

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 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 Annemarie 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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