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.

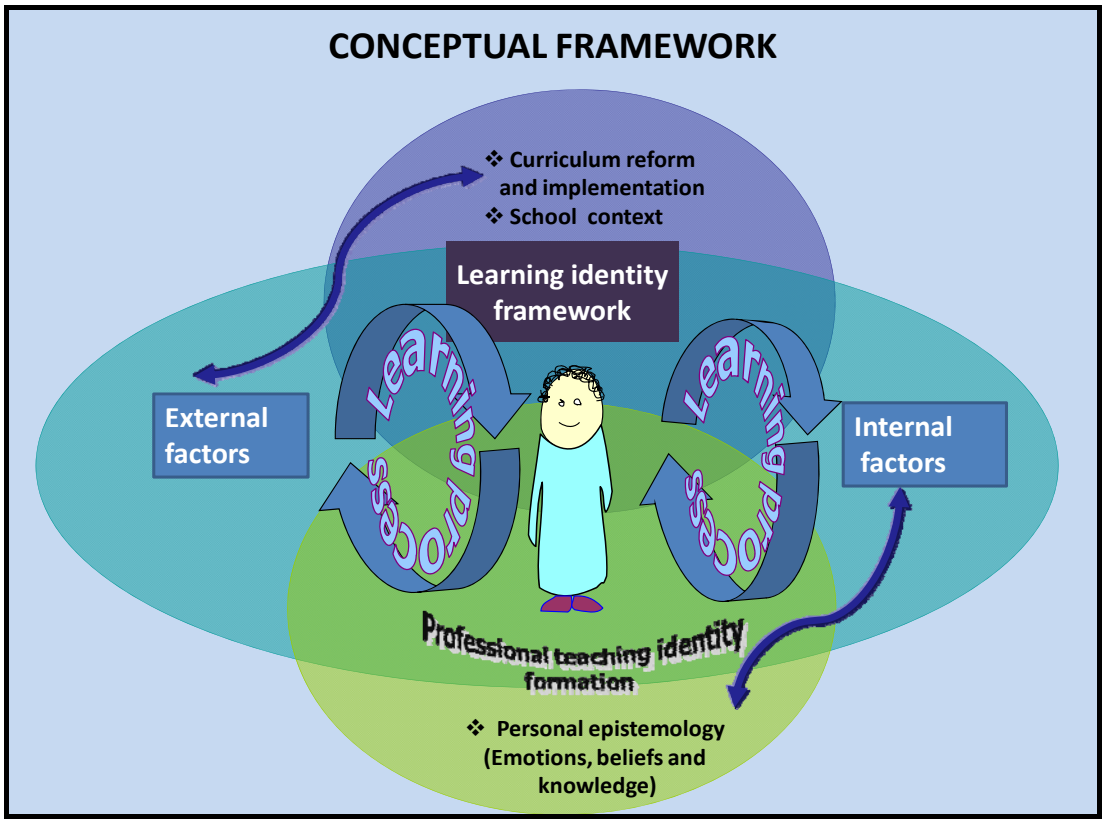

Figure 2.1: Conceptual framework (learning identity framework)

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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