident*' (In1) and positive. Bea's feelings about the importance of science and technology are emphasised when she said: '*I heard that science and technology are being removed from the curriculum and I am against this removal. The subjects are essential for the development of the child*' (In 2).

Riana and Lea's experiences were very similar. Riana had strong feelings about pedagogical approaches she did not agree with, because she believed in '*working creatively and three-dimensionally with the children before going to the abstract. Workbooks are difficult and ineffective because of the way they are constructed and used. I am not positive about workbooks because I think there are more effective ways of teaching*' (In1). Lea's comments about the envisaged curriculum change show her concern about the potential loss of scientific and technological knowledge at FP level. She said that '*I feel that science and technology will die out unless I do something about it. They [children] will lose out unless I introduce them to the children*' (In1). They entered their schools prepared to teach MST creatively to the benefit of their children.

Similarly, Jenna explained her pedagogical approach when she said that '*I feel that my method of teaching is effective and that there are learners who really benefited*' (OR). Gina said '*without a doubt my beliefs about MST correlate to the way in which I plan and teach these learning areas*' (NR1). Anne-marie truly believed that she was '*a good teacher because my children are happy, I am happy and we enjoy learning together*' (OR).

The six beginning teachers said that they had acquired insight into pedagogical approaches. They learnt adaptive coping and decision making skills and strengthened and sustained their professional teacher identity. All six beginning teachers said that they had specific beliefs about MST knowledge and of how to teach MST, thus illustrating their developing professional teacher identity. Acquiring specific subject matter knowledge and pedagogic content knowledge pertaining to MST teaching in the early years (Bleicher, 2006; Cross *et al.,* 2009) is considered

essential for the development of a positive MST professional teacher identity. The internal factors that affected the six beginning teachers' professional teacher identity formation are MST knowledge and beliefs.

5.2.2.2 External factors that influence beginning teachers' professional teacher identity in early MST

External factors that influenced learning and identity in the specialist field of ECP and FP are the following:

(a) Initial teacher education programme

(b) School context: The aspects from the school context that affected beginning teachers are the reality shock, school culture and politics and institutional support.

(c) MST curriculum interpretation and implementation

(d) MST teaching

(a) Initial teacher education programme

The initial teacher education programme is an important learning opportunity that provides MST pedagogical and content knowledge and experience to the beginning teacher.

Anne-marie was of the opinion that '*Theory provides a necessary foundation for what lies ahead*' (In2). Similarly Jenna remarked that the programme at university '*prepared me for teaching maths'* (In1). Gina felt that her experiences during the internship programme were *'definitely influenced by what I had learnt from the modules during my teacher training programme'* (NR1). Bea felt that *'University learning helps you know that you can be confident to innovate your teaching style'* and to *'apply new ways of teaching' and you then 'adapt your techniques to grow as a teacher'* (NR1). Lea *'became aware of many aspects and possibilities to teach mathematics'* (NR1). For Riana her university training was important as her thinking skills and other skills were developed. This was meaningful' and therefore '*My training taught me to think independently*' (In2).

The initial teacher programme consisting specifically of those reflective feedback skills and MST modules provided the beginning teachers with MST pedagogical knowledge and competences enabling them to apply theory to practice. The findings confirm what the literature suggests, namely that quality initial teacher programmes should help student teachers to develop a positive teacher identity (Bradford, Darling-Hammond & LePage, 2005a; Bradford, Derry, Berliner, Hammerness & Beckett, 2005b; Day, 2002; Hammerness, Darling-Hammond, Bradford, Berliner, Cochran-Smith, McDonald & Zeichner, 2005; Hill, 2003; Keiny, 2008; Keys, 2007; Vaillant, 2007). In this regard the FP programme at the institution could be said to have been successful in producing reform-minded MST teachers.

(b) School context

School context encompasses and describes the various aspects that affected and pressurised the beginning teachers in their first year of teaching: such as reality shock, school culture and politics, children, parents and administration as well as institutional support.

- **Reality shock**

With regard to the reality shock experienced by the beginning teachers when they arrived at their respective schools, In Lea's Grade 2 primary school classroom she soon realised that *'A new teacher cannot think that she can come into her classroom and do what she wants; there are too many restrictions and rules'* (In2). She described her first year of teaching as *'not easy' because when 'you stand in front of your own class for the first time you are uncertain'* (In2). She stated that *'being in your own classroom is vastly different. As student teacher you are unaware of what really happens at school. The pressure in your own classroom is tremendous, as other tasks obtrude on your teaching and everything has to be complete'* (In1).

The reality of school context, such as working with the established teachers and groups within the school, was an enormous shock to Riana*. 'Now that I have my own classroom it is difficult to teach the way I want to, because I have to fit in with what the other teachers* (In1). Riana's negative experiences in her first year of teaching infused many aspects of her teacher identity. In the end she said *'The biggest influence on my teaching was the school situation. I think I would have had a totally*

different learning process if I had been at a different school' (In2). In the case of Anne-marie, Lea and Riana, the principal contributed to the pressure experienced by the beginning teachers, especially as in Lea's case her head of department was not open to new ideas. Bea, Gina and Jenna had support from their principals.

- **School culture and politics**

Riana's experiences during her first year of teaching pressurised her teacher identity. She felt *'frustrated because in the primary school I cannot teach the way I would like to. I cannot teach like this for a whole year'* (In1). Lea realised that the *'older teachers have never done science and technology and therefore have no interest to teach the subjects'*. She was *'careful not to attract too much attention with new approaches and teaching methods. I keep a low profile not to attract attention'* (In2). and she explained that *'I conform because I do not want conflict'* (In1).

- **Children, parents and administration**

Bea experienced challenges with regard to the lack of parent support and the socio-economic background of the children in her class. Poverty and absenteeism played a major role in her case. Bea *'adjusted my [her] teaching approach to the practical situation at school. I still have the same attitude and beliefs about the subjects. But I have learnt specific information about the school, who my learners are and how to teach them'* (In2).

Riana felt challenged by the administrative duties that took her away from her MST teaching. *'I am out of my classroom to do other things, not teaching all the time'* (In1). She realised that she had to survive and consequently conformed to the politics and culture of the school, saying that *'I did things their way to know I was safe, and not to have pressure from the parents'* (In2).

Riana and Lea had to contend with pressure from parents and the school culture where teaching for all the classes had to be the same. This brought conflict to the creative approach in teaching that they believed in. In Riana's case parents *'compare books* [from the different Grade 2 classes] *and complain if the books are not the same'* (In2). In spite of this difficulty she finds innovative ways to maintain her beliefs about MST teaching *'if I do something original, I do it on a loose sheet so that the*

parents cannot pick it up' (In2). Similarly Lea felt that *'parents talk to one another and apply pressure'* (In2). To a lesser extent, the children's socio-economic situation and the special needs of children caused tension in Lea's case as *'children are from poor socio-economic homes and do not have food. Some children come from broken homes, with resulting problems'* (In2).

With regard to school context, the external factors that influenced the six beginning teachers' professional teacher identity formation were firstly the reality shock of moving from being a student teacher to being a beginning teacher in their own classrooms. The second factor identified as important was the beginning teachers' position and status within the school culture in which they found themselves. The third factor that affected their professional teacher identity formation was the issues surrounding children, parents and administrative duties. Most of these factors led to emotional reactions that threatened the formation and sustainability of their professional teacher identity.

The findings are confirmed by Egan's work (2004) that indicates that beginning teachers sometimes have to work within intrinsic constraints in order to establish their professional teacher identity within their classrooms and often feel obliged to conform to the specific requirements of a school culture. Beginning teachers who do not conform to the specific school culture may be isolated from the school community and this situation may prevent them from developing or maintaining a positive professional teacher identity (Parkison, 2008; Whitelaw, 2007).

- **Institutional support**

Bea received positive support from her colleagues: 'I experienced a lot of support from my fellow teachers and my senior' (OR). In the beginning of the year Jenna voiced her frustration as *'The owner of the school will not provide resources and I do not have the means to buy them, so at the moment they are unobtainable'* (In1). Then later in the year the situation at the school changed when she *'was made responsible for finances and we* [all the teachers] *collected funds for MST apparatus. The parents contribute an amount every term and we allocate funds where needed'* (In2). Institutional support strengthened Jenna's professional teacher identity by giving her the confidence to teach and develop a feeling of self-worth. Jenna values

the institutional support as vital; she says '*The most important aspect at school was the support I received. Teachers discussed lesson planning and that helped me a lot*' (In2). She acknowledges that '*my principal supports me and listens to what I have to say*' (In1).

Riana as a new teacher in a school with its own political culture where a *'first-year teacher is not recognised by the older teachers who feel that you have book knowledge, but you don't have teaching experience'* (In2), felt that she had no support. *'The older teachers have their ways of teaching and if you do not fit in with them, they are negative against you'* (In1). Lea had similar experiences. She felt that she did not *'have support, except from the other young teacher' (In1)*, her *'new ideas are not accepted'*; the *'situation at present makes me* [her] *feel like a failure, as if I am a bad teacher'* (In2).

Gina stated that '*The principal supported me in providing materials that I required. I would just write a note and she would order the material*' (In2).

Anne-marie found support for her ideas and worked closely with other teachers who held similar views about MST teaching at pre-primary level. She explained that she and her *'colleagues plan and work together. One of my colleagues is an experienced teacher and she supports me very well'* (In2) and *'I have support for my ideas on teaching at pre-primary school because my colleagues feel exactly the same'* (In 1).

Institutional support was important for the development of all six beginning teachers. The beginning teachers had mixed experiences regarding support. Positive support had a positive emotional effect and resulted in feelings of acceptance and confidence in their own abilities. Lack of support resulted in negative emotional reactions such as feelings of vulnerability, uncertainty, frustration, failure and disagreement.

The literature acknowledges the importance of effective support as a positive influence for beginning teachers in helping them to believe that what they are doing is correct and effective (Day, 2008; Day & Gu, 2010; Rizza, 2011; Whitelaw, 2007). With regard to the effects of lack of support, the literature indicates that lack of

support may lead to feelings of isolation and emotional conflict because of conflicting beliefs about teaching (Parkison, 2008; Billet & Somerville, 2004).

(c) MST curriculum interpretation and implementation

Bea found the documents they used unhelpful and *'very confusing'* (NR1). She appeared to lose a sense of herself as a MST teacher, when she learnt that the curriculum was about to change: *'I heard that science and technology are being removed from the curriculum and I am against this removal. The subjects are essential for the development of the child'* (In 2).

Riana's challenges were the cumbersome curriculum demands *'The curriculum requirements and goals set to achieve by the end of the term create pressure'* (In2). Moreover, the challenge of navigating and gaining familiarity with the curriculum requirements made it difficult to support the special needs of some learners in her class. *'The negative effect is that the weaker children cannot keep up and once they fall behind, they cannot catch up. Some children are disadvantaged because of the pace required'* (In2). Riana pointed out: *'Unless the curriculum provides more time and attention to science and technology, these two subjects will be sidelined as less important'*. She was pressurised as *'There is no time to teach these two learning areas'* (In2). She added: *'Workbooks are difficult and ineffective because of the way they are constructed and used. I am not positive about workbooks because I think there are more effective ways of teaching'* (In1).

For Lea, however, the challenge of navigating and gaining familiarity with the curriculum translated into the difficulty of teaching science and technology. *'The tempo of learning at school is high, as are the standards. Children have to achieve specific assessment standards and milestones. This makes the teaching of science and technology very difficult'* (NR2). Lea added that the announcement by the department of education that *'technology is going to be removed from the curriculum from 2011'* brought the realisation that *'we are moving backwards to the old ways of teaching that are less learner-centred and children cannot learn effectively'* (In2). Lea felt apprehensive about that curriculum change, as it was already difficult to teach science and technology. The change further impacted on her pedagogical beliefs that children learn through *'discovery and experimentation'* (NR1) The situation described

above pressurised Lea's professional teacher identity as she felt that she could not teach her children the way she believed she should.

Gina realised that she had more freedom to teach in the early childhood setting than teachers in the primary school. Gina believed that children should *'learn about maths, science and technology using physical objects, as far as possible. I incorporate the maths/science activity into an art activity'* (NR2).

Jenna explained that the dilemma of teaching MST to children of four and five years was that there was no curriculum in MST for this age group and consequently *'no assessment standards for children younger than grade R, but with a bit of initiative one can work out lessons that help the children to reach the grade R outcomes with ease'* (NR1). Because there were no clear curriculum guidelines for MST except for the FP curriculum, Jenna used knowledge from the FP curriculum acquired during her studies to adapt and plan her MST teaching. Anne-marie freely interpreted and implemented the curriculum in line with her teaching philosophy. She could *'think of creative activities in which to get the children actively involved and interested'* (OR).

In summary, the beginning teachers in the primary school setting also found it difficult to implement the science and technology learning area outcomes. Furthermore, curriculum changes and the imminent removal of science and technology from the curriculum caused stress and anxiety and increased the pressure on their professional teacher identity.

Research indicates that implementing the National Curriculum is regarded as a challenge to the beginning teacher (Bosman, 2006; Hoadley *et al.,* 2010; Van Heerden, 2005). Furthermore, there is uncertainty about the place of and how much science and technology should be included in MST teaching where the time allocation is already insufficient for inquiry-based learning (Bosman, 2006; Van Heerden, 2005).

(d) MST teaching

Anne-marie regarded mathematical knowledge and science and technology inquiry skills acquisition as an important focal point in her teaching. She stated that

'mathematics is the foundation subject' and *'I integrate and apply mathematics, science and technology concepts in structured lessons'* (In1) Jenna said that *'Learners enjoy MST and have a thirst for knowledge, it just needs to be stimulated and promoted by the teacher'* (NR2). Gina believed that *'Young learners need to experience mathematics for themselves. They need to see what concepts such as heavy and light mean'* (NR1) Lea observed that *'I integrate and apply MST concepts in structured lessons'* (In1). Riana was convinced that through hands-on, three-dimensional activities the *'learners don't experience the work as maths and think they are playing'* (In2) Bea said that with mathematics it was a little more straightforward: *'You do the maths, and have to integrate the science through other subjects this is difficult'* (In 2).

The literature on MST activities in FP and ECP (Cross *et al*., 2009*)* explains that an integrated approach is developmentally appropriate at this level and it was found that the six beginning teachers planned and presented MST activities an integrated way although it was not always easy.

5.3 CONCLUSION

In Chapter Five the findings were presented and the results were discussed in relation to the research questions. In Chapter Six the research questions that guided the inquiry will be answered. The potential contribution of this study and the recommendations for further research will be suggested.

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CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

'Identity formation is dynamic, versatile and active' – Vandebroeck (1999).

'The identity of teachers is a kaleidoscope of many permutations: race, class, gender, language, age and stage of career' – Michael Samuel (2008).

6.1 INTRODUCTION

In Chapter Five the findings of the study were presented and discussed by placing the results within the conceptual framework and existing literature.

In Chapter Six, a synopsis of the study is provided. The research questions that guided the inquiry will be answered. Thereafter, the conclusions and recommendations of the study are suggested. In conclusion, the final thoughts on this study will be given.

6.2. A SYNOPTIC OVERVIEW OF THE STUDY

This study was about the professional teacher identity formation of six beginning teachers in their first year of teaching MST at the FP and ECP level in different school settings. The purpose of this study was to explore, understand and describe the formation of these beginning teachers' professional identity. Furthermore, this study identified internal and external factors that influenced these beginning teachers' professional teacher identity formation and explained how these factors influenced their professional teacher identity formation. The question of why beginning teachers sustain or change their professional teacher identity in the context of teaching early MST in the different school contexts was discussed.

Chapter One focused on the background to the study. It introduced the reader to the research problem and postulated the significance and purpose of the study in relation

to the formation of professional teacher identity of FP and ECP beginning teachers in early MST teaching.

In Chapter Two, the literature review focused firstly on the background of teacher education programmes and further explained the notion of beginning teachers' professional teacher identity. This chapter also explored the teaching and learning of early MST. The conceptual framework was designed from the literature review.

In Chapter Three the research methodology of phenomenology was discussed. Furthermore, a multiple case study research approach to explore the phenomenon of professional teacher identity formation was clarified. The sampling procedure and data collection methods were described. To conclude this chapter, the ethical considerations, validation and verification of data, as well as the limitations and significant challenges, were set out.

Chapter Four reported the results of the six case studies. The six professional teacher identity portraits were described through themes illustrating the formation of professional teacher identity of the six beginning teachers.

Chapter Five presented a discussion of the results of six beginning teachers' professional teacher identity formation in early MST to existing literature. An analytical strategy was followed for cross-case comparison to determine the formation of professional teacher identity in early MST and how the process was influenced. The external and internal factors that affected the process were identified and the way in which they affected the formation process was discussed.

The research questions will be addressed in the following section.

6.3 MAIN RESEARCH QUESTION AND SUB-QUESTIONS

6.3.1 MAIN RESEARCH QUESTION

> *How do beginning first-year early childhood and foundation phase teachers form, sustain or change their professional teacher identity in the*

teaching of mathematics, science and technology (MST) in the early years and in different school settings?

The question of how beginning first-year teachers adjust, change and or sustain their professional identity is discussed and answered in this section.

The professional teacher identity formation process of the six beginning teachers is assumed to have started during their teacher education programme and continued during their first year of teaching. The first year of teaching is acknowledged as an important learning opportunity that can be negative or positive, resulting in a willingness or otherwise to stay in the profession. The knowledge and skills that the beginning teachers acquired through their teacher education programme positively affected their professional teacher identity formation process, enabling them to teach early MST with confidence, to make informed decisions and to take risks. They explained that they applied the MST content and pedagogical knowledge that they acquired through the initial teacher education programme to their classroom practice. For them, this was an important pedagogical consideration as it formed part of their learnt professional teacher identity. The process of becoming a teacher who can make decisions, take risks and participate in ongoing change is complex and continuous. The core beliefs about MST teaching and being a teacher that the beginning teachers acquired during their teacher education programme were important in the professional teacher identity formation process. This research highlights the important role that the initial teacher education programme played in the process of professional teacher identity formation.

This study underlines the importance of the first year of teaching as a learning opportunity and a contributing factor to the continuous and ongoing formation of professional teacher identity. When the six beginning teachers in this study were confronted with the reality of teaching in their own classrooms, they experienced an initial period of instability and uncertainty. They were confronted with workplace realities which did not necessarily match their expectations and purpose for teaching and being a teacher. Everything was a new experience and a challenge which included factors such as curriculum interpretation and implementation, teaching the children, accommodating the parents and the culture of the school. In spite of these

difficulties, they learnt adaptive coping and decision-making skills and strengthened, adapted and sustained their learnt professional teacher identity because they believed in what they were doing.

They all expressed a desire to be supported, respected and acknowledged as teachers. From their accounts it seems that support, respect and acknowledgement were important for sustaining a learnt professional teacher identity.

During their first year of teaching, these six beginning teachers experienced many learning opportunities. All of them used hands-on, practical, inquiry-based approaches in their MST teaching. In spite of the seeming mismatch between them and the other teachers in the interpretation and implementation of the MST curriculum, content and pedagogical knowledge, they tried to improve their teaching competence and skills. Furthermore, they retained their beliefs about the inquiry-based approach.

These learning events encompassed not only the practical experiences and reflective practice in the classroom, but also included discussions and negotiation with colleagues. The six beginning teachers acquired practical insight into pedagogical approaches.

The beginning teachers often used emotional language to describe the fulfilment, excitement and enjoyment of their practice and their interaction with the children in their classes. They expressed their caring roles as they positioned themselves alongside the knowledge and beliefs they had about children and the way children learn. This trusting, loving and caring position was important in the understanding of their professional teacher identity formation.

For the beginning teachers, the formation of a professional identity was an ongoing and multifaceted learning process. They had to cope with the demands of teaching, which meant that they had to evaluate their own beliefs and practices. As outsiders and newcomers they were sometimes frustrated and surprised by the nuances, meanings and beliefs that the other teachers brought to the understanding and implementation of the MST curriculum (content and pedagogical knowledge). During

their first year of teaching, the identity formation process involved finding a voice amongst the other, often contradictory, voices of the other teachers in the school. One of the key issues for the beginning teachers was to establish their professional teacher identity and to get professional recognition. In order to sustain their reform-mindedness they had to negotiate a professional voice and justify a respected place in the school culture. They further had to improvise and find ways to match their practice with their vision and beliefs about early MST teaching and the specific requirements of the school.

These six beginning teachers had to work and teach in creative and innovative ways to be consistent with their acquired MST knowledge and beliefs. They described their first year of teaching as a period of highs and lows that included transformative moments where their beliefs and images of what it meant to be a teacher were affirmed or in many ways challenged. They had to negotiate creative and innovative ways of taking risks and participating in changing MST teaching in their schools. For most of them, their self-knowledge and reflective practices helped them to conceptualise and express who they were as teachers and who they wanted to become. It seems as if the synergistic blend between MST knowledge acquired through the teacher education programme and the experience gained during the first year of teaching infused their MST classroom practice and their continued growth as early MST teachers.

This study highlights the effect that internal and external factors have on beginning teachers' professional teacher identity formation in the context of teaching MST.

6.3.2 SUB-QUESTION ONE

> *What internal and external factors, if any, influence beginning teachers' professional teacher identity formation in the context of teaching MST?*

The professional identity formation of the six beginning teachers was an ongoing process of integration of the 'personal' and the 'professional' aspects of their working environment against the background of institutional support or lack thereof. Through the beginning teachers' own accounts, observations and analysis of their work environment, the researcher was able determine how their learnt professional

teacher identities were deconstructed and reconstructed on the basis of key influencing factors such as the initial teacher education programme, personal histories and character traits, and the school/classroom environment.

Table 6.1 summarises the external and internal factors that affected the six beginning teachers' professional teacher identity.

Table 6.1: External and internal factors that affected beginning teachers' professional teacher identity

External factors	Internal factors
• Initial teacher education • MST curriculum interpretation and implementation • MST teaching • School context • Support or lack of support	• MST knowledge and skills • MST beliefs, values and assumptions

6.3.3 SUB-QUESTION TWO

How do the identified factors, if any, affect the beginning teachers' professional teacher identity formation in the teaching of MST in different school settings?

The ways in which these internal and external factors influenced the beginning teachers' professional identity are explained in order to answer the research question. Each factor is discussed in turn.

6.3.3.1 External factors

The six beginning teachers described some external factors that affected their professional teacher identity.

- **Teacher education programme**

In this study, the initial teacher programme provided the beginning teachers with MST pedagogical knowledge and competences that they applied in their classrooms.

The initial teacher programme therefore helped them to develop a positive professional teacher identity that enabled them to cope with the varied situations they experienced during their first year of teaching. They further said that they had acquired insight into MST pedagogical approaches. The programme provided them with adaptive coping and decision-making skills.

6.3.3.2 MST curriculum interpretation and implementation

Implementing the National Curriculum was regarded as a challenge to the beginning teachers. The focus was mainly on mathematics, which also had a prominent place in the curriculum, whereas science and technology were mostly integrated. The beginning teachers in the primary school setting found it difficult to implement the science and technology learning areas. There was uncertainty about how much science and technology should be included because the time allocation was insufficient for inquiry-based learning. Curriculum changes and the imminent removal of science and technology from the curriculum caused stress and anxiety and increased the pressure on their learnt professional teacher identity.

- **MST teaching**

All six beginning teachers planned MST activities and mostly used an integrated approach which was not always easy to apply. Science and technology were not regarded as important by the schools and therefore the beginning teachers in the FP found it difficult to find time and space for teaching these learning areas.

- **School context**

With regard to the school context, the six beginning teachers firstly experienced the reality shock of moving from being a student teacher to being a beginning teacher in their own classrooms.

Second, the beginning teachers' position and status within the school culture in which they found themselves sometimes caused tensions and uncertainty.

Thirdly, issues such as the pressure to conform to the school culture, the expectations of parents and the many unexpected administrative duties caused

identity dilemmas. Most of these factors led to emotional reactions that temporarily threatened the formation and sustainability of their professional teacher identity.

- **Support or lack of support**

Institutional support was important to all six beginning teachers. They had mixed experiences regarding support. Positive support had a positive emotional effect and resulted in feelings of acceptance and confidence in their own abilities. Positive support therefore strengthened professional teacher identity, whereas a lack of support resulted in negative emotional reactions such as feelings of vulnerability, uncertainty, frustration, failure and disagreement.

6.3.3.3 Internal factors

A number of internal factors also affected their professional teacher identity.

- **MST knowledge and skills**

The six beginning teachers said that they had acquired insight into MST pedagogical approaches during their teacher education programme and that they were emotionally committed to applying these pedagogical approaches which could benefit their children. In the six cases, the beginning teachers described the challenges that prevented them from creating opportunities to plan and implement their knowledge about science and technology teaching. The internal tensions noted in this study were the complex notions of the place and time for teaching science and technology activities in their classrooms as well as the lack of support from colleagues to apply inquiry-based approaches in their teaching.

- **MST beliefs, values and assumptions**

The six beginning teachers indicated that they did not change their convictions and beliefs about MST teaching acquired through their teacher education programme, although there were instances where some had to conform to some extent to avoid conflict. Nevertheless, there were indications throughout their classroom practices during the first year that all of them had retained their beliefs about MST teaching. The core beliefs teachers have about teaching and being a teacher are important for supporting and sustaining their professional identity.

6.3.4 SUB-QUESTION THREE

Why do beginning teachers sustain or change their professional teacher identity in the context of teaching early MST in the different school contexts?

The study has highlighted the interactive effect of the teacher education programme and the working environment in shaping the professional teacher identities of six beginning teachers in early MST teaching. It explored how early MST teaching and being a reform-minded teacher at FP and ECP level were challenged and accepted in the different school settings. Although the transition from student teacher to beginning teacher was mostly an unstable period of coping and surviving the unpredictable reality of the new workplace, for the six teachers this transition was also mainly a positive learning experience.

In spite of the positive learning experience, some identity dilemmas occurred when factors that may have been internal or external to their learnt professional teacher identity in their new teaching environment caused tension. In order to survive and cope in their new working environment, the beginning teachers made adjustments, developed strategies or adapted their learnt professional teacher identity.

This process of adjustment was continuous. The beginning teachers saw themselves as reflective thinkers who felt the need to continually find creative and innovative ways to teach early MST. It seems that the initial teacher preparation programme influenced the attitude and pedagogical knowledge of the six beginning teachers.

The six beginning teachers changed, adapted or sustained their learnt professional teacher identity. In their first year of teaching, the teachers questioned and reflected on their own MST teaching when they were confronted with the turbulences and flux of the new school context. External and internal factors affected the equilibrium of their professional teacher identity and this sometimes caused identity dilemmas that activated the adjustment process of changing, adapting or sustaining their professional teacher identity. The beginning teachers applied their knowledge, skills and beliefs to change, adapt or sustain their identity. The strategies for changing, adapting or sustaining their identity were reported through their narratives and observed in the reaction and actions of each individual beginning teacher. Some of

these strategies were acquired from their teacher education programme and others were found in their working environment.

The six beginning teachers indicated that they acquired the following skills and knowledge from their teacher education programme:

- Reflective practice skills.
- Creative, negotiation, thinking, improvising and coping skills.
- Teaching, content and pedagogical knowledge and learning theory.

The six beginning teacher pointed out that the following aspects from their working environment assisted or hindered them from sustaining or developing their professional teacher identity:

- School context: Teachers' work is emotionally demanding (children, parents, management, colleagues, school culture, responsibilities other than teaching and the beginning teacher's position in the school).
- Support or lack of support: The social and cultural organisation of schools.
- Curriculum interpretation and implementation.
- The nature of MST teaching in FP and ECP classrooms.

6.4 CONCLUSIONS OF THE STUDY

In this section the conclusions that derived from the findings are discussed.

6.4.1 CONCLUSION ONE: PROFESSIONAL TEACHER IDENTITY

The formation of a professional teacher identity is a dynamically evolving learning process (identity and learning are linked) intrinsically related to the beginning teachers' views of themselves as teachers (their beliefs and attitudes towards MST teaching), the knowledge they acquire about MST (content and pedagogical knowledge) and the school context in which they may teach. This means that internal and external factors can affect the process of professional teacher identity formation. It appears as if the nature of the teacher education programme can assist beginning teachers to acquire a core learnt professional teacher identity which will enable them to teach MST successfully.

The caring nature of the six beginning teachers was evident in their actions. They indicated through their actions and statements that they were compassionate and caring towards the children in their care and felt that they were successful if they made a difference. Being a caring FP or ECP teacher seems to be an important characteristic of teachers who feel that they are making a difference in children's lives and in MST teaching.

6.4.2 CONCLUSION TWO: TEACHER EDUCATION PROGRAMME

The initial teacher education programme is an important learning experience in the process of constructing a core learnt professional teacher identity. The initial teacher education programme should provide beginning teachers with MST knowledge, pedagogical content knowledge and skills. Initial teacher education programmes should provide experiences that improve early school teachers' MST knowledge.

A sound initial teacher programme with adequate MST content and pedagogical knowledge may equip beginning teachers to successfully implement MST in their classrooms and help them to cope with internal and external factors that may influence their professional teacher identity.

Conversely, a lack of sufficient exposure to science and technology during practice teaching may lead to insufficient preparation for teaching these subjects.

6.4.3 CONCLUSION THREE: MST TEACHING AND LEARNING

MST teaching and learning should be based on problem solving, reasoning, hands-on, creative inquiry-based teaching strategies which would advantage the children by providing basic MST knowledge, concepts and skills.

However, due to the lack of time and space allocated for exploration and investigation in many FP classrooms, MST teaching has become workbook-orientated, leaving no time for inquiry-based MST teaching. This has unfortunately led to worksheet-dominated classrooms to the detriment of children learning MST.

- **Mathematics**

The six beginning teachers in this study were positive about mathematics and regarded the subject as important and meaningful for the conceptual development of young children.

- **Science and technology**

The six beginning teachers regarded science and technology as important for the development of young children and therefore implemented an inquiry-based pedagogical approach. Because they believed that this approach would benefit the children they planned and strategised to teach science and technology in spite of impediments such as time constraints and restrictions.

6.4.4 CONCLUSION FOUR: MST CURRICULUM

The three beginning teachers placed in the primary school FP classrooms experienced difficulty at first in interpreting and implementing the curriculum. They felt restricted and did not know how to accommodate everything they had to accomplish in the time available. By way of contrast, the beginning teachers in the ECP felt that they had more freedom to teach the way they wanted to. Established teachers in the primary schools were opposed to teaching science and technology and regarded teaching technology as a waste of time. Consequently, the beginning teachers found it difficult to teach science and technology and they had to negotiate time and space to teach these subjects.

Curriculum change caused feelings of frustration for some of the beginning teachers and where the interpretation and implementation of curriculum differed from their own beliefs about MST teaching, serious dilemmas arose.

Although an integrated curriculum is developmentally appropriate and reflects the natural way of young children's learning, the implementation posed some challenges for the six beginning teachers. The integration of early MST seemed to be more easily accomplished in the ECP than in the FP.

6.4.5 CONCLUSION FIVE: SCHOOL CONTEXT

The first year of teaching was a meaningful learning experience but the transition from student teacher to beginning teacher was difficult. The transition required new roles and responsibilities from the beginning teachers, which caused stress experienced as a reality shock with accompanying conflicting emotions.

Beginning teachers wanted to be recognised and accepted as colleagues and to feel that they contributed. In some instances they were made to feel like outsiders by the school hierarchy or the veteran-orientated professional culture of a school that prevented the new teacher from being recognised and acknowledged as a skilled colleague. The school environment and other teachers often pressurised them into employing practices that were in conflict with their personal beliefs about MST teaching and how children learn. Each school seemed to have a distinct character that beginning teachers had to cope with and adapt to and this pressurised their learnt professional teacher identity.

An important component in the formation of professional teacher identity is the support, acceptance, affirmation, and interaction with the other teachers in the school; and this affected the six beginning teachers positively or negatively. To be valued as knowledgeable colleagues in MST teaching may have contributed positively to their professional teacher identity formation. It therefore seems that institutional support is important for creating and maintaining motivation and professional growth.

6.5 RECOMMENDATIONS AND FUTURE DIRECTIONS FOR RESEARCH

In this section, the recommendations and further directions for research are discussed.

6.5.1 RECOMMENDATION ONE: PROFESSIONAL TEACHER IDENTITY FORMATION

This study finds that if beginning teachers are confident, committed, flexible and creative lifelong learners who are able to participate in ongoing change and to cope

in the different school and classroom contexts, they will be able to negotiate and teach inquiry-based (exploration and discovery) MST activities.
This study recommends that beginning teachers be provided with opportunities for developing and sustaining a reform-minded professional teacher identity to address the challenge of ECP and FP MST in practice.

6.5.2 Recommendation two: Teacher education programmes

The conclusions of this study clearly indicate that the initial teacher education programme is an important learning experience in the process of constructing a positive professional teacher identity and becoming a reform-minded teacher.

This study recommends that the initial teacher education programme should provide beginning teachers with sound MST knowledge, pedagogical content knowledge and skills that will enable them to effectively teach inquiry-based FP and ECP MST activities.

6.5.3 Recommendation three: MST teaching and learning

The feedback from the beginning teachers on the difficulties they experienced about finding adequate time and opportunity to teach MST creatively and interactively, as well as the lack of opportunities to teach specifically science and technology, is of great concern.

This study recommends that the teaching of MST should be considered as extremely important for the development of early learners. This means that urgent attention should be given to the inclusion of creative and interactive teaching and learning opportunities and inquiry-based teaching. It is further recommended that there should be sufficient provision for science and technology and that the two subjects receive adequate recognition in terms of time allocation in the curriculum.

6.5.4 Recommendation four: MST curriculum (policy)

Evidence from this study points to the existence of various curriculum inadequacies and restraints at FP and ECP levels. Aspects such as frequent curriculum change

and the possible exclusion of science and technology caused uncertainty and frustration. Furthermore, the interpretation of the curriculum led to problems regarding its implementation. In addition, the teaching of an integrated MST curriculum caused some difficulties.

This study recommends that the curriculum should provide clear guidelines on the teaching of MST at ECP and FP level. This study also recommends the retention of science and technology at ECP and FP levels, considering the obvious beneficial value these subjects have for young children. More emphasis and clearer guidelines should be provided for teaching mathematics, science and technology in an integrated curriculum.

6.5.5 RECOMMENDATION FIVE: SCHOOL CONTEXT

The school context in which the beginning teachers found themselves indicated that some schools did not welcome the beginning teachers as knowledgeable and valuable colleagues and consequently made them feel like outsiders. Also, the beginning teachers felt that school support was an important factor to sustain their professional teacher identity. In the instances where school support was provided, the beginning teachers felt safe and they could teach MST creatively within a positive environment.

This study recommends that attention should be given to the professional and emotional developmental needs of beginning teachers. The school should provide adequate support and strive to sustain and reinforce a beginning teacher's positive professional teacher identity in order to retain beginning teachers in the profession.

This study further recommends that schools should give beginning teachers a voice and should be receptive to the new ideas that beginning teachers may bring to ECP and FP MST teaching and learning. Schools should recognise that context is part of professional teacher identity formation and that they must support beginning teachers at the beginning of their careers.

6.5.6 RECOMMENDATIONS FOR FURTHER RESEARCH

This study recommends the following areas for further research:

1. More research is needed to know and understand the core learnt MST professional teacher identity that beginning teachers have to acquire through their teacher education programme to successfully plan and teach MST in the ECP and the FP.
2. Further research may be undertaken on how the learnt professional teacher identity can assist beginning teachers to be reform-minded teachers who are able to make informed decisions and to become the nucleus of reform in their classroom and professional settings.

6.6 FINAL THOUGHTS

In this study, professional teacher identity was defined as the ongoing 'becoming' of an image of a teacher. The narrative stories of the six beginning teachers gave an insight into this ongoing learning process. It indeed gave an image of who these teachers were at that given time in their career and who they aspired to become in future.

The beginning teachers in this study had MST learning experiences from their initial teacher education programme and their different school contexts that formed and shaped their learnt professional teacher identity at that beginning stage in their careers (Figure 6.1).

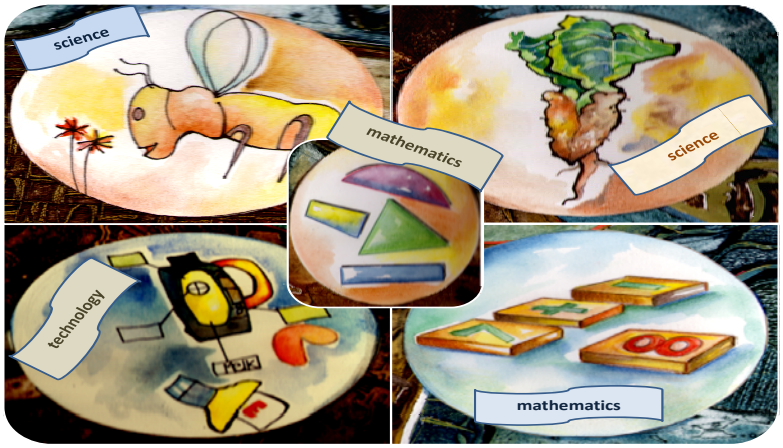

Figure 6.1: Operational learnt professional teacher identity reflects MST classroom practices

In this study Samuel's (2008:9) analogy that a beginning teacher's professional identity is a 'kaleidoscope of many permutations' is adapted and combined with Vandebroeck's (1999:25) idea that professional teacher identity is 'dynamic, versatile and active' and may therefore be altered, changed or sustained. For this reason the finding of this study is that external and internal factors influence the adaptation, change or sustainability of beginning teachers' core professional identity and therefore affect classroom practice. The question still to be answered in further research is: What is the core professional teacher identity of a beginning teacher?

In this study it became clear through the practices, experiences and voices of the beginning teachers that their initial teacher education programme was an important factor that influenced their professional teacher identity formation.

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APPENDICES

Appendix A:
Participants' letter of consent

Appendix B:
Photo collage & written narrative reflection

Appendix C:
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Declaration of language editor

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Appendix A:
Participants' letter of consent

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Education

SUSTAINING THE PROFESSIONAL IDENTITY OF BEGINNING TEACHERS IN EARLY MATHEMATICS, SCIENCE AND TECHNOLOGY TEACHING

Name of participant: _____

Name of investigator: Mrs M. Botha

Dear Participant,

The following information is provided for you to decide if you wish to participate in the research study. You should be aware that you are free to decide not to participate or to withdraw from the research study at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied.

The purpose of this study is to understand how you develop your professional teacher identity in the teaching of mathematics, science and technology in the early years.

The data will be collected at three stages: (1) April 2010: (1.1) Design and handing in of a photo collage and a written narrative reflection, (1.2) 45 minute individual semi-structured interview. (2) July – August 2010: 1 day informal observation and participatory reflection on your teaching. (3) September - November 2010: (3.1) Design and handing in of a photo collage and a written narrative reflection of your first year of teaching, (3.2) 45 minute individual semi-structured interview.

You may ask any questions before participation or during the time of participation. Do not hesitate to ask any questions concerning the data collection procedure. You will also be given an opportunity to verify the accuracy of my expressed views and you will have an opportunity to verify the accuracy of the interview transcripts. I will be happy to share my findings with you after the research has been completed.

The information and data collected are confidential and all the information that you provide will be safeguarded. Your identity as a participant will be known only to me. I will refer to you by pseudonym or a code name in any publications arising from the research.

Please sign your consent with full knowledge of the nature and purpose and the procedures that will be followed during the research. A copy of this consent form will be given to you to keep.

1. I consent to participate in the above mentioned research study, I consent that samples may be collected from the following; my photo collages, my narrative reflections and the individual semi-structured interviews. The collection of data will be at three stages during my first year of teaching.

2. I authorise the use of the photo collages, the narrative reflections, informal observation, field notes, observational reflections and individual interviews for data analysis.

Signature: _____ Date: _____

Tel or cell number: _____

Appendix B:
Photo collage & written narrative reflection

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Faculty of Education

Designing a photo collage and writing a narrative reflection on the planning and teaching (professional teacher identity) of mathematics, science and technology (MST) in Foundation Phase (FP) and in Early Childhood Phase (ECP) classrooms

Beginning teachers (April 2010/ September 2010)

1. Designing a photo collage

Guiding question(s) to select images or photos and to design the photo collage.

Think about the way you teach MST. Select any images and/or photos that represent the way you plan and teach mathematics, science and technology (MST). Design and create a photo collage.
Use the following questions to guide you to design and create the photo collage:

- What do you **believe about MST teaching (planning)** in the early years?
- How do you **plan and teach** MST? (Explain how you plan your lessons. Give examples.)
- What do you **believe** about MST? (Nature of MST, the content and curriculum of MST)
- What did you **learn** about MST teaching and learning during the BEd programme and internship (practice teaching)? / What did you learn about MST teaching and learning during your first year of teaching?

☺ **Please do not use photos where children or the school where you teach can be identified! Use photos or images that explain your practice.**

2. Write a narrative reflection to explain your photo collage

Browse through the images/photos and write a narrative reflection about what you believe and do when you plan and teach MST in the FP and/or in ECP classroom.
Use the guiding questions in the writing of your narrative reflection:

- What do you **believe/know about MST teaching (planning)** in the early years?
- How do you **plan and teach** MST? (Explain how you plan your lessons. Give examples.)
- What do you **believe/know** about MST? (Nature of MST, content knowledge, pedagogical knowledge and curriculum of MST.)
- What did you **learn** about MST teaching and learning during the BEd programme and internship (practice teaching)? / What did you learn about MST teaching and learning during your first year of teaching?

Reflection
Examine the images/photos you have selected, and reflect on how these images/photos connect in any way to the questions.

Appendix C:
Individual semi-structured interview schedule

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Faculty of Education

Interview questions/prompts (the questions are guidelines and the researcher will further be guided by the photo collage and narrative reflection

The stories of individuals can have their own twists and turns from the original prompts. This flexibility was encouraged during interview sessions. Two interviews were done with each participant. The first interview took place in April 2010 (at the beginning of their first year of teaching) and the second interview was conducted during the September holiday 2010 (during their first year of teaching). The same interview schedule was used for both interviews.

- How do you teach MST?
- What do you teach in MST?
- Why do you teach MST in this manner?
- Explain some of your experience during the teaching and learning of early mathematics, science and technology (MST)?
- What do you believe/know about MST teaching and learning?
- How do you feel about MST teaching in the early years?
- How would you summarise your MST planning?
- How do you plan MST activities? How would you summarise your MST teaching and learning?
- What influenced your early MST teaching?
- What influenced your MST learning?
- How do/did you respond to the influences?

Appendix D:
Gauteng Department of Education letter of consent

GAUTENG PROVINCIAL GOVERNMENT

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Enquiries: Nomvula Ubisi (011)3550488

Date:	23 June 2010
Name of Researcher:	Botha Mariè
Address of Researcher:	30 Edenpark, 195 Elizabeth Street,
	Wonderboom
	Pretoria 0182
Telephone Number:	012 5677358
Fax Number:	012 4205595
Research Topic:	The sustainability of professional teacher identity in the teaching of mathematics, science and technology in the early years
Number and type of schools:	Five [5]; Primary and ECD sites
District/s/HO	Tshwane North and -South

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*

Office of the Chief Director: Information and Knowledge Management
Room 501, 111 Commissioner Street, Johannesburg, 2000 P.O.Box 7710, Johannesburg, 2000
Tel: (011) 355-0809 Fax: (011) 355-0734

4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher must supply the Director: Knowledge Management & Research with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

2010-06-23

Shadrack Phele MIRMSA
CHIEF EDUCATION SPECIALIST: RESEARCH COORDINATION

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	

Appendix E:
Schools' letter of consent

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Faculty of Education

LETTER OF CONSENT FOR RESEARCH
Departmental schools, Private schools and Early Childhood settings

Dear

I am currently busy with my PhD on the title:

SUSTAINING THE PROFESSIONAL IDENTITY OF BEGINNING TEACHERS IN EARLY MATHEMATICS, SCIENCE AND TECHNOLOGY TEACHING

The main purpose of my study is to determine how 1st year teachers that have completed the Bachelor of Education (B.Ed.) Early Childhood and Foundation Phase Programme sustain, change or adapt their professional teacher identities in the context of teaching and learning of mathematics, science and technology (MST) at foundation phase (Grade R – Grade 3) and early childhood level classes.

The research question is: How do beginning first-year early childhood and Foundation Phase teachers form, sustain or change their professional teacher identity in the teaching of mathematics, science and technology (MST) in the early years and in different school settings?

I would like to involve_____ a 1st year teacher, in your schools in my research.

To obtain the necessary data for my studies I need to do classroom observation of teaching activities.

Should you agree, please sign the letter of consent below. I shall collect the letter of informed consent at a convenient time, as I need your approval before I can commence.
Yours truly

_____

Ms M Botha

Faculty of Education
Marie.botha2@up.ac.za
Fax number: (012) 420-5595

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

PERMISSION FOR RESEARCH

I, _____, hereby give permission to Marié Botha to do her research with the above mentioned beginning teachers.

Official: _____Signature_____Date_____

Appendix F:
Parents' letter of consent

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Education

Ms M Botha
Faculty of Education
marie.botha2@up.ac.za
Fax number: (012) 420-5595

PARENTS' CONSENT

Dear parents

I am currently doing my PhD with the following title:

SUSTAINING THE PROFESSIONAL IDENTITY OF BEGINNING TEACHERS IN EARLY MATHEMATICS, SCIENCE AND TECHNOLOGY TEACHING

The purpose of the study is to understand how teachers in the early childhood and foundation phase develop and sustain their identity in the teaching of mathematics, science and technology. To obtain the necessary data for my studies I need to do classroom observation of teaching activities. Your child's teacher will explain my presence and role in the classroom and I will also take care that I do not intrude on the teaching and learning of your child.

I would appreciate your consent to allow your child to participate in the classroom activities during the observation of teaching procedures. However, participation is voluntary.

Signature _____ Date _____

Thank you.

Marié Botha

Appendix G:
Open observation schedule

Observation: actions	Reflective notes
Description of the kind of mathematics, science or technology (MST) activity – Lesson planning	
Description of the pedagogical approach (inquire-based approach, hands on activity, workbooks, discovery learning, exploration, problem solving approach, scaffolding	
Interaction with the children and children's MST learning	
Interpretation and implementation of the curriculum	
Resource and classroom environment	
Aspects of classroom practice and management	

- **Observational reflection: The six teachers wrote an individual reflection on the planning and on the presentation of the observation activity**

Appendix H:
Clearance Certificate

UNIVERSITEIT VAN PRETORIA
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Faculty of Education

RESEARCH ETHICS COMMITTEE

CLEARANCE CERTIFICATE	**CLEARANCE NUMBER :** SM 10/02/03
DEGREE AND PROJECT	Sustaining the professional identity of beginner teachers in early mathematics, science and technology teaching
INVESTIGATOR(S)	Marie Botha
DEPARTMENT	Science, Mathematics and Technology Education
DATE CONSIDERED	15 March 2012
DECISION OF THE COMMITTEE	APPROVED

Please note:
For Masters applications, ethical clearance is valid for 2 years
For PhD applications, ethical clearnace is valid for 3 years.

CHAIRPERSON OF ETHICS COMMITTEE Prof L Ebersohn

DATE 15 March 2012

CC Jeannie Beukes
G.O.N Onwu

This ethical clearance certificate is issued subject to the following conditions:

1. A signed personal declaration of responsibility
2. If the research question changes significantly so as to alter the nature of the study, a new application for ethical clearance must be submitted
3. It remains the students' responsibility to ensure that all the necessary forms for informed consent are kept for future queries.

Please quote the clearance number in all enquiries.

Appendix I:
Language Editing

HESCOM
COMMUNICATION SERVICES

Translating.Writing.Editing

Hester van der Walt
HesCom Communication Services
Member: Professional Editors' Group

+27 84 477 2000
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0082

LANGUAGE EDITING STATEMENT

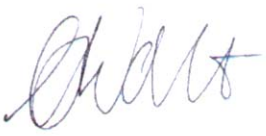
2012-03-11

Sustaining the professional identity of beginning teachers in early mathematics, science and technology teaching

by M Botha

- Has been edited for language correctness and spelling.
- Has been edited for consistency (repetition, long sentences, logical flow)
- Has been checked for completeness of list of references and cited authors.

No changes have been made to the document's substance and structure (nature of academic content and argument in the discipline, chapter and section structure and headings, order and balance of content, referencing style and quality).



HESTER VAN DER WALT

HESCOM
COMMUNICATION SERVICES