

# **The construction of Foundation Phase Mathematics Pedagogy through Initial Teacher Education Programmes**

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**The construction of Foundation Phase Mathematics  
Pedagogy through Initial Teacher Education Programmes**

by

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## ABSTRACT

The focus of this study is on the Foundation Phase mathematical and pedagogical knowledge construction. This study is about how two lecturers and a number of final year B.Ed. Foundation Phase student teachers construct Foundation Phase mathematical and pedagogical knowledge during the initial teacher education programme.

The initial B.Ed. Foundation Phase teacher education provides student teachers with different mathematical knowledge for teaching. A Foundation Phase mathematics pedagogical knowledge construction framework was utilised to generate and analyse data. The Foundation Phase mathematics pedagogical knowledge construction framework is developed with the assumption that the integrated learning knowledge and the process of pedagogical reasoning action is a continuous process. Furthermore, it is assumed that student teachers' active participation in their learning and paddling through the pedagogical reasoning action process, leads to the construction of Foundation Phase mathematical pedagogical knowledge.

The study utilised a qualitative case study design to investigate how two initial teacher education programmes construct Foundation Phase mathematical pedagogical knowledge in their programme to prepare student teachers to teach Foundation Phase mathematics. Data were collected from Foundation Phase mathematics lecturers through semi-structured interviews, focus group interviews with final year Foundation Phase student teachers as well as document analysis from the institutions to achieve triangulation. Data analysis and findings were based on themes and categories that emerged. The findings suggest that Foundation Phase mathematical and pedagogical knowledge construction is an interconnected and continuous process that includes different types of knowledge and pedagogical reasoning.

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## KEYWORDS

- Initial teacher education programme
- Student teachers
- Mathematics lecturers
- Foundation Phase mathematics pedagogical knowledge
- Foundation Phase mathematics content knowledge
- Foundation Phase mathematics
- Foundation Phase curriculum

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## ACRONYMS

ANA	Annual National Assessment
ACME	Advisory Committee on Mathematics Education
CAPS	National curriculum and assessment policy statement
DBE	Department of Basic Education
DBR	Design-based research
DHET	Department of Higher Education and Training
DoE	Department of Education
EU	European Union
FP	Foundation Phase
HEQF	Higher Education Qualification Framework
HSRC	Human Science Research Council
MRTEQ	Minimum Requirements for Teacher Education Qualifications
NCS	National Curriculum Statement
NCTM	National Council of Teachers of Mathematics
NQF	National Qualifications Framework
PCK	Pedagogical Content Knowledge
RNCS	Revised National Curriculum Statement
TIMMS	Trends in mathematics and science studies
WIL	Work-integrated learning
B.Ed.	Bachelor of Education degree

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# CHAPTER ONE

## INTRODUCTION AND ORIENTATION TO THE STUDY

### 1.1 INTRODUCTION

Mathematics is one of the four main subjects offered to learners in the Foundation Phase (FP). This is the case because becoming numerate is one of the requirements of the South African constitution and the curriculum (Department of Basic Education (DBE), 2012). Mathematics is compulsory for all students registered for the Bachelor of education (B.Ed.) FP teacher education programme. Pedagogical tenets equip student teachers with strategies for teaching the subject in the FP. There is a widespread agreement that the teaching and learning of mathematics in the FP demands specific pedagogical strategies akin to the field of mathematics, that allow learners to construct their own mathematics knowledge, communicate, investigate and solve mathematics problems posed to them (Billstein, Libeskind & Lott, 2013; Van de Walle, Karp & Bay-Williams, 2013).

Matthews, Rech and Grandgenett, (2010) agree with the above-mentioned statement and argue further that it is essential for B.Ed. initial teacher education programmes to employ the same strategies in the teaching and learning of Mathematics to FP student teachers. This is important as it presents student teachers with opportunities to construct new pedagogical knowledge of mathematics and they are equipped with skills to teach mathematics in FP classrooms (Tatto, Peck, Schwile, Bankov, Senk, Rodriguez, Ingvarson, Reckase and Rowley, 2012).

Pedagogical knowledge of mathematics is viewed as essential during FP B.Ed. initial teacher education programmes because it includes different types of knowledge, strategies and approaches as part of teaching and learning (Hill, 2010; Hill, Ball & Schilling, 2008; Shulman, 1987; 2000; Zazkis & Zazkis, 2010). However, Nason, Chalmers and Yeh (2012) suggest that it is important that mathematics lecturers identify and rectify student teachers' beliefs, attitudes and preconceived perceptions towards the pedagogy of mathematics. These perceptions can

influence how student teachers construct their own pedagogical knowledge with regards to mathematics and practices in future (Hsieh, Lin & Wang, 2012; Kleickmann, Richter, Kunter, Elsner, Besser, Krauss & Baumert, 2013).

Moreover, Shulman, (2000) points out that the construction of mathematics pedagogical knowledge, is a continuous and interwoven process that student teachers should engage with, in their effort to acquire knowledge of mathematics for teaching. This process involves student teachers' active participation in their learning through discussions, reflection and investigations during their mathematics pedagogy modules (Botha & Onwu, 2013). A basic requirement for effective engagement in discussions and problem solving is a good command of language in order to facilitate sound expression and interpretation of mathematical questions (Spaull, 2013). The purpose of engaging student teachers in this process is to try and change their preconceived beliefs about the pedagogy of mathematics and to assist them in the moulding, and shaping of new pedagogical knowledge in the field of mathematics (Stigler & Hiebert, 2009).

This study sought to understand how two B.Ed. initial teacher education programmes in South Africa construct FP pedagogical knowledge in their mathematics modules. The question that is addressed focuses on understanding the factors and processes that influence the construction of FP pedagogical knowledge pertaining to mathematics during their initial teacher education programme. This study therefore sought to answer the following question: "How do Foundation Phase initial teacher education programmes prepare student teachers to teach FP mathematics?"

## **1.2 BACKGROUND TO THE STUDY**

According to Mohan (2012) and Tatto et al. (2012), initial teacher education is intended to provide and scaffold FP mathematics student teachers with new sets of mathematics experiences, skills, resources, and knowledge for teaching and learning. In South Africa, initial teacher education is offered at universities as a four-year Bachelor of Education degree (B.Ed.). These universities subscribe to different curricula and each institution designs its own FP mathematics modules for the B.Ed. programme. The distinction is not only in the depth of knowledge, but also in



the skills and pedagogy offered to student teachers (Human Sciences Research Council [HSRC], 2006).

The problem is that South Africa is facing a mathematics crisis at school level. Various reports such as the National Education Evaluation and development Unit (NEEDU) National Report (DBE, 2012) and the Report on the Annual National Assessments (DBE, 2012) reveal that FP learners perform poorly in both international (Trends in Mathematics and Science Studies) (TIMSS) and national assessment such as the Annual National Assessments (ANA's). These reports state that South African learners perform "below acceptable levels in reading, writing and counting" (DBE, 2011, 2012: 6; DBE, 2012).

The poor performance of learners in mathematics may be influenced by various aspects such as knowledge of mathematics and the processes and strategies that student teachers acquire during their initial teacher education programme (NEEDU, 2012). The recent study conducted by Tatto et al. (2012:203), reveal that FP (lower primary) student teachers are trained as generalists and have a limited content and pedagogical knowledge of mathematics. This is because FP teachers are trained to teach all the subjects and do not specifically specialise in mathematics per se.

However, in contrast, the study by Youngs and Qian (2013:257) found that Chinese lower primary school student teachers have a high level of content knowledge of mathematics for teaching young children. They posit that the modules in their initial teacher education programmes expose student teachers to 'exploration, logical thinking, conjecture, and justification' in teaching mathematics. In addition, Lampert, Franke, Kazemi, Ghouseini, Turrou, Beasley, Cunard and Crowe (2013) suggest that student teachers' authentic practice with different instructional strategies and immediate reflection increase student teachers' knowledge to affect their mathematics content knowledge. The studies of Lampert et al. (2013), Tatto et al. (2012) as well as Young and Qian (2013) formed the background for this study to explore how two initial teacher education programmes in South Africa present pedagogical knowledge of mathematics for teaching, instructional strategies and mathematics language of learning and teaching practice in their modules.

Mathematics language of learning and teaching is regarded as one of the major predicaments in the teaching and learning of mathematics (Spaull, 2013). This is

because learners in the FP seem to have inadequate language to comprehend and solve mathematics problems (Wium & Louw, 2012). The question is then: “How does language affect student teachers’ teaching and learning of mathematics?” Chauma (2012) suggested that it is crucial that initial teacher education programmes should educate student teachers to effectively use the language they are going to teach at school in order to avoid mathematics pedagogical and language challenges.

The curriculum supports the use of mother tongue (home language) in early classes. Language in Education Policy (Liep, 1997) a language policy, also states that it is advisable to teach the first three years through mother tongue. In an attempt to improve the quality of mathematics teaching and learning in FP, the Department of Higher Education and Training (DHET) and different universities collaborated in a European Union (EU) funded project. The EU project was aimed at supporting quality, developing FP teacher education materials, strengthening the current FP teacher education programmes and developing new FP teacher education programmes (Green, 2011). This study as part of the EU project explored how two initial teacher education programmes implement mathematics content and pedagogical knowledge in their modules. The language of teaching becomes important as student teachers are expected to teach learners in their mother tongue.

Despite extensive literature (Hill, 2010; Rowland, Turner, Thwaites & Huckstep, 2010; Tatto et al., 2012; Zaskis & Zaskis, 2010) on the types of knowledge required for teaching mathematics in the early years (lower primary school level), accounts on how initial teacher education programmes construct Foundation Phase mathematics pedagogical knowledge in their modules rarely exist (Lampert et al., 2013; Libeskind, 2011). This study therefore provided an opportunity for addressing issues related to the construction of FP pedagogical challenges pertaining to mathematics in the initial teacher education programmes in South Africa. FP student teachers and mathematics lecturers’ experiences are considered in order to put this study into perspective.

### 1.3 PROBLEM STATEMENT AND RATIONALE

The Centre for Development and Enterprise (CDE, 2013:3) reported that the teaching and learning of mathematics in South Africa is “amongst the worst in the world as teachers themselves struggle to respond to questions that they are teaching from the curriculum and expecting their learners to answer”. According to Green (2011) the lack of mathematical knowledge is an indication that South African teachers are poorly trained to teach mathematics in the FP classrooms. Therefore, this study pursued to understand how two B.Ed. initial teacher education programmes in South Africa develop the teaching and learning of FP mathematics pedagogy in their mathematics modules.

Mathematics pedagogy in this study includes different types of knowledge such as; mathematics instructional strategies, mathematical content knowledge, knowledge of learners, knowledge of the curriculum and mathematics language to teach in the initial teacher education programmes (Bahr & de Garcia, 2010). Mathematics pedagogy is regarded as an essential approach in the teaching, learning and doing of mathematics (Bahr, Shaha & Monroe, 2013). This implies that the combination of the aforesaid types of knowledge can influence how student teachers construct pedagogical knowledge of mathematics (Lampert et al. 2013). This prompted the need to understand how the integration of these types of knowledge contributes to the moulding of the corpus of pedagogical knowledge regarding mathematics during initial teacher education programmes in South Africa.

My pre-service and in-service training in FP mathematics and the poor performance of FP South African learners in both the ANA's and TIMSS assessments intrigued me and prompted me to pursue how initial teacher education programmes prepare FP student teachers to teach early mathematics. Botha (2012) suggests that a well-developed initial teacher education programme equips student teachers with sufficient mathematics content and pedagogical knowledge for future teaching and learning in the FP classroom. For this reason it is important to explore how initial teacher education programmes develop mathematics content and pedagogical knowledge in their programmes. Furthermore, it became essential to understand the role and relationship of the mathematical language in the learning and teaching of FP mathematics in the initial teacher education programme and FP classrooms.

Based on these problems I subsequently present the problem statement and the research questions for this study.

Teachers cannot answer simple mathematical problems they are supposed to be specialists in. Learners in FP classrooms perform poorly in mathematics. This was revealed in ANA and TIMSS assessment results. Student teachers at higher education institutions are taught in the medium of English. The problem which arises is that when they complete their studies they are expected to teach in their mother tongue. Mathematics is an abstract subject using abstract concepts. This study therefore deals with an investigation of how these teachers construct their mathematical knowledge and the focus is on how this knowledge capacitates them for teaching in schools where the medium of instruction is different from the language they are trained in.

The research questions that underpin this study are presented as follows:

## **1.4 RESEARCH QUESTIONS**

### **1.4.1 MAIN RESEARCH QUESTION**

How do Foundation Phase initial teacher education programmes prepare student teachers to teach Foundation Phase mathematics?

### **1.4.2 SECONDARY RESEARCH QUESTIONS**

1. How do Foundation Phase student teachers perceive their mathematics module in their teacher education programme?
2. What is the role of the mathematics language of learning and teaching in the construction of foundation phase mathematics pedagogy?
3. What factors influence the construction of Foundation Phase mathematics pedagogy during initial teacher education programme?

## **1.5 SIGNIFICANCE AND PURPOSE OF THE STUDY**

Mathematics pedagogical knowledge is regarded as an important component in the FP initial teacher education programme, however; research is limited in South

Africa on how this knowledge is constructed in the teaching and learning of FP student teachers. Youngs and Qian (2013) suggest that there is a need to understand how pedagogical knowledge pertaining to mathematics is constructed in the initial teacher education programmes. This study is regarded as significant as it responded to the research suggestions of Youngs and Qian (2013) and therefore investigated how two initial teacher education programmes in South Africa constructed mathematics pedagogical knowledge in their programmes.

Another contribution of this study is to understand the impact of the language of learning when teaching mathematics in the initial teacher education programmes and FP classrooms (Spaull, 2013). Therefore, this study also tried to understand how the language of learning (LoLT) impacts the teaching of mathematics in the initial teacher education programme when student teachers are involved in their practical teaching as part of their studies.

The study is regarded as significant as it is intended to make recommendations to the Department of Higher Education and Training, lecturers and student teachers in strengthening the teaching and learning of FP mathematics in South Africa. This study also gives insight into student teachers' and lecturers' experiences on mathematical pedagogical knowledge construction during the initial teacher education programme.

The purpose of this study is to explore how two initial teacher education programmes in South Africa implement FP pedagogical knowledge of mathematics in their modules in order to prepare student teachers to teach FP mathematics effectively. The voices of the lecturers' and student teachers' from two initial teacher programmes presented some insight and understanding of practices and process of mathematics pedagogical knowledge construction in the South African context.

To be precise, this study aimed at:

- Understanding how FP student teachers perceived their mathematics module in their teacher education programme.
- Exploring the role of the mathematical language of learning and teaching in the construction of FP mathematical pedagogy.
- Indicating some factors that influenced the construction of FP mathematical pedagogy during initial teacher education programme.

## **1.6 RESEARCH METHODOLOGY**

This study employed a qualitative research approach using a case study design within an interpretive paradigm (Maree, 2010) to explore how two different initial teacher education institutions in South Africa structure FP pedagogy pertaining to mathematics in order to prepare student teachers to teach FP mathematics (Creswell, 2012). The sample was purposefully selected and consisted of FP mathematics lecturers and final year FP B.Ed. student teachers from two initial teacher education programmes at institutions (Creswell, 2012). Data were collected through interviews (one-on-one, focus group) as well as document analysis related to the FP modules in the two programmes. Triangulation of data was used to ensure credibility of the findings (McMillan & Schumacher, 2010). Inductive analysis strategies were utilised to interpret and reduce the collected data, discussing these according to the emerging themes. Furthermore I adhered to all ethical considerations as stipulated by the University of Pretoria (see Chapter Three). The next sections clarify concepts utilized in this study.

## **1.7 CONCEPT CLARIFICATION**

The purpose of clarifying these concepts is to ensure that there is a common understanding of the pertinent concepts used in this study.

### **1.7.1 FOUNDATION PHASE**

FP refers to the first phase of the General Education and Training Band. It includes learners from Grade R to 3 and age range from six to ten years (DoE, 2003; Anthony & Walshaw, 2009). Learners in the FP are taught four subjects; home language, first additional language, mathematics and life skills (DBE, 2012:9).

### **1.7.2 FOUNDATION PHASE CURRICULUM (CAPS)**

Curriculum Assessment Policy Statement (CAPS) is a single, comprehensive, and concise South African curriculum policy document, which stipulates the depth and breadth of mathematical content knowledge, skills and values that learners should learn in each grade (DBE, 2012). CAPS emphasises that the teaching and learning of mathematics in FP should be learner-centred. This suggests that learners should

be actively engaged in their learning in order to develop their critical thinking skills (Brodie, 2011; DBE, 2012; Van de Walle et al. 2013).

### **1.7.3 FOUNDATION PHASE MATHEMATICS**

FP mathematics refers to knowledge of the subject such as knowledge of mathematics concepts, rules and related procedures to solve mathematical problems (Brijlall & Isaac, 2011; Rowland et al. 2010). FP mathematics covers five content areas; Numbers, operations and Relationships, Patterns, Functions and Algebra, Space and Shape (Geometry), Measurement and Data Handling with the main focus in Numbers, Operations and Relationships (DBE, 2012: 9-10, Van de Walle et al. 2013).

### **1.7.4 LANGUAGE OF LEARNING IN FP MATHEMATICS**

The language of learning in mathematics is regarded as an instrument of communication that nurtures interaction and conceptual understanding (Vukovic & Lesaux, 2013). Mathematical language involves specialised terminology (Simmons & Singleton, 2008). The language of teaching and learning mathematics in this study refers to home language (African languages) (DBE, 2012; Wium & Louw, 2012).

### **1.7.5 INITIAL TEACHER EDUCATION PROGRAMME**

Initial teacher education is a programme of education that develops students into effective teachers. The B.Ed. FP teacher education programme develops student teachers to a point where they are able to teach from Grade R – Grade 3 in all four subjects, namely: home language, first additional language, mathematics and life skills (DHET, 2011). Furthermore, FP teacher education programmes develop students to a point where they are able to identify and address barriers to learning. The core knowledge mix for FP teacher education programme comprises of disciplinary, pedagogical, practical and fundamental learning (Advisory Committee on Mathematics Education (ACME, 2008); DHET, 2011).

### **1.7.6 MATHEMATICAL CONTENT KNOWLEDGE**

Mathematical content knowledge is concerned with knowledge of mathematical concepts, rules and procedures of doing mathematics (Hill et al. 2008; Van de Walle et al., 2013).

### **1.7.7 PEDAGOGICAL CONTENT KNOWLEDGE**

Pedagogical content knowledge refers to how teachers transform their own knowledge to a form that makes it accessible to learners. It includes knowledge of how to use resources, representations or analogies for teaching mathematical ideas and how to break down ideas to explain concepts to learners (Rowland et al. 2010).

### **1.7.8 Pedagogical Knowledge**

Pedagogical knowledge refers to the broad knowledge that teachers require in order to be effective in the classroom. This includes content knowledge, knowledge about how to teach, knowledge about the curriculum and knowledge about the discipline and classroom management (Brijlall & Isaac, 2011).

## **1.8 OUTLINE OF CHAPTERS**

The study is presented in the following layout:

### **CHAPTER ONE:**

#### **INTRODUCTION AND ORIENTATION TO THE STUDY**

This chapter discussed the background and orientation to the study and the rationale and research questions that directed the study. Furthermore, the significance problem and purpose of the study is explained. I also presented a brief summary of the research design, methodology and data analysis of this study.

### **CHAPTER TWO:**

#### **LITERATURE REVIEW**

This chapter presents literature review on the construction of FP mathematics in the initial teacher education programme. An attempt was made to highlight how teacher education programmes help student teachers to construct mathematical content and pedagogical knowledge to teach. I also described the importance and role of



language in teaching mathematics in the FP. The conceptual framework that underpins this study was discussed as well.

### **CHAPTER THREE:**

#### **RESEARCH METHODOLOGY**

Chapter Three provides a description of the research process and methodology utilised in this study. A multiple case study design which comprised of twelve final year B.Ed. FP student teachers and two mathematics lecturers was used. Participants were purposefully selected. Data were gathered through semi-structured interviews, focus group interviews and document analysis. Data analysis strategies, research trustworthiness and ethical considerations are stated.

### **CHAPTER FOUR:**

#### **DATA ANALYSIS AND RESEARCH FINDINGS**

This chapter presents the research findings of the two lecturers and twelve student teachers. The findings are presented and analysed according to the themes and categories that emerged during data analysis process.

### **CHAPTER FIVE:**

#### **INTERPRETATION OF RESEARCH FINDINGS, SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

In Chapter Five the research finding are discussed in relation to the literature review. The research question is answered in terms of the findings. Recommendations and conclusion of the study is presented.

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## **CHAPTER TWO LITERATURE REVIEW**

### **2.1 INTRODUCTION**

Chapter one served as a primer to my investigation and presents the research problem and how it would be dealt with. This chapter provides a review of the literature related to aspects that contributed to the construction of the FP mathematical pedagogy. I present a debate about the process and action, types of learning knowledge as well as student teachers' perceptions that contribute to the constructing FP mathematical pedagogy in the B.Ed. initial teacher education programmes (FP).

My discussion further focuses on how the B.Ed. initial teacher education programmes prepare student teachers to teach mathematics in FP including the type of knowledge and competences they should acquire during their preparation to be able to teach mathematics at FP level. I present student teachers' experiences and feelings with regards to mathematics pedagogical content knowledge.

I conclude this chapter with the conceptual framework which utilised the types of learning knowledge as prescribed in the Minimum Requirements for Teacher Education Qualifications (MRTEQ), (DHET, 2011) in conjunction with Shulman's (1987) process of pedagogical reasoning and action and student teachers' perceptions to analyse how B.Ed. FP initial teacher education programmes structure their programmes. This chapter is divided into the following sections: the construction of FP mathematical pedagogy, initial teacher education programmes and student teachers' experiences of mathematics teaching and learning.

### **2.2 THE CONSTRUCTION OF FOUNDATION PHASE MATHEMATICAL PEDAGOGY THROUGH FOUNDATION PHASE INITIAL TEACHER EDUCATION PROGRAMME**

This study is about the construction of FP mathematical pedagogy through the B.Ed. initial teacher education programme. Furthermore, the study investigated how

two initial teacher education programmes construct FP mathematical pedagogy as well as the experiences and perceptions of student teachers gained through the mathematical pedagogy module. In this study, pedagogic practice and reasoning action process in conjunction with the types of learning knowledge are viewed as an interconnected, interdependent, cyclical and continuous process in the construction of FP mathematics pedagogies (Bernstein, 2000; Shulman, 1987). The pedagogical process involves knowledge, acquisition and transformation. The pedagogical process emphasises the way in which teachers comprehend and break down ideas. Student teachers interact with learners and mathematical content; explain mathematical concepts to learners, (Bernstein, 2000; Rowland et al. 2010); identify and rectify learners' misconceptions (Schwartz, 2008) and understand how learners think when they do FP mathematics (Turnuklu & Yesildere, 2007).

Shulman's (1987) pedagogical reasoning and action processes and the seven categories of knowledge base for teaching are essential components for learning to teach. The seven categories of his knowledge base for teaching are specified as follows: 1) content knowledge; 2) general pedagogical knowledge; 3) curriculum knowledge; 4) pedagogical content knowledge; 5) knowledge of learners and their characteristics; 6) knowledge of educational contexts, and 7) knowledge of educational ends, purposes, and values. It is important to note that literature is not conclusive on the type of knowledge that should be included in the B.Ed. initial teacher education programmes (Ball, Thames & Phelps, 2008; Thanhiesier, Browning, Moss, Watanabe & Garza-Kling, 2010; Zazkis & Zazkis, 2010). My study therefore will dwell into the type of knowledge that forms the core of mathematics modules. Therefore, in this study, Shulman's seven categories of knowledge for teaching are incorporated and used as the types of learning knowledge as prescribed by DHET (2011). The types of learning knowledge applicable to South African teacher education are; disciplinary learning; pedagogical learning; practical learning; fundamental learning and situational learning which are similar to Shulman's suggested content knowledge (Shulman, 1987). These types of learning knowledge and the pedagogical reasoning and action process are viewed as some aspects that influence the construction of the pedagogical knowledge of mathematics. The aforesaid types of knowledge are subsequently discussed.

## 2.2.1 DISCIPLINARY LEARNING IN FOUNDATION PHASE MATHEMATICS

Literature suggests that disciplinary learning or content knowledge involves knowledge of mathematical concepts, procedures and rules of doing mathematics (Hill et al. 2008). Matthews et al. (2010); Youngs and Qian (2013) argue that mathematical content knowledge plays a vital role in the process of learning to teach. That is why Bernstein (2000) and Rowland et al. (2010) emphasise that it is important for initial teacher education programmes to provide student teachers with sufficient mathematical content knowledge in order for them to be effective teachers.

Kilpatrick, Swafford and Findell, (2001) contend that for student teachers to be effective teachers initial teacher education programmes should teach student teachers about mathematical proficiency. Mathematical proficiency involves the knowledge about the bond between the teacher, the learner, and the content and embraces the context to learn mathematics successfully. This suggests that for student teachers to be effective teachers they should know how to teach mathematics successfully to diverse learners and different learning environments. Mathematical proficiency is grounded on five interrelated and interwoven strands that describe what it means to competently learn and teach mathematics. The five strands are; conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition. The strands are described as follows:

- Conceptual understanding is the core knowledge of mathematics that involves comprehension of mathematical concepts, operations, and relations in the teaching and learning of mathematics;
- Procedural fluency is the capability to apply rules and procedures flexibly, accurately, efficiently, and appropriately in a mathematical classroom using different strategies;
- Strategic competence is the ability to plan and communicate instruction effectively, represent, and solve mathematical problems in the classroom while teaching;
- Adaptive reasoning involves the ability to justify and explain one's instructional practices logically and reflect on those practices;

- Productive disposition toward mathematics teaching and learning is embedded in the ability to see mathematics as sensible, useful and worthwhile, linked with precision to improve one's teaching practices and attitude (Kilpatrick et al. 2001; Van de Walle et al. 2013).

The above mathematical proficiency strands emphasise the importance of introducing student teachers to effective mathematics instructional approaches and practices, and the ability to justify their practices. It is, therefore, essential to understand whether the two initial teacher education programmes in this study consider the five mathematics proficiency strands essential in the construction of their mathematics pedagogy modules.

## **2.2.2 PEDAGOGICAL LEARNING IN FOUNDATION MATHEMATICS**

Pedagogical learning is viewed as a multi-faceted combination of mathematical knowledge such as pedagogy, how children learn, concepts and theories and curriculum and content knowledge (DHET, 2011; Zaskis & Zaskis, 2010). For this study some aspects of pedagogical learning are emphasised as they are viewed as crucial knowledge that student teachers have to acquire in the process of the construction of mathematical pedagogy. These aspects include knowledge of learners, knowledge of the curriculum and instructional approaches in the FP mathematics classrooms. As indicated earlier Shulman's, (1987) theory of pedagogical process and reasoning form the basis of this study. The above-mentioned aspects would be achieved by allowing student teachers to paddle through a cycle of the integrated activities of the six stages of the pedagogical reasoning and action processes (Shulman, 1987). The six stages include: comprehension; transformation; instruction; evaluation; reflection and new comprehensions. The six stages are discussed in section 2.2.6 below. Subsequently, knowledge of the curriculum, instructional approaches and knowledge of the learners are discussed.

### **➤ Knowledge of learners in Foundation Phase mathematics**

Mathematics pedagogical knowledge includes knowledge about learners. It is further suggested by Anderman and Corno (2013:684) that the focus should be on learners' mathematics understanding and regard to their learning as "cognitive-mediational conception". In other words, student teachers should know that learners

are diverse, have different learning styles, are active problem solvers, are able to construct their own mathematical knowledge and that all learners are capable to learn mathematics (Charlesworth & Lind, 2013). For this reason, it is important for student teachers to know and be able to select mathematics instructions suitable for diverse learners (Sullivan, 2011).

Teaching and learning of diverse learners should include knowledge about learners experiencing mathematics difficulties and knowledge to adjust lessons to accommodate all learners and to teach mathematics for understanding (Sullivan, 2011). Van de Walle et al. (2013) indicate that the sociocultural environment of a mathematical community of learners or co-operative learning improves learners' development of mathematical ideas. Student teachers should model mathematics concepts and encourage learners to communicate their mathematical ideas. They should as well understand that learners learn more effectively when engaged in constructing their own mathematical knowledge (Inoue, 2009). This study is intended to find out the how initial teacher education programmes prepare student teachers to acquire knowledge of FP mathematics curriculum.

➤ **Knowledge of the curriculum in Foundation Phase mathematics**

Lattuca and Stark (2009: 4-5) defines the curriculum as a plan that teachers use as the foundation for their lessons. They further state that the curriculum includes the “purpose, content, sequence, learners, instructional processes and resources, evaluation and adjustment”. In the South African context the curriculum is referred to as the National Curriculum and Assessment Policy Statements (CAPS). CAPS is a policy document that provides the skills, values and knowledge that learners should acquire in their schooling years. CAPS as well offer guidelines on the mathematics content knowledge, resources, instructional strategies and assessment strategies that teachers should teach and use in each grade (DBE, 2012). It is important to note that South Africa had various changes on the curriculum since the democratic dispensation; Curriculum 2005 (C2005), the Revised National Curriculum Statement (RNCS) and now CAPS (DBE, 2012). The DHET, (2011) however, notes the basic competences that a beginner teacher should have in completion of their B.Ed. in initial teacher education programme should include a teacher being a scholar, researcher and a lifelong learner. Therefore, these suggest that teachers should attune easily to the new curriculum,

resources, technology, learners' understanding and teaching approaches (Kilpatrick et al. 2001).

The current South African curriculum (CAPS) aims to develop learners' deeper conceptual understanding of mathematics. CAPS requires learners to solve mathematical problems through investigations, analysing, representing and interpreting information (DBE, 2012). This is a new teaching approach and is referred to as the constructivist learning approach. Literature suggests and emphasises that the constructivist learning approach should be utilised in the teaching and learning of mathematics (Billstein et al. 2013; Mathison, 2011; Schwartz, 2008; Van de Walle, 2007, Van de Walle et al. 2013). Moreover, Van de Walle et al. (2013) highlight that curriculum material and resources such as textbooks direct the 'what, when and the how of actual teaching' occurs (Van de Walle et al. 2013).

Castro (2006) suggests that student teachers should be exposed to appropriate curriculum materials and resources. They should know how to select relevant material, analyse mathematical tasks, identify appropriate instructional strategies and clarify mathematics concepts (Behm, 2008; Remillard, 2005).

Furthermore, CAPS, provides skills and the progression of the mathematical content knowledge that learners should acquire during FP schooling. The mathematics curriculum covers five content areas viz.: numbers, operations and relationships; patterns; functions and Algebra; space and shape (Geometry), and measurement and data handling. The main focus of the South African curriculum is on numbers, operations and relationships (DBE, 2012:10). Weightings are allocated to the different mathematical content areas as "guidance" for time to be spent on each content area and for the distribution of the content in the assessment. Table 2.1 below presents the weighting of the mathematical content areas as prescribed by CAPS for the teaching and learning of FP mathematics.

**Table 2.1: The weighting of the content areas in the foundation phase**

<b>WEIGHTING OF CONTENT AREAS</b>			
<b>Content area</b>	<b>Grade 1</b>	<b>Grade 2</b>	<b>Grade 3</b>
Numbers, Operations and Relationships	65%	60%	58%
Patterns, Functions and Algebra	10%	10%	10%
Space and Shape (Geometry)	11%	13%	13%
Measurement	9%	12%	14%
Data Handling	5%	5%	5%
	100%	100%	100%

However, after careful scrutiny of the weightings it was realised that Grade R is excluded on the weightings of the content areas provided by the DBE. This is because Grade R is not compulsory and is regarded as a preparatory class where children are engaged in informal learning and they learn through play (DBE, 2012). It is evident from the weighting percentages that numbers, operations and relationships enjoy abundant time allocation. Therefore, it is an important content area for FP mathematics as it forms the basis of doing and learning mathematics in the early years (Van de Walle, 2007). For this reason it is important to note that the DBE (2012) anticipates that proficiency in numbers, operations and relationships will enhance learners' overall mathematics skills for future learning. It is, therefore, essential for this study to understand how instructional approaches are embedded in the initial teacher education programme for the teaching and learning of FP learners.

➤ **Knowledge of instructional approaches in Foundation Phase mathematics**

LaParo, Thomason, Maynard and Scott-Little (2012) stated that instruction is concerned with knowledge transformation and instructional approaches involved in the teaching and learning of FP mathematics. Thus teaching and learning of FP mathematics comprise of different instructional approaches. These approaches include, for example; inquiry-based, problem-solving and traditional teaching approaches. Furthermore, these teaching approaches showcase the type of relationship that should exist between the teachers, learners in different mathematics learning context (Van de Walle et al. 2013). The different instructional



approaches in the FP as they appear in this order, traditional teaching approach, inquiry-based approach and problem solving approach, are discussed below:

- **Traditional teaching approach to Foundation Phase mathematics**

Research reveals that traditional teaching approach is teacher-centred and embraces rote learning, and the drill and practice approach (Lange, 2010; Mathison, 2011; Philippeaux-Pierre, 2009). In this approach, instruction begins with rules and procedures and progresses to applications of those rules and procedures. This shows that the teacher's role in the traditional teaching method is to provide learners with information while they sit and listen (Linder, Powers-Costello & Stegelin, 2011). Hiebert and Grouws (2007) criticise traditional teaching approach and reveal that it inhibits mathematical understanding and expose learners to only low level cognitive skills. They contend that learners are not engaged in critical thinking when doing mathematics and only expected to recall, list and categorise mathematical concepts. It is against this background that this study explored the role of the traditional teaching approach in the teaching and learning of mathematics as part of the initial teacher education programmes.

Despite that research is advocating for change from the traditional teaching approach to reformed based pedagogy such as inquiry-based approach (Lange, 2010; Mathison 2011; Philippeaux-Pierre, 2009); Baumann (2009) argues that the traditional teaching approach is still valuable in the teaching and learning of mathematics. Baumann asserts that the traditional teaching approach provides teachers with the opportunity to impart purposefully selected mathematical curriculum knowledge. For this reason, I support Baumann and suggest further that it is important that initial teacher education programmes should expose student teachers to different instructional approaches including the traditional teaching approach and reformed based pedagogy such as inquiry-based teaching approach.

- **The inquiry-based teaching approach**

The inquiry-based teaching approach is a reformed based pedagogy that was introduced to address the gaps found in the traditional teaching approach such as the passivity of learners in their learning of mathematics (Billstein et al. 2013; Brodie, 2011; Mathison, 2011; Schwartz, 2008; Van de Walle, 2007, Van de Walle et al. 2013). The inquiry-based teaching approach is based on the constructivist learning theory, which promotes teaching practices that allow learners to construct

their own knowledge, investigate, communicate and solve mathematical problems posed to them (Billstein et. al. 2013). Schwartz, (2008) concurs with the strategies involved in the teaching and learning of mathematics using the inquiry-based teaching approach. He argues that this kind of pedagogy is learner-centred; it promotes intellectual engagement that helps learners to see and make connections, value individual's knowledge and culture and encourages learners to work in groups. Moreover, in an inquiry-based approach, learners communicate their mathematical ideas; use different tools to solve and in doing mathematics (DBE, 2012; Hope, 2008; Van de Walle, 2007).

Although an inquiry-based approach promotes understanding in doing mathematics, Nadarajan (2011) contends that an inquiry-based approach poses challenges for both teachers and learners. These challenges include amongst others, insufficient teaching and learning time, shortage of teaching resources, and teachers' inadequate content and pedagogical knowledge. In order to exemplify the challenges mentioned the following situation is referred to. When the teachers' mathematical content knowledge is lacking and learners are constantly asking challenging questions and the teacher cannot not provide answers learners will lose confidence and trust in their teacher. It is important to note that the teachers' role in the inquiry-based approach is to facilitate learning, allow learners to investigate and solve mathematical problems applying different problem-solving strategies (Magee & Flessner, 2012; Van de Walle et al. 2013).

- **The problem-solving teaching approach**

It is increasingly acknowledged that problem solving is important for the teaching, learning and understanding mathematics (Linder et al. 2011; Long, DeTemple & Millman, 2012; Van de Walle et al. 2013). Problem-solving promotes reasoning, logical thinking and critical thinking (DBE, 2012; Driscoll, Lambirth & Roden, 2012). Learners are exposed to practices such as interpreting, representing, analysing, reasoning and proving their answers (ACME, 2008; DBE, 2012). Thus, Billstein et al. (2013), Fierro (2013), Schwartz (2008), Tipps, Johnston and Kennedy, (2011), Van de Walle (2007) and Van de Walle et al. (2013) are of the opinion that the teaching and learning of mathematics in the early primary schools should be based on the five process standards, namely: problem-solving, reasoning and proof, communication, connections and representation.

According to Van de Walle et al. (2013:4) the five process standards which are recognised internationally focus on “doing all mathematics”. Learners are provided the opportunity to solve problems by applying appropriate problem solving strategies such as reflecting, investigating, reasoning and proving their findings as well as recording and communicating, using mathematical language with confidence to express their ideas (Long et al. 2012).

Table 2.2 below presents the five process standards and their descriptors as specified by the National Council of Teachers of Mathematics (NCTM) (2000) in Van de Walle et al. (2013:4).

**Table 2.2: The five process standards**

Process standard	Standard descriptors
Problem solving	<ul style="list-style-type: none"> <li>▪ Build new mathematical knowledge through problem solving</li> <li>▪ Solve problems that arise in mathematics and in other context</li> <li>▪ Apply and adapt a variety of appropriate strategies to solve problems</li> <li>▪ Monitor and reflect on the process of mathematical problem solving</li> </ul>
Reasoning	<ul style="list-style-type: none"> <li>• Recognise reasoning and proof as fundamental aspects of mathematics</li> <li>▪ Make and investigate mathematical conjectures</li> <li>▪ Develop and evaluate mathematical arguments and proofs</li> <li>▪ Select and use various type of reasoning and methods of proof</li> </ul>
Communication	<ul style="list-style-type: none"> <li>• Organise and consolidate their mathematical thinking through communication</li> <li>• Communicate their mathematical thinking coherently and clearly to peers, teachers, and others</li> <li>• Analyse and evaluate the mathematical thinking and strategies of others</li> <li>• Use the language of mathematics to express mathematical ideas precisely</li> </ul>
Connection	<ul style="list-style-type: none"> <li>• Recognise and use connections among mathematical ideas</li> <li>• Understand how mathematical ideas interconnect and build on one another to produce a coherent whole</li> <li>• Recognise and apply mathematics in context outside mathematics</li> </ul>
Representation	<ul style="list-style-type: none"> <li>• Create and use representation to organise, record, and communicate mathematical ideas</li> </ul>

Process standard	Standard descriptors
	<ul style="list-style-type: none"> <li>• Select, apply, and translate among mathematical representations to solve problems</li> <li>• Use representation to model and interpret physical, social, and mathematical phenomena</li> </ul>

Van de Walle et al. (2013) suggest that the process standards should be utilised in conjunction with Pólya's four problem solving principles for learners to do and apply mathematical knowledge in their everyday learning. Pólya suggests that learners should try and understand the problem, devise a plan to solve the problem, carry out the plan and look back or reflect to assess for understanding (Long et al. 2012; Van de Walle et al. 2013). For this study, Pólya's four problem solving principles are viewed as essential and interrelate well with the pedagogical reasoning and action process. This is because when student teachers are engaged in the four principles they construct new mathematical knowledge. I therefore take a theoretical view that the teaching and learning of FP mathematics should be based on a constructivist philosophy of learning. This philosophy emphasises that teaching and learning of mathematics should include: active learning strategies, teaching and learning for understanding, treating of errors as opportunities for learning, scaffolding of new content and honour learners' diversity (Van de Walle et al. 2013). Student teachers may achieve these skills during their practical learning.

### **2.2.3 PRACTICAL LEARNING IN FOUNDATION PHASE MATHEMATICS**

Practical learning incorporates learning from and in practice. Learning from practice includes the study of practice, for example, from case studies, video recordings and lesson observations. Learning in practice involves teaching in authentic and simulated classroom environments. This means that student teachers are engaged in teaching mathematics to learners in schools during teaching practice. Literature indicates that teaching practice experience is a fundamental component of the initial teacher education programme (Amin & Ramrathan, 2009; Botha, 2012, DHET, 2011; Mutemeri & Chetty, 2011). For this study, learning from practice means observing and reflecting on FP mathematics lesson presented by others like a mentor teacher in a real classroom setting.

Observation and reflection are said to increase student teachers' knowledge such as: mathematics pedagogical knowledge, knowledge about teaching diverse learners and teaching and learning in different contexts (Akkoç & Yaşildere, 2010; Coffey, 2010). Butler and Cuenca, (2012); DHET (2011); I'mre and Akkoç (2012) and Korthagen, Loughran and Russell (2006) argue that engaging student teachers in the process of observation and reflection through effective interaction with their peers and literature, increase student teachers' knowledge construction. Interaction requires that student teachers should have profound mathematics language to effectively express their views (Hardy, 2011). Hence it is essential to prepare student teachers who are proficient in the language of mathematics. Fundamental learning in this study is focusing on conversing effectively in a second language. Fundamental learning is discussed next.

#### **2.2.4 FUNDAMENTAL LEARNING IN THE FOUNDATION PHASE**

Fundamental learning in the South African context refers to learning to converse competently in a second official language (DHET, 2011). Language is defined as a code for encoding and decoding information and is an essential tool for communication (Fitch, 2010; Steinberg, 2007). This suggests that student teachers should be equipped with mathematics language and the language of teaching and learning mathematics for them to be able to interact effectively in the teaching of mathematics. Spull (2013) argues this is important as FP classrooms in South Africa cater for learners with diverse home languages. Moreover, South Africa has eleven official languages which are accepted by the constitution as languages of learning and teaching in schools (DBE 2013). It is therefore, important that initial teacher education programmes prepare the student teachers who are bilingual or able to communicate efficiently in other languages. That is why Kempert, Saalbach, and Hardy (2011) emphasise that bilingualism in the teaching and learning of FP modules enhances understanding and cognitive development. This means that language is crucial in the teaching and learning of mathematics, as it helps in making meaning and aids with the understanding of concepts and processes. Since language is so important in the teaching of mathematics, I therefore ask, which language of learning and teaching is used in the teaching of FP mathematics?

➤ **The importance of the language of learning and teaching of Foundation Phase mathematics in a South Africa context**

Language of learning and teaching (LoLT) is described as “the language chosen by a school’s governing body in consultation with parents. It is the language teachers use to instruct and assess” (DBE, 2013: 4). However, the South African curriculum (CAPS) emphasises that the medium of instruction in the FP should be the home language, including the teaching and learning of mathematics (DBE, 2012). Langtang and Venter, in Du Plessis (2013: 21) define a home language as the language that the child has learnt from the parents.

Literature supports the use of the home language as a medium of instruction and state that learners learn effectively when they learn in their home languages (Langer, 2013; Mashiya, 2011; Skovsmose & Greer, 2012; Skutnabb-Kangas, 2009). South African mathematics curriculum documented that learners should possess the following language skills in mathematics.

Learners should:

- develop number vocabulary, number concept and calculation and application skills;
- learn to listen, communicate, think, reason logically and apply the mathematical knowledge gained;
- learn to investigate, analyse, represent and interpret information (DBE, 2012: 8).

The above-mentioned skills indicate the impact language has in the teaching and learning of mathematics in the FP. According to the National Education Evaluation and Development Unit (DBE, 2012) and Spaul (2013) the language of learning and teaching has a direct effect on the poor performance of learners in mathematics in South Africa. They indicate that due to diversity of learners with regard to different home languages and the reason that learners from townships speak a simplified form of African languages to communicate, the language of learning and teaching becomes a challenge in the teaching and learning of mathematics in the FP. This is because the languages that these learners use daily, are not their real home languages but the languages designed by communities to accommodate and understand each other due to the diverse nature of home languages in these communities (Spaul, 2013). Furthermore, the reason is that parents decide on the

language of learning and teaching for their children regardless of their language spoken at home.

According to Cambourne in Killen (2010) learners learn effectively when they have sufficient language skills to make connections, identify patterns, and to organise previously unrelated bits of knowledge, behaviour and action into new knowledge. However, in the case where learners are multilingual in a classroom, teachers often code-switch or teach mathematics in English to reinforce concepts. It is also stated that sometimes, due to a lack of relevant mathematical home language terminologies, teachers implement code-switching as a teaching strategy to accommodate all learners in the classroom (NEEDU, 2012).

➤ **The use code of switching in the teaching and learning of Foundation Phase mathematics**

Code-switching is defined as the proficiency to communicate and teach while changing from home language to another language. In the context of this study, only African language speakers took part in this study, therefore it is assumed that English is only used as a target language in teaching and learning of mathematics in the initial teacher education programmes (Cantone, 2007). It is further assumed that these student teachers code-switch from English to their home languages when teaching FP mathematics. This is done in order to reach the diverse nature of learners in FP classrooms due to presupposed ideas and a lack of the needed mathematical language concepts in African languages. Nevertheless, Kempert et al. (2011), are of the opinion that code-switching promotes bilingualism and it has cognitive gains for learners who struggle with the language of learning and teaching, specifically in mathematics.

However, Chauma (2012); Halai and Karuku (2012) caution that code-switching has its own flaws. They argue that teachers' inadequate competence in the language they use to translate mathematics concepts may hamper the process of learning and teaching. Hence, Moto in Chauma (2012) suggest that it is essential for planners of initial teacher education programmes to prepare student teachers to teach in their home languages as there is no assurance that if you know how to speak a language, you can automatically teach it. This suggests that it should not be assumed that the capability to converse in a language means that you can transform and teach mathematics effectively in that language. It is therefore

essential for this study to investigate the impact of the mathematical language of learning and teaching in the construction of FP mathematics pedagogies, especially if the language used in the initial teacher education programmes is different to the ones used in schools where student teachers do their practicum.

Chauma (2012) conducted a study in Malawi on teachers engaged in the teaching of mathematics. He maintains that there are numerous challenges that teachers' encounter. Teachers also need to find the appropriate strategies to manage teaching mathematics in the language that they in some cases are not trained to teach in. His study reveals that teachers are confronted with linguistic and pedagogical difficulties. They struggle because of a lack of pedagogical knowledge and the necessary mathematical vocabulary. Chauma (2012) further discovered that these teachers used different languages to try and explain mathematical concepts to learners. However, because of a lack of language proficiency he found that there were translational discrepancies, which sometimes led to the loss of real meaning of the words and concepts in the teaching and learning of mathematics. Therefore, it is important to understand how the student teachers, who are African language speakers in this study, perceive their code-switching skills in the teaching and learning of FP mathematics. Furthermore, it is imperative to explore how their initial teacher education programme prepared them to teach mathematics in different contexts and in this study it is referred to as situational learning.

### **2.2.5 SITUATIONAL LEARNING IN FOUNDATION PHASE MATHEMATICS**

Situational learning refers to the knowledge of varied learning situations, contexts and environments of education as well as policy (DHET, 2011). Learners experience mathematics in various contexts informally from peers, parents and the environment and formally at school (Landsberg, Kruger & Swart, 2011). In a formal setting the teaching and learning of mathematics promote conceptual understanding, the rules and procedures of doing mathematics (Bryant, Bryant, Roberts, Vaughn, Pfannenstiel, Porterfield & Gersten, 2011; Van de Walle et al. 2013).

It is important to note that one of the requirements for teaching and learning in Foundation Phase is that teachers should know how to identify and support learners experiencing mathematical learning difficulties (DHET, 2011).



Mathematical learning difficulties may be caused by various reasons to mention a few: inappropriate mathematical teaching strategies, mathematical language of learning and teaching and or teachers' lack of mathematical and pedagogical content knowledge (Landsberg et al. 2011; Morin & Franks; 2009). It is therefore important to understand the pedagogical reasoning and active processes that two initial teacher education programmes investigated to prepare student teachers to teach FP mathematics.

## **2.2.6 PEDAGOGICAL REASONING AND ACTION PROCESS IN FOUNDATION PHASE MATHEMATICS**

In section 2.2.2 it was indicated that the pedagogical reasoning and action process is an integrated and continuous process that comprises of six stages. The six stages of pedagogical reasoning and action process are discussed and include; comprehension; transformation; instruction; evaluation; reflection and new comprehensions (Shulman, 1987; 2000).

**Comprehension** is viewed as closely related to content knowledge (Kleickmann et al. 2013; Nason et al. 2012) as it requires profound understanding of mathematical concepts and rules of doing mathematics (Kilpatrick et al. 2001; Shulman, 1987; Rowland et al. 2010; Van de Walle et al. 2013). However, it is essential for initial teacher education programmes not to only focus on mathematics content knowledge but also to provide student teachers with the skills to transform their knowledge constructively (Shulman, 1987).

**Transformation** is embedded in pedagogical content knowledge (PCK). PCK is regarded as the "specialised knowledge for teaching" and described as the capacity of teachers to transform the content knowledge they possess into forms that are pedagogically efficacious and yet adaptive to the differences in ability and background presented by students (Shulman, 1987: 15). This means that initial teacher education programmes should ensure that student teachers acquire the skills to break down mathematical ideas, and to interact and explain mathematical concepts to learners proficiently (Bernstein, 2000; Rowland et al. 2010). Additionally, Schwartz, (2008) contends that these student teachers should also know how to identify and rectify learners' mathematics misconceptions and understand how learners think when involved in doing mathematics (Turnuklu &

Yesildere, 2007). For this reason, I support Rowland et al. (2010) that student teachers should learn how to communicate mathematics effectively, to analyse their learners' expressions and be taught how to use different instructions in the teaching and learning of mathematics.

**Instruction** comprises of presentations, providing concise explanations and interacting constructively with learners through questions and answers (LaParo et al. 2012). Mathematics may be represented in different strategies including analogies, examples, metaphors and experiments (Siemon, Adendorff, Austin, Fransman, Hobden, Kaino, Luneta, Makonye, van der Walt, Putten, Beswick, Brady, Clark, Faragher & Warren (2013). Tatto et al. (2012) highlight that mathematics is sometimes presented in a lecture format targeting the whole group, small groups or individuals. They further suggest that student teachers should learn how to cater for learners' needs, values and interests while presenting mathematics. This suggests that it is important for initial teacher education programmes to prepare student teachers to have mathematical knowledge and language skills to be able to communicate mathematics efficiently to FP learners (LaParo et al. 2012). In the context of this study, it is important to understand how mathematics pedagogy is presented and evaluated in two initial teacher education programmes in South Africa.

**Evaluation** deals with assessing learners' mathematics understanding before, during and after the lesson and helps student teachers to reflect and improve their own practices (LaParo et al. 2012). According to Siemon et al. (2013) assessment plays a vital role in the teaching and learning of mathematics. It provides a clear understanding of where your learners are at the moment and help teachers to plan for the future mathematics lessons and lastly it provides guidelines on how to support learners in doing mathematics. During assessment teachers need to have the capacity to reach their learners through asking appropriate questions and using relevant mathematics language (Langer, 2013). Therefore, this study intends to explore student teachers' knowledge and capacity to use appropriate language in the teaching and learning of mathematics and how they reflect on their practices in order to strengthen their mathematical and pedagogical skills.

**Reflection** involves observing and evaluating mathematical lessons presented by others and own practice during mathematics presentations (I'mre & Akkoç, 2012).

Research clearly indicates that by observation and reflection from and experience in practice which deepen mathematical learning and the construction of pedagogical knowledge (Fadde & Sullivan, 2013; Korthagen et al. 2006). This suggests that reflection should be viewed as a social phenomenon that promotes dialogue, discussions and arguments in the construction of FP mathematics pedagogy (Shulman, 2000). According to Harford and MacRuairc (2008) this kind of communication in the teaching and learning of mathematical pedagogy, promotes student teachers' profound investigation of the content they are learning and enhances their critical thinking skills. Their new knowledge and comprehension abilities are also impacted.

**Comprehension and new knowledge** are only realised after going through the process of evaluation, reflection, writing, analysing and discussions (Shulman, 2000). This should be viewed as an integrated and continuous process in the construction of FP mathematical pedagogy in the initial teacher education programme (Fadde, Aud & Gilbert, 2009; Fadde & Sullivan, 2013). However, Redington (2008) argues that engaging student teachers in these processes without proper feedback and intervention from lecturers may produce unwarranted results. Hence he suggests that lecturers should plan for effective ways to provide student teachers with feedback that would scaffold mathematical and pedagogical knowledge construction. I agree with Redington (2008) that it is important for initial teacher education to ensure that the new knowledge constructed is solid and student teachers are confident about their pedagogical skills.

### **2.2.7 STUDENT TEACHERS' PERCEPTIONS ABOUT MATHEMATICAL AND PEDAGOGICAL KNOWLEDGE**

Literature reveals that some student teachers enter initial teacher education with preconceived and negative ideas about mathematics content and pedagogical knowledge from their school years (Kleickmann et al. 2013; Nason et al. 2012). However, in South Africa it is documented that student teachers' perceptions about mathematics content and pedagogical knowledge turn out to be positive during their initial teacher education programme especially in their mathematics modules (Botha, 2012).

Burton (2012) conducted a study in one initial teacher education institution in southeastern United States to investigate student teachers mathematics perceptions before and after their module on mathematical pedagogy. The findings revealed that the strategies that were used such as discussions, reflection and investigation changed student teachers' perception from being negative to positive. Furthermore student teachers revealed that they feel confident as their mathematics content and pedagogy knowledge increased during their initial teacher education programme Burton (2012).

This view is corroborated by the studies of Henderson and Hudson (2010); Rosas and West (2011) and they further state that student teachers' content and pedagogical knowledge increases when they are engaged in activities that promote problem solving. They emphasise that student teachers gain adequate confidence to teach mathematics as they investigate; learn different teaching and learning strategies; communicate and reflect on their practices and construct new mathematical knowledge.

### **2.3 INITIAL TEACHER EDUCATION PROGRAMMES**

Initial teacher education provides student teachers with formal learning opportunities to acquire content knowledge and pedagogical content knowledge (PCK) (Kleickmann et al. 2013; Nason et al. 2012). Therefore, student teachers often enter initial teacher education with different beliefs, misconceptions, insufficient and disjointed content knowledge and PCK from their schooling years (Botha 2012; Kleickmann et al. 2013; Nason et al. 2012; Rowland et al. 2010, Tatto et al. 2012). Student teachers beliefs may include: beliefs about nature of mathematics, beliefs about learning mathematics and beliefs about their mathematics achievement (Botha, 2012; Tatto et al. 2008).

According to Kleickmann et al. (2013) student teachers' beliefs, content knowledge and misconceptions about the teaching and learning of mathematics acquired during their schooling years may impact on how they respond to their learners' mathematics conceptions. Hence, Nason et al. (2012) emphasise that it is important that initial teacher education programmes should try and rectify student teachers' mathematics misconceptions, beliefs and content knowledge through lectures, workshops, teaching practice and collaboration with peers. Therefore, it is important

for initial teacher education programmes to use a constructivist approach to change student teachers' beliefs (Nason et al. 2012).

The constructivists believe that student teachers have preconceived knowledge and experiences about mathematical pedagogies and then, they endeavour to make sense of their experiences by connecting their previous knowledge with the latest acquired knowledge in order to construct their new knowledge (Van de Walle et al. 2013). Additionally, Nason et al. (2012) argue that the application of constructivist principles instil anxiety and doubt on student teachers with insufficient mathematics pedagogy content knowledge (MPCK).

Student teachers who lack mathematical and pedagogical content knowledge (MPCK) tend to use traditional teaching methods which include presenting lessons in a lecture format, repetition and rehearsal of concepts and procedures (Murphy, 2012:188). However, student teachers with deep mathematical knowledge utilise inquiry-based learning approaches to reflect, collaborate, investigate and communicate to construct new MPCK.

Hence, Beers and Davidson (2009:521) emphasise that initial teacher education mathematics modules should be based on the “constructivist philosophy” of learning that supports active learning strategies. This means that initial teacher education mathematics modules should allow student teachers to conduct mathematical investigations, ponder, struggle, communicate their mathematical thinking and reflect on their prior knowledge for them to acquire new MPCK (Stigler & Hiebert, 2009). For this reason, I agree with I'mre and Akkoç (2012) that initial teacher education should provide student teachers with sufficient MPCK for them to be confident and effective teachers.

Many critics assert that profound MPCK have an influence on teachers' instructional practices, learners learning success and promote effective teaching and learning (Hsieh et al. 2012; Kleickmann et al. 2013; Walshaw, 2012). Hill et al. (in Murphy, 2012) indicate that effective teaching is influenced by “how to teach” and not by the knowledge of the mathematical content. This suggests that student teachers' mathematics content knowledge should be supported with the skills and knowledge to impart that knowledge to learners. That is why Walshaw (2012) and Kleickmann et al. (2013) emphasise that comprehensive MCK is a “prerequisite” for determining

learners' conceptual understanding. Conceptual understanding refers to the knowledge of mathematics concepts and operations symbols like addition, subtraction, multiplication and division. I therefore agree with Newton et al. (2012) that initial teacher education should prepare student teachers to have a deep understanding of the mathematics for effective teaching and learning. It is therefore important, to understand what comprises mathematics content knowledge.

Literature indicates that initial teacher education programmes play a vital role in the process of preparing student teachers for teaching and learning FP mathematics (Ford & Strawhecker, 2011; Mohan, 2012; Tatto et al. 2012). Student teachers acquire skills such as mathematics instructional approaches, mathematics knowledge, knowledge of learners, knowledge of the curriculum and professionalism required for teaching and learning (Hill et al. 2008) through co-operative teaching, classroom observation and practice teaching (König & Blömeke, 2012). In this study, the initial teacher education programme is viewed as the foundation of teacher knowledge with the emphasis on knowledge “acquisition and transformation” of the MCK and MPCK (Botha, 2012; Shulman, 1987).

Furthermore, Matthews et al. (2010) postulate that initial teacher education programmes should educate student teachers to teach FP mathematics in reformed based pedagogies that involve inquiry-based learning and problem-solving. McCrory and Cannata, (2011) caution that, student teachers who are passive recipients of mathematics knowledge tend to lack confidence and conceptual understanding. Hence, Livy and Vale (2011) suggest that initial teacher education should educate student teachers to reflect, communicate, recognise and correct mathematical errors and misconception during lectures to enhance their content knowledge. Shulman (2000:133) emphasises that collaborative learning which involves “co-operative learning, reciprocal teaching, learning communities” help student teachers to change their misconceptions in their prior knowledge through reflection, transmission and imparting ideas to construct new knowledge about the teaching and learning of FP mathematics pedagogies. This means that initial teacher education should allow student teachers to scaffold each other through communication and discussions to construct FP MPCK (Inoue, 2009).

It is important to note that the construction, quality and regulation of initial teacher education programmes differ across institutions and countries with regards to

quality and philosophy (Tatto et al. 2012; Thanheiser et al. 2010). The standard and quality of initial teacher education as well as FP mathematics programme is of immense concern in South Africa and internationally (Benken & Brown, 2008; Botha, 2012; Isiksal, Koc, Bulut & Atay-Turhan, 2007; Tatto et al. 2012). To ensure the best quality and standard of the initial teacher education programme, the International Association for Evaluation of Educational Achievement (IEA), Teacher Education and Development Study in Mathematics (TEDS-M) indicate that different countries employ government or independent organisations to evaluate and to regulate teacher education programmes and qualifications offered at their institutions (CHE, 2010, Tatto et al. 2012).

➤ **Quality Regulations in South Africa: The Minimum Requirements for Teacher Education Qualifications**

In South Africa, the Minimum Requirements for Teacher Education Qualifications (MRTEQ) policy prescribes quality and design in order to strengthen the capacity of the higher education system and to prepare more and better trained FP teachers (DHET, 2011; Schäfer & Wilmot, 2012). The MRTEQ policy provides clear guidelines with regards to the construction of initial teacher education programmes and the quality of teachers to be produced (DHET, 2011). This policy is grounded on the Higher Education Qualification Framework (HEQF). The HEQF policy incorporates all higher education qualifications into the National Qualifications Framework (NQF) and provides the standards for qualifications design (DHET, 2011). However, HEQF and NQF do not form part of this study. It is important to mention that the MRTEQ policy presents guidelines on the types of knowledge that strengthen teachers' practices, and provides standards for the construction of initial teacher education programmes. The standards are stipulated as follows:

- It describes the knowledge mix appropriate for teacher qualifications;
- It sets minimum and maximum credit values for learning modules leading to qualifications in terms of the knowledge mix and different levels (DHET, 2011:7).

Furthermore, the MRTEQ document describes requirements for the design of initial teacher education programmes. It stipulates that they should;

- be clear, specific requirements for the development of learning programmes, as well as guidelines regarding practical and work-integrated learning (WIL) structures;
- allow for institutional flexibility and discretion in the allocation of credits within learning programmes, and encourages teacher educators to become engaged with curriculum design, policy implementation and research;
- require all teacher education programmes to address the critical challenges facing education in South Africa today especially the poor content and conceptual knowledge found amongst teachers, as well as the legacies of apartheid, by incorporating situational and contextual elements that assist teachers in developing competences that enable them to deal with diversity and transformation (DHET, 2011:9-10).

Researchers (Hill, 2010; Hill et al. 2008; Rowland et al. 2010; Shulman, 1987) agree with the standards stipulated by the MRTEQ policy, that the knowledge mix for the construction of FP initial teacher education programme should include MCK, for this study. It is referred to as (disciplinary learning), MPCK (pedagogical learning), work-integrated learning (practical learning), information and communication technologies (fundamental learning) and situational learning (Hill et al. 2008; Shulman, 1987). The knowledge mix for the construction of initial teacher education is discussed in the conceptual framework.

In South Africa student teachers are required to achieve a four-year degree course (B.Ed.) at a university to be recognised and registered as qualified teachers (DHET, 2011). However, initial teacher education institutions have the flexibility to design their own programmes. That is why FP teacher education programmes in South Africa differ in terms of mathematics content and pedagogical knowledge (HSRC, 2006). In order to change the disparity in the construction of mathematics modules in the initial teacher education programmes, Tatto et al. (2010:314) suggest that initial teacher education institutions should collaborate with each other. They argue that should initial teacher education institutions work together to design mathematics modules these would strengthen the programmes and prepare teachers who are capable to compete globally.

This study intends to explore how lecturers plan and prepare for FP mathematics pedagogy in initial teacher education programme.



### **2.3.1 LECTURERS PLANNING AND PREPARATIONS FOR MATHEMATICAL PEDAGOGY**

There is limited literature on how lecturers both in South Africa and internationally plan and prepare to teach FP phase mathematics student teachers during initial teacher education programmes (Berk & Hiebert, 2009). However, Fuentes, (2011) points out that lecturers consult various mathematics text and resources to purposefully plan for mathematical content and pedagogical aspects that student teachers should acquire during their initial teacher education programme. Lecturers also plan for the instructional strategies to teach different mathematical content and pedagogy (Ball et al. 2009).

McCrary and Cannata (2011) indicate that most lecturers in the study they conducted, use textbooks and other lecturers compile their own resources. They posit that appropriate and quality textbooks provide student teachers with content and pedagogical knowledge for the different mathematical concepts.

For this reason it is important to explore what material lectures use in their mathematics content modules in the initial teacher education programmes.

### **2.3.2 MATHEMATICS CONTENT KNOWLEDGE MODULES IN THE INITIAL TEACHER EDUCATION PROGRAMMES**

Research indicates that the structure, percentage and sequence of content modules differ across institutions and countries (McCrary & Cannata, 2011). Matthews et al. (2010) and Thanheiser et al. (2011) maintain that various initial teacher education programmes prepare student teachers with mathematical content knowledge that is taught to learners in the FP classrooms, namely; numbers and operation, geometry, measurement, probability and statistics. In the study conducted by McCrary and Cannata (2011:33) in the United States, numbers, operations and relationships serve as the main content for mathematics module presented to student teachers as these areas embrace 51% of mathematics content. The second mathematical content area as in McCrary and Cannata study include geometry and measurement. The content course is presented in the traditional way, through lecturer's presentation for fourteen weeks.

Similarly, in Spain, Ruiz, Molina, Lupianez, Segovia, & Flores, (2009:432) reveal that numbers, operations and relationship occupy 50% of the content module with the main focus on number sense. The lecturer in Spain facilitates learning, “models and scaffolds” student teachers to improve conceptual understanding for twenty one weeks of their academic year. From these studies conducted from United States and Spain, it is evident that number, operations and relationships are the main content and it is similar to the FP mathematics school curriculum. However, they differ with regards to the teaching approaches and duration of the contact time. These aspects are important for this study because it provides the basis to understand the impact of the duration and instructional approaches utilised in two initial teacher education programmes.

I therefore agree with Ruiz et al. (2009) that the acquisition and transformation of content knowledge should be an active and continuous process where the lecturer facilitates, models and scaffolds student teachers. Furthermore, student teachers should be engaged in the pedagogical reasoning and action process to construct mathematical pedagogies (Bernstein, 2000; Shulman, 1987). Hill (2010) agrees with Rowland et al. (2010) that the focus of mathematics content module should promote conceptual understanding of mathematics and mathematical skills processes. Conceptual understanding is an essential knowledge for understanding the procedures, principles, meanings, recognising connections among mathematical ideas and number relationships in the teaching and learning of FP mathematics (Kilpatrick et al. 2001; Van de Walle et al. 2013).

Literature suggests that for effective mathematics teaching and learning, student teachers should possess mathematical knowledge and reasoning that surpass that of learners (Hill et al. 2008; Markworth, Goodwin & Glisson, 2009; Suzuka, Sleep, Ball, Bass, Lewis & Thames, 2009). Additionally, they emphasise that teachers’ MCK determines learners learning. Insufficient MCK of the teacher increases poor performance and quality of classroom mathematics (Ma, 1999; Henderson & Rodrigues, 2008; Zazkis, Leikin & Jolfaee, 2011). I therefore, support Smith, Swars, Smith, Hart, & Haardörfer, (2012) idea that initial teacher education mathematical content module should prepare student teachers with deep mathematics conceptual understanding, knowledge to engage all learners and cater for different learners’ learning needs. In this study the views of lecturers and student teachers regarding

mathematics conceptual understanding will be explored. For this reason it is important to understand how initial teacher education programmes curricula their pedagogical and content knowledge modules.

### **2.3.3 MATHEMATICS PEDAGOGICAL MODULES IN THE INITIAL TEACHER EDUCATION PROGRAMMES**

Zaskis and Zaskis (2010:248) state that the pedagogical module comprises of the combination of pedagogy, research, theories of learning and teaching, curriculum and mathematical content knowledge. The pedagogical module develops student teachers' understanding of how children learn various mathematical concepts and skills to teach mathematical ideas to learners (Ford & Strawhecker, 2011). The pedagogy module is delivered to student teachers in reformed based methods, including; lecture, student presentations, video presentations, small group work, and whole group discussions (McCrary & Cannata, 2011). Fuentes (2011:2) investigated strategies that simulated the teaching of mathematics like in a real FP classroom. Student teachers were given instructions to solve mathematical problems without using familiar procedures of problem solving. Student teachers had to think of new strategies to solve mathematical problems using mathematics resources provided to them. They had to investigate, communicate their findings in small groups and whole-class discussions with much emphasis on logic and reasoning in doing mathematics during mathematical method course contact time. This caused frustration and cognitive imbalance to student teachers as the teaching approach was new to them. It is important also for student teachers when they construct new knowledge that they should reflect critically on their shortcomings, share with their peers and to help each other for better understanding (Shulman, 2000).

In Rowland et al. (2010:32) lecturers were challenged by some of the strategies that student teachers invented, because it is important for student teachers to learn to think independently. This implies that student teachers will learn how to respond to FP learners ideas that are not planned for. It is therefore essential that student teachers bridge the gap that exists between their content and pedagogy modules by practising the new strategies during their teaching practice at schools for them to be effective teachers (Ford & Strawhecker, 2011; Hart & Swars 2009; Ruiz et al. 2009; Totto, Lerman & Novotna, 2010).

#### **2.3.4 TEACHING PRACTICE WITH REGARD TO FOUNDATION PHASE MATHEMATICS**

Literature indicates that teaching practice experience is a fundamental component of the initial teacher education programme (Amin & Ramrathan, 2009; Botha, 2012, DHET, 2011; Mutemeri & Chetty, 2011). Teaching practice provides student teachers with the experience in an authentic teaching and learning environment (Kiggundu & Nayimuli, 2009). Teaching practice involves work-integrated learning (WIL) that is, learning from practice and learning in practice (Cheng, Cheng & Tang, 2010; DHET, 2011). For this study, learning from practice means observing and reflecting on FP mathematics lesson presented by others like a mentor teacher in a real classroom setting. Coffey (2010) and Akkoç and Yaşildere, (2010) point out that observation and reflection increase student teachers' content knowledge, mathematics teaching and learning strategies, knowledge about teaching diverse learners and teaching and learning in different contexts. Learning in practice includes aspects such as student teacher's processes of planning, critical preparations, interpreting and analysing mathematical texts, selecting instructional techniques and strategies, examples and explanations appropriate for mathematics lesson to be presented.

However, Kiggundu and Nayimuli (2009:345) caution that teaching practice can be weakened by various impediments including, the quality of the teachers' mathematical knowledge, lack of mathematics teaching and learning resources and the geographical distance. They point out that geographical distance between the initial teacher education institution and the schools where student teachers go for their teaching practice sometimes deny student teachers effective feedback on their mathematics practices. Hence, Mutemeri and Chetty (2011) suggest that initial teacher education institutions and schools should collaborate and share, publicise good practice, develop and utilise new research regarding teaching and learning of mathematics and lastly plan and develop the programme as a collective.

With regards to student teachers' placement in schools for teaching practice, DHET (2011) and Rots, Kelchtermans, & Aelterman, (2012) emphasise that placement should be in a functional school. A functional school is a school which provides student teachers with the opportunity to observe and learn from effective mentor teachers that can teach mathematics (Van de Walle et al. 2013). Butler and Cuenca

(2012:296) believe that a mentor teacher is an “instructional coach, emotional support system, and a socialising agent” that offers student teachers with mathematical content knowledge, PCK, curriculum knowledge, different teaching approaches, practical and structural guidance. I’mre and Akkoç (2012) support this assertion by saying that mentor teachers should guide and support student teachers by modelling best practice in mathematics classrooms. Furthermore mentor teachers and lecturers play an essential role to assess student teachers with the intention to scaffold and support them with mathematical and pedagogical knowledge during teaching practice (DHET, 2011) I therefore agree that the process of WIL that includes observation and reflection in an effective school, and an effective mentor teacher who has a solid content knowledge and PCK, increases student teachers pedagogical content knowledge (Butler & Cuenca, 2012; I’mre & Akkoç, 2012).

Research reveals that teaching practice duration is structured differently across initial teacher education institutions and countries (Tatto et al. 2012). In South Africa, DHET (2011) stipulates that the minimum duration of teaching practice or school-based WIL should be twenty weeks and maximum of thirty two weeks over a period of a four-year programme and a maximum of twelve-weeks is compulsory to be spent in schools. In the study conducted by Brown, Westenskow and Moyer-Packenham (2012) in USA, teaching practice is scheduled for five weeks while in Spain it is allocated seven weeks (Ruiz et al. 2009). These facts support the findings of Tatto et al. (2012) that indicate that literature is not conclusive on the duration that student teachers should spend in practice. However, Mutemeri and Chetty, (2011) emphasise that the longer student teachers are placed in an effective and functional school the more effective the student teacher develops with regards to pedagogical content knowledge. Henceforth, it is important to explore student teachers’ experiences during teaching practice and its contribution towards their construction of how mathematics should be taught in schools.

## **2.4 STUDENT TEACHERS’ EXPERIENCES IN FOUNDATION PHASE MATHEMATICS**

It is essential for this study to understand the experiences of student teachers before and during the mathematics teacher programme. Recent research indicates that student teachers enrol for the FP initial teacher education programme with

preconceived beliefs about mathematics and mathematical pedagogy (Briley, 2012; Holm & Kajander, 2012; Newton et al. 2012; Smith et al. 2012). They also experience anxiety with regards to both the action of teaching and then to top it all of the subject maths per se due to their negative perceptions of what they experienced at school level (Brown et al. 2012). Anxiety of Mathematics is described as an “individual’s internal lack of mathematics content knowledge or confidence, whereas mathematics teaching anxiety reflects how an individual measures her/his ability to communicate with and engage children in mathematics interactions” (Brown et al. 2012:367).

Researchers and critics indicate that beliefs influence teachers’ views, actions, the teaching and learning approach and the use of curriculum materials (Behm, 2008; Briley, 2012; Castro, 2006; Holm & Kajander, 2012; Newton et al. 2012; Philipp, 2007; Remillard, 2005). Hence, Smith et al. (2012) suggest that student teachers’ beliefs on what and how they learn mathematics should be the main ‘targets’ of change during initial teacher education programme. However, Van de Walle et al. (2013) emphasise that change may be achieved only when student teachers are persistent in trying to understand mathematics, have positive attitude towards learning, be ready to change and reflect on their practices during initial teacher education mathematical programmes. Subsequently I discuss student teachers’ perception about mathematics content and pedagogy knowledge during initial teacher education programme.

#### **2.4.1 CURRICULUM KNOWLEDGE AND INTERPRETATION IN FOUNDATION PHASE MATHEMATICS**

The curriculum is a plan that teachers utilise as the foundation of their lessons and it involves knowledge of the content and pedagogy (Lattuca & Stark, 2009). For the purpose of this study curriculum knowledge is an essential component of teaching and learning. It involves comprehension of mathematical content and pedagogical knowledge (Shulman, 1987).

The study conducted by Wilson and McChesney (2010) in New Zealand reveals that student teachers do not have adequate knowledge to develop and interpret the curriculum. They indicate that student teachers rely on the curriculum documents provided by the Ministry of Education to determine what to teach and how to teach

the mathematical content to learners. They further assert that student teachers mentioned that engaging with the curriculum document increased their mathematical content and pedagogical knowledge.

In South Africa the new curriculum CAPS is perceived differently by FP student teachers. Some student teachers welcome CAPS and respond to it positively; they indicate that it has reduced their workload in terms of administration, planning and preparation of lessons and they can focus on the teaching and learning of mathematics (Makeleni & Sethusha, 2014). However, in the study conducted by Fang and Clarke (2014) it was evident that not all teachers are happy with CAPS. Participants in Fang and Clarke (2014) mention that CAPS is “content-orientated” and too many concepts are being introduced simultaneously. For this reason teachers teach mathematics through the traditional teaching approach in order to cover and complete the prescribed content as per the work schedule provided by CAPS in preparation for tests (Moodley, 2013). Therefore, learners experiencing mathematical learning difficulties are left behind with no support from their teachers (Harrop-Allin & Kros, 2014). Teachers point out that they are denied the opportunity to apply their professional judgement in terms of repeating or revising concepts to emphasise, teach for understanding and to promote inclusive education (Ramatlapana & Makonye, 2012). It is therefore imperative for initial teacher education to ensure that student teachers are familiar with the FP curriculum and are able to teach mathematics to learners experiencing mathematical learning difficulties.

#### **2.4.2 KNOWLEDGE TO TEACH MATHEMATICS TO LEARNERS EXPERIENCING MATHEMATICAL LEARNING DIFFICULTIES**

Landsberg et al. (2011) value programmes that accommodate diversity in teaching, especially in identifying and supporting learners experiencing mathematical learning difficulties. It is argued that all children can learn mathematics with relevant and appropriate support (DoE, 2001; Landsberg et al. 2011). This view is embedded in the United Nations Educational, Scientific and Cultural Organisation (UNESCO) (1994:6) that recommended the establishment of inclusive education systems that embrace and accommodate all children irrespective of their “physical, intellectual, social and emotional” status. In 2001 the Department of Education in South Africa pursued the establishment of an inclusive education and training system (DoE,

2001). It is therefore essential to understand the role of the initial teacher education programme in educating and changing student teachers perceptions with regards to learners experiencing mathematics difficulties.

The findings of the survey conducted by Hemmings and Woodcock (2011) in an Australian initial teacher education institution reveal that student teachers in this study feel inadequately prepared to teach in diverse educational environments. These student teachers expressed their concerns regarding the availability of physical and human resources. It is further pointed out that the more student teachers gain knowledge about learners experiencing learning difficulties in education, the more anxious they become. This supports the research conducted by Forlin and Chambers (2011). Sharma, Forlin and Loreman (2008) and Oswald and Swart (2011) responded to these concerns and stated that student teachers should be in contact with learners with disabilities and be supported with more lessons to boost their confidence about inclusive education and teaching diverse learners. They argue that student teachers' exposure to learners with varying disabilities in the same classroom may positively change their views about inclusive education. Furthermore, Baglieri (2008) suggests that in order to enhance student teachers' pedagogical knowledge, they should be provided with opportunities to reflect and communicate their prior knowledge and make connections to their newly acquired knowledge about disabilities during their teaching practice.

#### **2.4.3 STUDENT TEACHERS' TEACHING PRACTICE EXPERIENCES IN FOUNDATION PHASE MATHEMATICS**

Teaching practice should expose student teachers to a real teaching and learning context (Kiggundu & Nayimuli, 2009). However, some student teachers revealed that they experienced various challenges during their teaching practice. In South Africa Maphosa, Shumba and Shumba (2007) pointed out that due to shortage of teachers in some schools and teachers taking various types of leaves, they were expected to manage classrooms on their own without supervision. It was clear that this increased their workload as they were now expected to plan and prepare lessons daily as well as to complete their own assignments from their institutions. Furthermore, it was disclosed that mentor teachers denied some student teachers the opportunity to teach and they only observed throughout their teaching practice. These student teachers indicated that they felt ignored and left behind as they were



not learning the skills of teaching from their mentors as expected (Heeralal & Bayaga, 2011; Maphosa et al. 2007).

The studies conducted by Hudson and Hudson (2007); Mukeredzi and Mandrona, (2013) revealed that mentor teachers inadequately prepared student teachers with regards to pedagogical knowledge which involved the teaching and learning of mathematics using different teaching strategies such as problem-solving and assessment. Student teachers indicated that their mentor teachers did not involve them in the planning of these mathematics pedagogical aspects. That is the reason why Maphosa et al. (2007) caution that if student teachers are not guided and mentored properly during their teaching practice then the process of teaching practice is defeated. Hence it is essential that mentor teachers are adequately prepared to pass their knowledge and skills with clear guidance and collaboration with the initial teacher education institutions (Hudson & Hudson, 2007).

According to Fang and Clarke (2014) evaluation of student teachers practical teaching skills is essential. However, student teachers expressed their frustration of the fact that due to lack of pedagogical lecturers, student teachers are sometimes evaluated by supervisors without the relevant experience. This leads to poor feedback to student teachers pertaining to mathematical pedagogy knowledge they should acquire during their teaching practice. Therefore, I suggest that it is important for the B.Ed. FP programme that it should provide student teachers with effective feedback to increase their mathematical content and pedagogical knowledge.

The next section will focus on the conceptual framework that underpinned this study.

## **2.5 CONCEPTUAL FRAMEWORK**

### **2.5.1 DEVELOPMENT OF CONCEPTUAL FRAMEWORK**

After careful analysis mentioned earlier in this chapter, it became evident that the integrated relationship between the types of learning knowledge and pedagogical reasoning and action process are important for this study. The abovementioned phenomena are regarded paramount for the construction of FP mathematical

pedagogy in the initial teacher education programme and embedded in the conceptual framework of this study.

The conceptual framework is regarded as essential, because it will guide the development of the research questions, regulate the data collection strategies and assist in the interpretation of the results of this study (McMillan & Schumacher, 2010). The conceptual framework of this study (FP mathematics pedagogical knowledge construction framework) is drawn from the theories of Bernstein's ideas (2000) of pedagogical practices and Shulman's (1987) pedagogical reasoning and action process in conjunction with the types of learning knowledge as prescribed in MRTEQ (DHET, 2011). The integration of the different types of learning knowledge the process of pedagogical reasoning and action are regarded as important in the construction of FP mathematics pedagogical knowledge during initial teacher education programmes (DHET, 2011:10). The two theories are subsequently discussed.

#### ➤ **Bernstein's Theory**

Bernstein's theory of pedagogical practices focuses on the re-contextualisation process which comprises of acquisition and transmission of knowledge. The re-contextualisation process involves the 'what', for example, FP mathematics content or curriculum and the 'how' which directs the selection of appropriate instructional approaches for teaching different topics. For Bernstein (1990:185), "the re-contextualisation rules regulate not only selection, sequence and pace, but also how instruction should be imparted to learners".

For this reason, this study concentrates on how two initial teacher education programmes select, sequence and pace FP mathematics content and pedagogy modules. The focus is also on instructional approaches used to teach student teachers with the teaching and learning of mathematics in different context. The MRTEQ document provides knowledge mix appropriate for FP phase student teachers and PCK is related to the re-contextualisation rules and processes of Bernstein's theory.

#### ➤ **Shulman's Theory**

Shulman's (1987) theory presents the seven categories of knowledge base for teaching and the process of pedagogical reasoning and action. The knowledge

base for teaching (types of learning knowledge) as referred to in this study comprise of different knowledge types that provide different skills. The types of knowledge include disciplinary knowledge, mathematics pedagogical knowledge, mathematics language of teaching and the skills to transpose mathematics content knowledge effectively to promote learners conceptual understanding. It is assumed that for student teachers to construct FP mathematical knowledge during initial teacher education programmes, an integrated and a continuous pedagogical reasoning and action process should be implemented. Shulman's (1987) pedagogical reasoning and action process and Bernstein's (2000) pedagogical practices emphasise that student teachers should interact and critically reflect on their practices to construct new knowledge. Figure 2.1 below presents the conceptual framework diagrammatically, then a brief description thereof will follow.

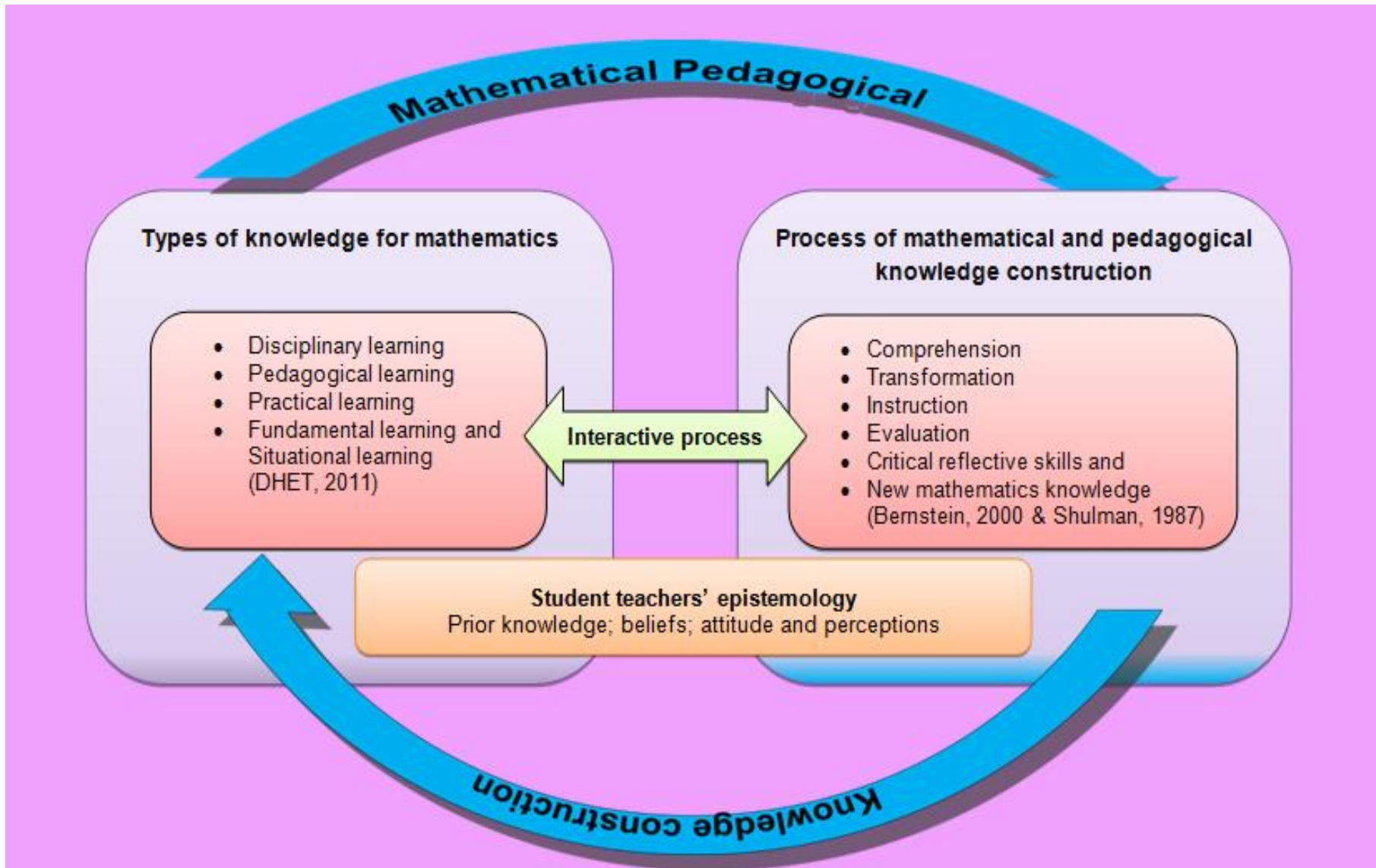


Figure 2.1: Conceptual Framework: Foundation phase mathematics pedagogical knowledge construction framework

Figure 2.1 illustrates the conceptual framework regarding the construction of FP mathematics pedagogical knowledge during B.Ed. initial teacher education programme.

The conceptual framework (figure 2.3) displays that student teachers enter the B.Ed. initial teacher education programme with different beliefs, attitude and perceptions about mathematical pedagogy. Literature suggests that student teachers' beliefs may influence how they construct mathematical and pedagogical knowledge during their B.Ed. initial teacher education programmes (see section 2.3). These beliefs are referred to as student teachers' epistemology in the framework.

The arrows in the framework indicate that the construction of FP mathematics pedagogy knowledge is a cyclical, interdependent and continuous process. The process comprises of the types of knowledge and the process and actions of FP mathematics pedagogical knowledge acquisition. The types of learning knowledge includes; disciplinary learning, pedagogical learning, practical learning, fundamental learning and situational learning that student teachers should acquire as they construct mathematics pedagogy knowledge. The process of mathematics pedagogical knowledge acquisition in (figure 2.3) portrays the actions and processes that student teachers should engage in, as they construct new mathematics pedagogical knowledge. These processes include; comprehension, transformation, instruction, critical reflective skills and new mathematics knowledge construction.

Below is a detailed discussion of FP mathematical and pedagogical knowledge construction conceptual framework. The discussion begins with student teachers' epistemology followed by the types of learning knowledge and lastly the process and actions of FP mathematics pedagogical knowledge acquisition.

### **2.5.1.1 Student teachers' epistemology**

The literature studied, provides axiomatic evidence that that student teachers' epistemology such as mathematics prior knowledge, socio cultural beliefs and perceptions about mathematics pedagogy knowledge are factors that may influence the construction of FP mathematics pedagogical knowledge (Botha, 2012;

Cakiroglu, 2008; Kleickmann et al. 2013; Nason et al. 2012). Cakiroglu, (2008) posit that the beliefs that the society holds about the teaching and learning of mathematics either positive or negative can influence how student teachers construct their mathematics pedagogy knowledge.

According to Chauma, (2012); Halai and Karuku, (2012) and Spaul, (2013) mathematics language of learning and teaching may contribute as well. Hence, it is essential that student teachers beliefs, prior knowledge and mathematics language should be considered during the construction of FP mathematics pedagogy knowledge and the different types of learning knowledge involved (Ryang, 2007).

### **2.5.1.2 The types of learning knowledge**

As indicated in figure 2.3, the types of learning knowledge include: disciplinary knowledge, pedagogical knowledge, practical learning, fundamental learning and situational learning. It is assumed that in order for student teachers to construct mathematics pedagogical knowledge, they should dispose of all the above-stated knowledge types. Student teachers should acquire disciplinary knowledge first as it deals with mathematics concepts, rules and procedures of doing mathematics (Hill et al. 2008). However, as it is indicated that the construction of FP mathematics pedagogical knowledge is an integrated process, student teachers should learn the skills to transmit their mathematics content knowledge effectively to learners. This type of knowledge is referred to as pedagogical knowledge and houses other knowledge types such as knowledge of learners, knowledge of the curriculum and knowledge of instructional approaches in the teaching and learning of mathematics. Student teachers should be provided with the opportunity to practise and observe practising teachers, teaching mathematics in the classrooms. As they observe they should reflect and change their preconceived beliefs about teaching and learning of mathematics in FP (Shulman, 2000).

In order for the student teachers to reflect effectively, they should have adequate mathematics language to express their mathematical ideas and this type of learning knowledge is known as fundamental learning (DHET, 2011). Moreover, student teachers should have the knowledge to teach mathematics in different contexts and to diverse learners in the conceptual framework. This type of learning knowledge is referred to as situational learning. That is why it is assumed that the construction of

FP mathematics pedagogical knowledge is an interconnected and continuous process that can change student teachers beliefs, attitude and perception about the teaching and learning.

### **2.5.1.3 The process of mathematical and pedagogical knowledge construction**

The process and action of mathematics pedagogical knowledge acquisition in (figure 2.3) defines the stages and actions that could affect how student teachers construct mathematics pedagogical knowledge (Kleickmann et al. 2013; Nason et al. 2012; Shulman, 2000). It is assumed that as student teachers are engaged in actions such as observation, discussions and critical reflection during their B.Ed. initial teacher education programme, they change their conceptions about mathematics pedagogical knowledge and construct new mathematics pedagogical knowledge (Botha, 2012; Fadde & Sullivan, 2013; Korthagen et al. 2006; Shulman, 2000).

Hence, construction of FP mathematics pedagogical knowledge should be seen as a cyclical, integrated and uninterrupted process. This process acknowledges student teachers beliefs and includes the different types of knowledge learnt and the process and actions of FP mathematics pedagogical knowledge acquisition. In this study these factors will be investigated to understand the process that two B.Ed. initial teacher education programmes consider in the construction of FP mathematics pedagogy.

## **2.6 CONCLUSION**

The initial teacher education programme is regarded as a stepping stone for student teachers with regard to the teaching and learning of FP mathematics. Student teachers learn different instructional techniques and strategies which facilitate learning to take place and provide opportunities for the attainment of knowledge, skills, methods and the nature of different social context (Machado & Botnarescue, 2011; Landsberg et al. 2011). Lecturers should model effective mathematics pedagogies through co-operative learning, communication and reflection (Shulman, 2000). Mathematics pedagogy should prepare student teachers who are competent in solving mathematical problems.

This study will add to knowledge in the construction of FP mathematics pedagogy in South African B.Ed. initial teacher education programmes. The conceptual framework employed the MRTEQ knowledge, Bernstein and Shulman's pedagogical reasoning and action process. The combination of the learning knowledge and pedagogical reasoning and action process helped me to understand the construction of FP mathematics pedagogy of two initial teacher education programmes in South Africa.

Chapter three provides a description of the research methodology used in this study.

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## CHAPTER THREE RESEARCH METHODOLOGY

### 3.1 INTRODUCTION

The previous chapter presented the review of the literature relevant to the study with the aim of understanding FP mathematics pedagogies presented to student teachers during initial teacher education programme. I critically investigated, interpreted and presented literature related to FP mathematics pedagogies, knowledge mix for the construction of FP mathematics pedagogies, knowledge mix for the construction of initial teacher education programmes, student teachers' beliefs and lecturers planning and preparation to teach FP mathematics pedagogies. The conceptual framework was developed, which outlines not only the knowledge mix for the construction of initial teacher education programmes, but also emphasises the pedagogical reasoning and action process essential for mathematics content knowledge and mathematics pedagogical content knowledge acquisition.

This chapter explores the research method and design for the data collection and analysis. I begin with the description of the research method, sampling procedure data collection and analysis and conclude the chapter with ethical considerations.

As I was seeking to understand the construction of FP Mathematics pedagogies through initial teacher education programmes, I used data collection instruments that yielded thick and detailed information regarding the topic under study. Lecturers were interviewed individually through open ended semi-structured interviews and student teachers through focus group interviews and I also examined supporting documents of two initial teacher education programmes with regard to their FP mathematics modules. Ethical considerations were adhered to, conforming to University of Pretoria procedures.

Table 3.1 is the diagrammatical presentation summary of the research methodology applied in this study.

**Table 3.1: Research Design and Methodology Overview** (Adapted from Mugweni, 2012:96)

<b>RESEARCH DESIGN</b>	<ul style="list-style-type: none"> <li>• Qualitative</li> <li>• Interpretive</li> <li>• Case study</li> </ul>
<b>DATA COLLECTION STRATEGIES</b>	<ul style="list-style-type: none"> <li>• Individual Semi-structured interviews</li> <li>• Focus group interviews</li> <li>• Document Analysis</li> </ul>
<b>TRANSCRIPTION</b>	<ul style="list-style-type: none"> <li>• Researcher</li> <li>• Participants</li> </ul>
<b>DATA ANALYSIS</b>	<ul style="list-style-type: none"> <li>• Codes</li> <li>• Themes</li> <li>• Categories</li> </ul>

### 3.2 RESEARCH METHODOLOGY

This study employed a qualitative research approach using a case study design within an interpretive paradigm (Maree, 2010). According to McMillian and Schumacher (2010), qualitative research involves face-to-face interaction between the researcher and participants. Hence, Merriam (2009) mention that in a qualitative research design the researcher is regarded as the main source for data collection and analysis. I therefore interviewed lecturers and student teachers in person to explore how two different initial teacher education institutions in South Africa construct FP mathematics pedagogies in their programmes to prepare student teachers to teach FP Mathematics (Creswell, 2012).

Furthermore, the qualitative research approach was utilised because it allows for, and present an in-depth, rich and descriptive data about the experiences and views of lecturers and student teachers regarding the phenomenon under study and not to validate my own assumptions (Creswell, 2012). However, Yin (2011:7) defines qualitative research with the following five characteristics:

1. Studying the meaning of people's lives under real-world conditions;
2. Representing the views and perspectives of participants in the study;
3. Covering the contextual condition within which people live;
4. Contributing insight into existing or emerging concepts that may help to explain human social behaviour; and
5. Striving to use multiple source of evidence rather than relying on a single source alone.

I attempted to investigate the two lecturers and twelve student teachers' experiences in their natural setting. Interviews were conducted at the lecturer's offices and student teachers in the meeting rooms of their institution (Merriam, 2009). I tried to gain a "deeper understanding" of the instructional practices employed in the teaching and learning of FP mathematics (Nieuwenhuis, 2007:75). Additionally, I used multiple sources such as data, semi-structured interviews with lecturers, focus groups with student teachers and document analysis to investigate and understand the processes and views of lecturers and student teachers with regards to the teaching and learning of FP mathematics pedagogies in the initial teacher education programme. The following research questions guided this study:

### **Main research question**

How do Foundation Phase initial teacher education programmes prepare student teachers to teach foundation phase mathematics?

### **Secondary Research questions**

1. How do Foundation Phase student teachers perceive their mathematics modules in their teacher education programme?
2. What are the roles of mathematics language of learning and teaching in the construction of Foundation Phase mathematics pedagogy?
3. What factors influence the construction of Foundation Phase mathematics pedagogy during initial teacher education programme?

#### **3.2.1 INTERPRETIVE PARADIGM**

According to Denzin and Lincoln (2011) and Maree (2010) a paradigm involves the beliefs that the researcher holds. This suggests that the researchers' "beliefs about the nature of reality (ontology)", the "relationship about the inquirer and the known (epistemology)" and the methodologies for acquiring "knowledge about the world" is subjective to the researcher (Denzin & Lincoln, 2011:91; Maree, 2010:47). It is therefore important to acknowledge that the investigation of this study was influenced by my beliefs and experience in the teaching and learning of FP mathematics. This study therefore followed the interpretivist paradigm.

The interpretivist paradigm was selected because it attempts to understand the phenomena through the meanings that lecturers and student teachers assign (Maree, 2010:59). The interpretivist qualitative methodology allowed lecturers to present their version with regard to the construction of FP mathematics pedagogies and student teachers representation of their experience with respect to FP mathematics programme (McMillan & Schumacher, 2010). During the interview process, participants were not curbed or marginalised in sharing their experiences. This was done in order to understand the topic under study through the participants' own lenses (Creswell, 2012). I utilised a qualitative case study design for this study with two FP mathematics lecturers and six final year B.Ed. student teachers from each institution. FP student teachers in the two initial teacher education institutions explained their experiences with regard to FP mathematics initial teacher education programme (De Vos, Strydom, Fouché & Delpont, 2011).

In order to understand and to create meaning of lecturers and student teachers' experiences, the qualitative research design allowed me to investigate using a variety of methods until 'deep understanding' was achieved (Merriam, 2009:6-8; McMillan & Schumacher, 2010:19). I employed a multiple case study design to collect data through individual semi-structured interviews, focus-group interviews and document analysis (Merriam, 2009). The multiple data collection strategies from the lecturers and student teachers was used to understand how FP mathematics initial teacher education programmes prepare student teachers to teach FP mathematics (McMillan & Schumacher, 2010).

### **3.3 CASE STUDY RESEARCH DESIGN**

I employed a qualitative multiple case study design to collect and analyse data. A case study is a "systematic inquiry" into an event or set of related events which aims to describe and explain the phenomenon of interest (Nieuwenhuis, 2007:75). For this study, case study research design was utilised to understand lecturers and student teachers' subjective reality and experiences in the teaching and learning of FP mathematics during initial teacher education programmes (Maree, 2010; Merriam, 2009). The case study design enhanced an in-depth investigation of a bounded system involving triangulation of data techniques, namely; individual semi-structured interviews, focus-group interviews and document analysis (Creswell, 2012:465). Triangulation was used to provide a thick description of how two initial

teacher education programmes construct FP mathematics pedagogies and on the experiences of FP mathematics student teachers (Merriam, 2009; McMillan & Schumacher, 2010).

The purpose of this study was to gain insight into the construction of FP mathematics pedagogies through initial teacher education programmes; hence, the case study was appropriate notwithstanding the fact that the results are not generalisable (Nieuwenhuis, 2007:76). The multiple case study design was used to identify commonalities and differences (McMillan & Schumacher, 2010) in the two FP Mathematics programmes. Furthermore, the multiple case study method helped me to understand the experiences and challenges (Cohen, Manion & Morrison, 2004) experienced by lecturers and student teachers in the FP mathematics programmes.

### **3.4 SAMPLING PROCEDURE**

This study adopted purposeful sampling to select two FP mathematics lecturers, twelve final years FP B.Ed. student teachers, six from each initial teacher education institution (Cohen et al. 2004; Creswell, 2012). I purposefully selected these participants because of their knowledge and experience in FP initial teacher education programmes (Merriam, 2009). The sample provided for in-depth investigation and a comprehensive knowledge of the construction of FP mathematics pedagogies in the initial teacher education programmes (Leedy & Ormrod, 2005). Furthermore, when selecting participants, the sample size was not statistically determined as the purpose was to gather thick and rich data and not for generalisability (Merriam, 2009). The sample was also selected based on practicability as the total coverage of all initial teacher education institutions in South Africa was not feasible for this study (De Vos et al. 2011).

The sample was selected based on the following characteristics:

- (a) The sample represented two geographically diverse institutions (rural and urban area).
- (b) Both institutions foundation phase programmes are fully accredited by the Council of Higher Education.
- (c) Final year B.Ed FP student teachers.

- (d) Both lecturers and student teachers agreed that they would voluntarily participate in this study.
- (e) Both FP programmes offer mathematics pedagogy module as compulsory for all their student teachers.

The participants in this study included a male lecturer, a female lecturer and twelve final years B.Ed. FP student teachers, males and females with an age range of 21 to 29 years of age. The sample was selected because of their knowledge and experience of FP mathematics in the initial teacher education programme from different context and hence, they formed a unit of analysis (Babbie, 2007). The participants were chosen to increase variance whereas keeping the size of the study manageable (Creswell, 2012).

### 3.4.1 RESEARCH SITE SELECTION

As indicated earlier that the sample is purposefully selected, the two cases selected offer the B.Ed. FP programme and obtained full accreditation status from the Council on Higher Education review committee, the Higher Education Quality Committee (HEQC), (CHE, 2010). The HEQC evaluated initial teacher education institutions for quality purposes. The two sites selected complied with all the requirements of the review committee and managed to exceed the minimum requirement standards stipulated by the HEQC for “good practice and innovation” (CHE, 2010: viii). See detailed description of the sites in Chapter Four.

The sites are presented as (urban and rural) institutions. I deliberately selected these sites to understand how initial teacher education institutions in two different contexts in South Africa construct FP mathematics pedagogies in their programmes. Table 3.2 presents the summary of participants.

**Table 3.2: Summary of participants**

Institution	Participants	Gender
Urban University	Lecturer	Male
	Six student teachers	Females
Rural University	Lecturer	Female
	Six student teachers	Three females and three males

### **3.5 ASSUMPTION OF THE STUDY**

The main assumption of this study is that the initial teacher education programme involves student teachers in an on-going and integrated process of mathematics content knowledge and mathematics pedagogical content knowledge acquisition and transformation through reflection and interaction. Therefore, in order to understand how initial teacher education constructs FP mathematics content knowledge and mathematics pedagogical content knowledge acquisition and transformation in their programmes, I developed questions based on the methods of interaction, processes of planning and preparing the teaching and learning of FP mathematics. These questions were designed with the assumption that both the lecturers and student teachers have the experience of FP mathematics through the initial teacher education programme. Furthermore, I explored FP mathematics curriculum, modules and student teachers experiences during the programme.

It was further assumed that the participants could convey their experiences and processes of mathematics pedagogical content knowledge development during the initial teacher education programme. I therefore, employed semi-structured interviews, focus group interviews and document analysis to understand, investigate and elucidate the various realities of the construction of FP mathematics pedagogical content knowledge during the initial teacher education programme.

### **3.6 THE RESEARCH PROCESS**

This study was part of the EU-DHET (EU) funded project to find ways of strengthening Foundation Phase programmes at Higher Education. The EU project consisted of different consortiums formed by the universities, focusing on all the learning areas in the teaching and learning of FP. I was involved in the Pretoria University mathematics consortia. All participants, including myself were granted ethical clearance for the project by the ethical Committee of the University of Pretoria in 2011. I therefore, approached four institutions which were also part of the project but in different consortia to request permission to conduct a pilot study. Only three of the four institutions responded and granted me permission to interview FP mathematics lecturers. I was, however, denied access to talk to student teachers and the perusal of some of the relevant documents. Some of the lecturers allowed me to view the documents in their presence and immediately after

the interview they retrieved the documents claiming that they are protecting their intellectual property that they had gathered over many years. The information and data collected for the pilot study from these three initial teacher education institutions are not used for this study.

### **3.6.1 PILOT STUDY**

I followed the suggestions by Yin (2011:37) and McMillan and Schumacher (2010) that conducting a pilot study, provides the researcher with an opportunity to clarify interview questions that may have been confusing or ambiguous. Furthermore, the pilot study allowed me to “test, refine fieldwork procedures, data collection instruments and or analysis plans” and also presented prospects to develop interviewing skills with participants (Yin, 2011:206). The interview questions were pilot tested with seven lecturers from three initial teacher education institutions. The first pilot study was conducted with four lecturers from one institution. In the second institution two lecturers participated and lastly only one lecturer was available in the third institution to contribute to the study. As indicated in the research process that the findings of the pilot study are not included in this study.

However, the findings of the pilot study helped me to review and modify some of the questions on the lecturer’s interview schedule with the intention to generate relevant data (Yin, 2011). Moreover, the pilot study made me have a deeper understanding of the items on the interview schedule and to enhance validity and reliability of the findings of the study (Merriam, 2009).

Nevertheless, after my own individual ethical clearance was granted for my study by the University of Pretoria, I contacted six institutions excluding the ones in the pilot study to request for permission to conduct my research project. Two institutions requested an ethical approval letter and the proposal of my study to present it to their institutions ethics committee and they never communicated to me ever since even though I kept on following them to request for feedback. The one institution kept on promising to connect me to the relevant FP mathematics lecturers from July 2013 and the lecturer only responded to my request at the end of November 2013 just to inform me that final year FP B.Ed. students teachers are out for teaching practice for good and there is no way they could be contacted. The other institution did not respond to my request at all even after I had sent numerous



requests through e-mails. However, I acknowledged that participation is voluntary and only those participants that were willing to take part were free to do so. However, these rejections made me realise the difficulty to access initial teacher education institutions and how protective the lecturers are in revealing their practices to someone they do not know. During the pilot study, some lecturers stated that issuing documents to a stranger and especially to a novice lecturer teaching the same module that is under investigation is problematic. Hence, they are not prepared to share detailed documents to avoid the risk of scrutiny of their FP mathematics programmes and safeguarding their intellectual property rights. Nonetheless, two sites granted me permission and henceforth the visits were organised for data collection.

### **3.7 DATA COLLECTION INSTRUMENTS**

Before data collection, I applied for ethical clearance from the University of Pretoria and the two initial teacher education institutions before permission was granted. Data was collected from two lecturers and twelve final year B.Ed. final year FP student teachers. I used various tools and sources to collect data to ensure trustworthiness through triangulation. Triangulation is a process of validating evidence from different sources, for this study lecturers and student teachers (Creswell, 2012:259). Data was collected through interviews (individual, focus group) and document analysis. I used semi-structured interviews to collect data from the two FP mathematics lecturers and focus group interviews to gather data from the six final year B.Ed. FP student teachers from each institution to determine their views regarding the teaching and learning of FP mathematics pedagogies in their teacher education programmes (Creswell, 2012). This made me aware that some student teachers could express themselves more clearly in their mother tongue than in English, thus deepening my curiosity on the role of language in the teaching of mathematics.

Even though data was intended to be collected in English, sometimes during the focus group interviews with the student teachers, some students randomly switched and responded to questions in isiZulu and Setswana. I understand both languages and I was able to interpret their responses even when transcribing data. Nevertheless, most of the interviews were conducted in English. The interviews provided information on how both lecturers and student teachers view their world

and explain how they make sense of FP mathematics pedagogies in their programmes. A detailed discussion of each of the data collection strategies is presented below.

### **3.7.1 SEMI STRUCTURED INTERVIEWS**

Liang, in Cohen et al. (2004:267) state that an “interview is inter-subjective, and it involves discussing and sharing similar views and considering social contexts” in relation to the topic under study. For this study, semi-structured interviews were used to collect data from FP mathematics lecturers from two initial teacher education institutions. The qualitative research approach utilising semi-structured interviews provides for an in-depth, rich and descriptive data about the experiences and views of lecturers with regards to the construction of FP mathematics pedagogies in their teacher education programmes (Creswell, 2008; Merriam, 2009). I used semi-structured interviews to probe so as to understand, get explanations and clarity on the phenomena under study (McMillan & Schumacher, 2010). Interviews were used as a “guided conversation rather than structured queries” (Yin, 2009:106). I asked lecturers open-ended questions in the form of one-on-one interviews about the construction of FP mathematics pedagogies in their initial teacher education programme (Creswell, 2012).

The open-ended semi-structured interviews with lecturers originated from the main research questions and included questions such as:

- How do you structure FP mathematics pedagogies in your mathematics module?
- Which instructional strategies do you use to teach FP mathematics student teachers?
- What are your experiences for planning and preparing FP mathematics module?

Each of the individual semi-structured interviews lasted for about forty-five minutes in the lecturers’ offices. I recorded all interviews with a digital voice recorder to gain more clarifications of the interview (Yin, 2009:109). In the process of the interview I gained participants’ co-operation by establishing a rapport with them and this enabled me to gather more detailed information (Maree, 2010).

Semi-structured interviews allowed lecturers to voice their experiences without restrictions, by my own preconceptions and prejudices (Creswell, 2012). Furthermore, I was able to record lecturers' non-verbal cues and this as well offered a rich and meaningful data (ibid).

### **3.7.2 FOCUS GROUP INTERVIEWS**

Focus group interview involves a discussion “among a group of people with the purpose of collecting in-depth qualitative data” (Maree, 2010:91). The focus group interviews consisted of two groups of students, six student teachers from each of the institution under study. For this study, focus group interviews allowed me to understand the perceptions, attitudes and experiences of six B.Ed. FP final year student teachers from each institution about FP mathematics pedagogies during initial teacher education programmes. The participants of these groups comprised of both male and female student teachers. It was interesting in this study to listen and understand the male participants' views and experiences as FP is mainly dominated by females. Before I commenced with the interviews, I explained the purpose of the study to the student teachers and requested them to sign the informed consent form (Cohen et al. 2004; McMillan & Schumacher, 2010). I developed a rapport with the group and encouraged them to express their feelings fully and honestly without fear. Furthermore, student teachers were reassured that the interviews were strictly confidential, and that their identity would remain anonymous.

The interviews were conducted once for approximately forty five minutes guided by a twenty item interview schedule in the staffroom which was private, neutral and non-destructive to conduct an interview. The interview schedule comprised of questions of which the intention was to understand student teachers knowledge about aspects such as:

- instructional strategies for the teaching and learning of FP mathematics,
- contents of mathematics content and pedagogical modules and
- knowledge of the curriculum and language of learning and teaching mathematics in the FP.

I used a semi-structured interviews schedule, which allowed the use of techniques such as explaining, probing and recapitulating to understand student teachers lived

experiences (McMillan & Schumacher, 2010). I used questions like why and what to probe student teachers responses and to understand why they responded the way they did. For example, when student teachers described their preference of language of learning and teaching of mathematics in the FP classroom, I asked in a subtle way why and what propelled them to make that choice. Furthermore, I used phrases like, “please elaborate” or “tell me more about that to clarify what you have just mentioned” (Creswell, 2012). To enhance validity and credibility of the study, all participants’ views were considered (McMillan & Schumacher, 2010).

This made the focus group discussion beneficial as it allowed student teachers to provide detailed information of their experiences with regard to the FP mathematics programme. Moreover, student teachers helped each other to recall forgotten details (McMillan & Schumacher, 2010). I audio-recorded the interviews and transcribed them to note all the discussions of the interview session. The transcribed data was summarised to explore for themes and patterns for further analysis (Creswell, 2012). Apart from the audio-recordings, I employed field notes to capture student teachers’ personal reactions such as their non-verbal cues like, gestures and body language to support the audio-recordings (Yin, 2009).

Nevertheless, De Vos and Strydom (2005) highlight the limitation of focus-group interviews as they state that the findings are not generalisable due to a very limited number of participants of the broader population. In this case study, twelve final year B.Ed. FP student teachers from two initial teacher education institutions in South Africa, participated. McMillian and Schumacher (2010) suggest that during the interviews, there may be contrasting opinions that may lead to tension amongst the diverse group of participants. Moreover, some participants maybe too vocal and dominate the discussion (Maree, 2010). I had to intervene in a subtle way and requested dominating participants to allow other participants to contribute in the discussion but being very careful not to dampen their enthusiasm.

### **3.7.3 DOCUMENT ANALYSIS**

According to Merriam (2009:139) document ‘refers to a wide range of written, visual, digital, and physical material’ and that may shed light on the phenomenon under study. Documents may include official documents, memos, student journals, as well as policy documents that provide more information about the research

question (McMillan & Schumacher, 2010). The purpose of qualitative document analysis is to determine new or emergent patterns that might have been ignored by participants during the interviews (Hesse-Biber & Leavy, 2008). Furthermore, Grady (1998:24) states that the major benefit of document analysis is accuracy and the data that is “free-standing”. However, Bailey (1994:317) caution that sometimes documents like journals and diaries may not be authentic and reliable as these documents are subjective. Nonetheless, Babbie and Mouton (2001:303) emphasise that personal documents enhance “theory development and verification”.

The intention of this study is to understand how lecturers of initial teacher education programmes construct FP mathematics pedagogical knowledge in their modules. I requested documents such as study guides and readers from the two institutions. The rural institution gave me the study guide and the readers while the urban institution provided me with a list of prescribed and recommended text books. Grady (1998) indicated that the disadvantage of the document analysis is the problems experienced with access. I experienced this during the pilot study and again with the urban institution as I was shown and given the titles of prescribed and recommended text books and advised to download the yearbook from the internet. The purpose of collecting these documents was to support and increase evidence from the semi-structured and focus group interviews (Yin, 2009). The yearbooks from both institutions and the readers from the rural institution presented the module outline and full mathematics pedagogical text including related articles, dates, times and sequence of the module content, assessment criteria and module requirements of students. These documents helped me to understand lecturers’ actions, beliefs and experiences of constructing FP mathematics modules including MCK and MPCK (Creswell, 2008).

### **3.8 DATA ANALYSIS**

McMillan (2008:283) describes qualitative data analysis as “working with data, organising it, breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned, and what you will tell others”. This process of working with data is referred to as inductive analysis. Inductive analysis illustrates the process of thoroughly and thematically arranging lecturers and student teachers data from transcripts by assigning codes to interesting data and then group the data into topics and themes (McMillian &

Schumacher, 2010). Furthermore, Creswell, (2012) states that “coding is segmenting and labeling text to form descriptions and broad themes in the data”. This process helped me to identify similarities and differences in texts and corroborate or disapprove with the theory about the construction of FP mathematics pedagogies in the initial teacher education programmes (Maree, 2010; McMillan & Schumacher, 2010).

Data collection, analysis and interpretation of individual semi-structured interviews, focus group interviews and document analysis were on-going, and intertwined and allowed me to present clarifications about the construction of FP mathematics pedagogies during initial teacher education programme (Maree, 2010:99; Merriam, 2009). Subsequently I present the methods I utilised to analyse the data.

### **3.8.1 ANALYSIS OF INDIVIDUAL SEMI-STRUCTURED AND FOCUS GROUP INTERVIEWS**

I started by listening to the lecturers’ audio-recorded interviews, transcribing and editing the data to add verbal and non-verbal cues such as, nodding of the heads, and laughs. I immersed myself in the data, I checked and rechecked the original field notes and interviewed transcripts to agree or disagree with what has been recorded (Maree, 2010). Furthermore, I formulated a table that included each interview question, the lecturers’ and student teachers’ responses, my explanations and remarks. These processes helped me to interpret emerging themes, patterns and codes of transcribed data with ease (Maree, 2010; McMillan & Schumacher, 2010, Yin, 2009). Additionally it helped me identify relationships, silences and unexpected trends in relation to the teaching and learning of FP mathematics pedagogies during initial teacher education programmes (Nieuwenhuis, 2007).

### **3.8.2 DOCUMENT ANALYSIS**

I analysed the year books, readers and prescribed textbooks from both institutions after I had analysed both semi-structured and focus group transcribed interview data. The questions and patterns expressed by the interview analysis assisted me to determine which data were most suitable to analyse in exploring how initial teacher education constructs FP mathematics pedagogies in their programmes. For example, because lecturers were vague in explaining the structure of the credits allocated to MCK and MPCK modules, I wanted to understand exactly how these

credits were reflected in their year books and the amount of time allocated to the modules. The following questions evolved after analysing the interview transcripts and directed my investigation of the year books and readers:

1. How MCK and MPCK are constructed in the programme?
2. What is the sequence and progression of MCK and MPCK contents in modules or programme?
3. What instructional strategies student teachers experience during their mathematics programme?

First I read each year book and the readers which comprised of comprehensive B.Ed. FP programme information such as the module name, credits, purpose of the module, contents of the modules, assessment and lastly the prescribed textbook. I created a table in which I displayed data for each institution that included: credits, purpose of the module, content of the module and assessment. The table assisted me to explore patterns, categories and codes within the data (McMillian & Schumacher, 2010). Subsequently, I present credibility and trustworthiness of the study.

### **3.9 CREDIBILITY AND TRUSTWORTHINESS**

The validity and reliability in a qualitative study refer to the credibility and trustworthiness of the results (Merriam, 2009). Lincoln and Denzin (2004:172) state that trustworthiness incorporates credibility, dependability and transferability which equals to internal and external validity, reliability and neutrality.

#### **3.9.1 CREDIBILITY**

Flick (2009) defines credibility as a concept that relates to whether the findings of the study are believable. To attain believable findings, I presented a truthful account of what transpired in the research setting (Cohen et al. 2004; Merriam, 2009). To achieve credibility of the findings, I presented accurate and deliberate inferences from data about the lecturers and student teachers' experiences with regards to the construction of FP mathematics pedagogies during initial teacher education programmes. I used strategies such as triangulation to address credibility (Flick, 2009).

Triangulation is an important strategy that enhances trustworthiness of the study. I used interviews (focus and individual) and document analysis for data collection (Creswell, 2012). I acknowledge that reality cannot be determined by a single truth (Maree, 2010). Hence I utilised two types of triangulation; data triangulation and methodological triangulation. Data triangulation “refers to the use of different data sources” (Flick, 2009:444). The data sources used for this study includes FP mathematics lecturers and final year FP B.Ed. student teachers. King and Horrocks (2010) describe methodological triangulation as a combination of different methods. I used interviews (semi-structured and focus group) and document analysis to validate this study.

### **3.9.2 DEPENDABILITY**

Member checking, which is referred to as dependability, involves taking back the findings of the data, analysis and interpretations back to participants to examine for accuracy (Cohen et al, 2004:120; Creswell, 2012:259). I provided participants with transcribed data, interpretations and findings to verify their experiences with regards to FP Mathematics pedagogies during initial teacher education programmes (Lincon & Guba, in Cohen et al, 2004). I had to be clear when asking questions, cautious, neutral and not biased to influence participants with my own personal beliefs, opinions and experiences (Cohen et al, 2004:121; Creswell, 2012).

### **3.9.3 TRANSFERABILITY**

Lincoln and Denzin (2004:172) define transferability as the capacity to apply the findings of the study to a similar context. Lapan, Quartaroli and Riemer, (2011) suggest that, to achieve transferability the researcher should provide sufficient descriptive information about the research context and the research findings to determine the legitimacy and be able to compare the findings in a similar context. Hence they further assert that the findings of the study should lack personal bias and the researcher should provide a trail of evidence from the data that support the conclusions of the study.



### **3.10 ETHICAL CONSIDERATIONS**

As a researcher I had to attend to moral issues and conduct as stated by Cohen et al. (2004). Before I engaged with data collection, I applied for ethical clearance from the Ethics Committee of University of Pretoria and permission was allowed (see clearance certificate). I also requested permission from the two initial teacher education institutions (see Appendix A). I secured an appointment with participants. Before I started with the interview I introduced myself to participants and explained the purpose of the study, the information I need and the procedures to follow during the interview. I read the consent forms that explained the purpose of the study to participants and indicated that participation is voluntary (Creswell, 2012). The participants then signed consent letters (see Appendix B and C) and I continued with the interviews.

I followed the following processes to ensure ethical conduct during the research:

- Informed consent
- Voluntary participation
- Confidentiality and anonymity
- Privacy
- Risk

#### **3.10.1 INFORMED CONSENT**

Cohen et al. (2004) indicate that participants' rights should be respected and at all times without any fear. I therefore, ensured that the lecturers were informed before data collection about the purpose of this study that is, to explore how they construct FP mathematics pedagogies in their programmes. Furthermore, I made student teachers aware that this study is interested in understanding their experiences with regards to FP mathematics pedagogies during their preparation. This allowed for participants to make informed decision as to whether to participate in this study or not.

#### **3.10.2 VOLUNTARY PARTICIPATION**

I advised participants that participation is voluntary and that they could withdraw at any given time during the research process without penalties (Creswell, 2012). The

two lecturers and six student teachers from each institution agreed to take part in this study by signing consent forms, which endorsed their right to participate.

### **3.10.3 CONFIDENTIALITY AND ANONYMITY**

Confidentiality was maintained at all the times, I ensured that participants' information such as their location, identity and all the research documents, audio-tapes, and transcriptions are kept anonymous. However, documents are available for participants and my supervisors for verification and validity. This was maintained to develop a trusting relationship with participants (Bless, Higson-Smith & Sithole, 2013; McMillan & Schumacher, 2010).

### **3.10.4 PRIVACY**

Cohen et al. (2004) assert that participants' privacy should be respected and sensitive information should not be compromised, and the location of the research project should be concealed. I therefore used pseudonyms for participants. Furthermore, participants were assured that their privacy will always be respected.

### **3.10.5 RISKS**

I collected documents such as readers from one initial teacher education institution and this may be regarded as a risk as the lecturer revealed information about the design and the content of the mathematics modules. More specifically participants subjected themselves to an inquiry and exposed their intellectual property to an outsider. However, as I am guided by the ethics rules and procedures of Pretoria University, I promised the lecturers that all the information and documents collected during data collection only is meant only for the purpose of this study (Creswell, 2012).

### 3.11 CONCLUSION

I conducted my study in two initial teacher education institutions to explore how they construct FP mathematics pedagogies in their programmes. I collected data through a qualitative method, using semi-structured interviews, focus group interviews and document analysis. I adhered to all ethical issues as presented by University of Pretoria.

Chapter four presents the analysis of data and the findings.

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## CHAPTER FOUR ANALYSIS OF DATA AND REPORTING OF FINDINGS

### 4.1 INTRODUCTION

Chapter Three provided a comprehensive justification for the selection of the research methodology and design utilised for this study. The purpose of this study was to investigate the construction of FP mathematical pedagogies through initial teacher education programmes. This chapter focuses on presenting the research findings of the data collected from research participants. As indicated in chapter three, data was collected from two initial teacher education institutions respectively. Participants comprised of two lecturers and twelve student teachers combined and data was collected through semi-structured interviews with lecturers, focus group interviews with student teachers and document analysis.

After document analysis, I reflected on the data, literature review and conceptual framework and emerged with themes related to the research questions. Themes were developed based on specific words and sentences from the data that were relevant and reflecting on how initial teacher education constructs FP mathematics pedagogies in the programme (McMillan & Schumacher, 2010). I identified categories and codes from the data that highlighted the process of mathematics pedagogy knowledge acquisition and transformation in the initial teacher education programme. Some fundamental thematic questions of the semi-structured interviews and focus group interviews are presented in table 4.1 and 4.2 below:

**Table 4.1: Lecturers' semi-structured interviews**

PARTICIPANTS	INTERVIEW QUESTIONS	AIMS
<b>LECTURERS</b>	1. How is your FP mathematics programme structured?	To accumulate data on how lecturers arrange and plan for mathematics knowledge for teaching
	2. What teaching and learning strategies do you utilise to develop FP mathematics concepts in your module?	To acquire knowledge of how lecturers interact, present and teach MPCK to their student teachers

**Table 4.2: Student teachers focus group interviews**

PARTICIPANTS	INTERVIEW QUESTIONS	AIMS
<b>STUDENT TEACHERS</b>	1. How do you feel about mathematics modules?	To understand and accrue data on student teachers experiences with regards to mathematics
	2. How do you acquire mathematics concepts and pedagogical knowledge in your modules	To collect data on how student teachers learn mathematics content knowledge and mathematics pedagogical content knowledge

Table 4.1 and 4.2 above, presented some of the lecturers' semi-structured interviews and student teachers' focus group interviews that chartered the emergence of some dominant themes during thematic analysis. The findings are presented and analysed according to the themes and categories that emerged during data analysis process (Creswell, 2012).

I commenced with the description of each case research site, participants and subsequently the themes and categories that emerged from the data. The findings of the document analysis are discussed and integrated in each theme. The following themes emerged:

- Mathematics content and pedagogical knowledge in FP
- Mathematics language of learning and teaching in FP
- Student teachers' perceptions about their mathematics modules

#### **4.2 DESCRIPTION OF THE CASES**

Since it is important to maintain the anonymity of the research site and participants, I developed codes to signify participants' responses and research sites. The two research sites are referred to as institution one and institution two. The participants in institution one are allocated the following codes; the lecturer who is female (LF1/1), three student male participants (SMF1-1 to 3) and three female student teachers (SFF1-1 to 3). Institution two participants are referred to as follows; the lecturer who is male (LM1/2) and six female student teachers (SFF2-1 to 6). Hence, SMF1-1 means a male student teacher participant number 1 from institution one and likewise SFF2-3 suggest that it is a female student teacher participant number 3 from Institution two. The codes are presented in table 4.3.

**Table 4.3: Coding of participants**

INSTITUTION	CODES	EXPLANATION
INSTITUTION ONE	LF1/1	Female lecturer
	SMF1-1 to 3	Three male student teachers participants 1-3
	SFF1-1 to 3	Three female student teachers participants 1-3
INSTITUTION TWO	LM1/2	Male lecturer
	SFF2-1-6	Six female student teachers participants 1- 6

Table 4.4 below presents documents that were utilised in this study for document analysis.

**Table 4.4: Analysed Documents**

DOCUMENTS	Purpose
<b>Curriculum and Assessment Policy Statement (CAPS)</b>	<ul style="list-style-type: none"> <li>To understand the aims and purpose of mathematics in the Foundation Phase</li> <li>To acquire knowledge of teaching strategies stipulated in the curriculum</li> <li>To become acquainted with the skills and the progression of mathematics content knowledge that learners should acquire during FP schooling</li> <li>To determine the weightings of the different mathematics content areas and time to be spend on each content area and for the distribution of the content in the assessment</li> </ul>
<b>INSTITUTION ONE</b>	
<b>Study guide</b>	<ul style="list-style-type: none"> <li>Provides mathematics teaching and learning strategies</li> <li>Duration of the module</li> <li>Dates and topics for each lesson</li> <li>Assessment strategies</li> <li>Weighting of the modules</li> </ul>
<b>Readers</b>	<ul style="list-style-type: none"> <li>Indicated detailed mathematics curriculum for the programme</li> <li>Provides mathematics teaching and learning strategies</li> <li>Duration of the module</li> </ul>
<b>INSTITUTION TWO</b>	
<b>Year book</b>	<ul style="list-style-type: none"> <li>Admission requirements</li> <li>Detailed contents and progression in the modules</li> <li>Duration of the modules</li> <li>Structure of the programme</li> </ul>

DOCUMENTS	Purpose
List of book names	The prescribed books and the recommended addressed mathematics content and pedagogical knowledge relevant for teaching Foundation Phase mathematics

These documents provide a general overview of the structure and sequence of mathematics content and pedagogical knowledge of the two initial teacher education institutions. Furthermore, these documents indicate the methods in which mathematics pedagogy module is presented to student teachers.

Subsequently the themes and categories that emerged from the data are presented in table 4.5

**Table 4.5: Summary of themes and categories that emerged from the data**

<b>THEME 1</b>	
<b>Mathematics content and pedagogy knowledge in foundation phase</b>	
<b>CATEGORY</b>	<ul style="list-style-type: none"> <li>i. Mathematics content knowledge</li> <li>ii. Mathematics pedagogical knowledge</li> <li>iii. Instructional strategies used in mathematics teaching and learning.</li> </ul>
<b>THEME 2</b>	
<b>Mathematics language of learning and teaching in foundation phase</b>	
<b>CATEGORY</b>	<ul style="list-style-type: none"> <li>i. Lack of mathematics concepts in African languages</li> <li>ii. Code-switching as a technique for mathematics teaching</li> </ul>
<b>THEME 3</b>	
<b>Student teachers' perceptions about their mathematics modules</b>	
<b>CATEGORY</b>	<ul style="list-style-type: none"> <li>i. Interpretation and implementation of the school curriculum in the South African context.</li> <li>ii. Teaching and learning of mathematics to learners experiencing mathematics difficulties (inclusive education).</li> <li>iii. Student teachers' teaching practice experiences</li> </ul>

#### 4.2.1 CONTEXT OF INSTITUTION ONE

Institution one is located in a rural province whereby only one language is predominately spoken. However, the institution prides itself for catering for culturally and linguistically diverse student teachers from other provinces as well. According to the South African Council of Higher Education, Report on the National Review of

Academic and Professional Programmes in Education (2010), the institution was fully accredited in 2006 to prepare teachers to teach literacy and numeracy in FP. This indicates that the institution satisfied all the requirements of the regulatory framework as prescribed in the Norms and Standards for Educators (NSE) to offer B.Ed. programme with specialisation in foundation phase (CHE, 2010).

The lecturer in institution one (LF1/1) has a MEd degree in education and she was pursuing her PhD degree by time this study was conducted. Furthermore, LF1/1 has three years' experience of teaching FP mathematics. As it is highlighted in chapter 3 that participants were purposefully selected, LF1/1 nominated six final year student teachers participants, i.e. three males and three females. Both the lecturer and the six student teachers were welcoming and confident in sharing their experiences with regards to their mathematics pedagogical content knowledge (MPCK). All student teachers enrolled for this programme passed either mathematics literacy or mathematics in matric level. The mathematics module in this institution is compulsory for all student teachers registered for FP programme. However, this study focused on the final year student teachers because of their experience in the teaching and learning of FP mathematics in practice and from practice. The module is divided into units that integrated mathematics content and pedagogical knowledge. The module is offered for fourteen weeks which is equivalent of a semester.

#### **4.2.2 CONTEXT OF INSTITUTION TWO**

Institution two is located in a large city in an urbanised multilingual province. Similarly, the institution is catering for student teachers that are multilingual and of diverse cultures. Institution two was accredited in 2011 when they launched their Foundation Phase programme. The FP programme in this institution was fully supported by the Department of Higher Education and Training (DHET) and Department of Basic Education (DBE) with the purpose of strengthening Foundation Phase programme in the initial teacher education programme in South Africa.

The lecturer, LM1/2 has a PhD degree and approximately ten years' experience in teaching FP mathematics in initial teacher education. LM1 selected the six final



year female student teachers to be participants. Likewise, all the student teachers in this programme passed mathematics literacy or mathematics in matric.

All student teachers registered for FP programme are compelled to do mathematics as a subject as they are trained to be generalists and have to teach all the learning areas in the FP. This institution has two mathematics modules; a content and pedagogy module. These modules are divided into phases that deal with different topic each year. These modules are each offered for a year for the period of three years.

### **4.3 RESEARCH FINDINGS**

In this section I report on the themes and categories that emerged during the data analysis process. I begin with Theme One, and it is about mathematics content and pedagogical knowledge during initial teacher education then followed by its categories. I present the findings as they happened and for easy understanding of the presentation of the research findings, the actual words of the lecturers and student teachers are in quotation marks and italicised.

#### **4.3.1 MATHEMATICS CONTENT AND PEDAGOGICAL KNOWLEDGE IN FOUNDATION PHASE**

Data revealed that lecturers in this study understood the significance of emphasising mathematics content and pedagogical knowledge to student teachers during initial teacher education programme. The student teachers also indicated the importance of knowing and understanding mathematics content and pedagogy knowledge in the process of learning to teach mathematics to FP learners. Regardless of the fact that the participants in this study expressed their views differently on some aspect, they described the essence of teaching and learning of the content and pedagogy in mathematics.

The document analysis of the two institutions helped me to verify what was said during the interviews with the lecturers and the focus group interviews with student teachers. The findings of the interviews and document analysis are integrated in the presentation. The following categories emerged in theme 1 during the interviews and are sequentially discussed:

- Mathematical content knowledge;
- Mathematics pedagogical knowledge;
- Instructional strategies used in mathematics teaching and learning.

#### 4.3.1.1 Mathematical content knowledge

According to Matthews et al. (2010); Hill et al. (2008); Youngs and Qian (2013) mathematical content knowledge involves knowledge of mathematical concepts, procedures, command of underlying principles and meanings, and understanding of connections amid mathematical ideas. This category highlighted lecturers' views and opinions about mathematical content knowledge in the teaching and learning of FP student teachers. During the interviews, lecturers emphasised the significance of mathematical content knowledge in the preparation of FP student teachers.

They said:

LF1/1: *"With the content I don't know whether they have much, they need to know and know how to teach".*

LM1/2: *"So you see, we have the specific maths content and cover the maths that teachers are going to teach but slightly at a higher level".*

The lecturers believe that mathematics content knowledge is important during initial teacher education programme. LM1/2 revealed that they are teaching their student teachers mathematics content that is above FP learners. LM1/2 said:

LM1/2: *"We go quite deep in the sense that we cover which is done up to grade 12 level. We do cover quite high but remember these are FP teachers, they are not supposed to do quite high maths but it's to know maths at that level in order to be able to explain it at FP level. For instance, we look at the different kinds of shapes in terms of content, what are quadrilaterals, what are the polygons, what are polyhedrons, that is looking at it in perspective of content that is covered in the shapes then we come to look at how do you teach shapes".*

LM1/2 comments indicate that student teachers are exposed to deep mathematical content knowledge. Document analysis of the textbooks recommended for student

teachers in institution two portrayed the need for deep mathematical content knowledge. Institution one lecturer was silent on the depth and breadth of mathematics content knowledge in their programme. This silence indicated to me that it could be that the student teachers from institution one are trained on the same level of mathematics that they are going to use for teaching. However, after going through institution one study guide and the reader, I found that the content of the mathematical level in those documents were at the same level as what FP learners are taught at school. It was also clear from the interviews with the lecturers and student teachers that content modules of these two institutions, followed the same mathematics topics and sequence as defined in the South African school curriculum policy CAPS (see, section 2.2.3).

This was highlighted by LM1/2 and LF1/1:

LF1/1: *“We follow the five mathematics concepts starting with number sense. I looked into the school curriculum and I designed activities according to those topics”.*

LM1/2: *“We have tried to follow in the school in the sense that in FP you start with numbers, so we have tried to follow the sequence that is how the programme has been developed”.*

The student teachers from the two institutions supported their lecturers as they tried to state the sequence of their mathematics module:

SMF1-3: *“Mhh... it includes all the five contents of mathematics. That is errr...shapes, Geometry and Fractions”.*

SFF1-2: *“Basically we started with subtraction, addition, numbers and operations”.*

SFF2-6: *“We started with numbers in the first year and our second year we did measurement, space and shapes”.*

SFF2-6: *“Oh yes, and last year we did data handling”.*

From the above statement, it is clear that CAPS forms an integral part in the preparation of FP student teachers. The two lecturers in this study acknowledged

that they do refer from CAPS for the preparation and teaching of their modules. They said:

LF1/1: *“When I have this particular unit, I must refer them to CAPS as it is talking this particular topic for each grade this is how far you go”.*

LM1/2: *“If you look at the programme, we cannot follow CAPS because we go beyond the limits of CAPS. The maths curricular is the same, measurement is measurement wherever you go, so that is universal and those are the topics we cover but you go beyond what is covered in CAPS but we use CAPS as these instruments the students are going to use in the school”.*

The lecturer’s responses above suggest that even though they consider CAPS in their teachings, it is used to familiarise student teachers to mathematics content and progression of content from Grade R to Grade 3. The lecturers indicated that they consult different sources to prepare for their mathematics modules. The following comments emerged during the interviews:

LM1/2: *“I can show you one now, I have written my own book but we have several books that others have written. In my book the whole of chapter 5 covers teaching elementary mathematics content. So it covers all the content that they are going to cover throughout the programme. There are several books that we recommended our students to use. So they have different books and we encourage them to write their own books and you will be amazed because some of them are really good. I would use them in my class, they are resourceful, and they have added teaching aids”.*

LF1/1: *“There are no books I compiled that reader from the content from the university. I looked into the school curriculum and I designed activities into those topics. I got information from a whole lot of sources besides on line, Toyota teach, some from my work from (...) as I was the facilitator there for five years so whatever material we designed I put it in there”.*

The discussions above suggest that student teachers from these two institutions were exposed to various reading materials and sources to improve their mathematical content knowledge. Student teachers from the two institutions mentioned the sources they use to learn and understand MPCK. They said:

SMM1-4: *“We have two books, the small one titled How to Learn and Teach and Mathematics for Elementary School Teachers...mmh... mhh...written by Van de Walle”*

SFF2-3: *“We use Mathematics for Elementary School teachers, Early Numeracy, Assessment for teaching and intervention”.... (Interruption)*

SFF2-3: *“Mmh...Elementary and Middle School Mathematics”.*

SFF2-6: *“In fact, we are told to read different books so that we can have a better understanding of FP mathematics and become better teachers”.*

It emerged that Mathematics for Elementary School Teachers written by Van de Walle was used in both institutions. The mathematics content in this book is beyond FP mathematics content knowledge. Despite one lecturer being silent on the topic, the use of the book is testimony that mathematics content in the initial teacher education is beyond the FP school classroom requirements. The book also emphasises the importance of mathematics pedagogical knowledge in the teaching and learning of FP student teachers. Pedagogical knowledge was very prominent in the interviews as it charts the process of teaching mathematics.

#### **4.3.1.2 Mathematics pedagogical knowledge**

Mathematics pedagogical knowledge encompasses how FP teachers represent their own mathematics conceptual knowledge to increase learners' understanding. It also involves knowledge of how to use mathematics 'resources, representations or analogies for teaching mathematical ideas' (Rowland et al. 2009:21). Chapter 2 (section 2.5.3) described the importance of teaching FP student teachers mathematics pedagogy. The focus of this study is to understand how initial teacher education constructs FP mathematics pedagogy in their programmes. During the interviews, it was evident that the teaching and learning of pedagogy is structured differently in the two institutions. This is how the lecturers expressed the structure of their pedagogy module in their institutions:

- LM1/2: *“The instructional approach is covered during the methodology. The methodology lecturer would then ask the students what they have done in the content; they would say we have covered shapes up to this point. Now let’s talk about introducing shapes, what are some of the important factors that you ought to put before the children in order for them to understand the concept of shapes, when they are supposed to know the properties what are they identified with, which instructional approaches are regarded as most effective when teaching shapes.”*
- LF1/1: *“For now I taught them about 4 theorists; Vygotsky, Piaget, Skinner and Bordo and the content part is the lesson plan and essays”.*

The findings revealed that the structure of mathematics pedagogical knowledge of these two institutions differs. The mathematics pedagogical knowledge of institution one seemed to be mostly focused on the teaching and learning of theories of learning. The emphasis of institution two mathematics pedagogical knowledge seemed to be shared in the teaching and learning of pedagogy, theories of learning, psychology and research. Student teachers from these institutions supported their lecturers’ statements. They said:

- SFF1-1: *“Mam, we did the five concepts, teaching strategies, traditional teaching method and constructivism”.*
- SM1-2: *“Actually (...) module dwells much on the method, the how you teach concepts, Piaget and Vygotsky’s theories”*
- SFF2-4: *“In our method course we learnt about how learners learn, different teaching strategies, about what Vygotsky and Piaget are saying, the aims and objectives of teaching mathematics”.*
- SFF2-1: *The how you teach, teaching strategies and approaches, classroom management and assessment, things like that”.*

Student teacher comments revealed that their mathematics module prepared them to understand the importance of knowing how learners learn and which teaching and learning strategies are appropriate for teaching different mathematics concepts. The lecturers in this study indicated that they use different instructional strategies to present the MPCK to their student teachers. Instructional strategies used in the

teaching and learning of mathematics in the two cases of this study are discussed below.

#### 4.3.1.3 Instructional strategies used in mathematics teaching and learning

Mathematics instructional strategies involve different instructional techniques and strategies that provide for the acquisition of mathematics knowledge, skills, attitudes through the co-operative processes between teacher, learner and to the learning in the classroom environment (Siemon et al. 2013; Van de Walle et al. 2013) (see section 2.4).

In the context of this study, instructional strategies such as lectures, group presentations and discussions in the teaching and learning mathematics in the two initial teacher education institutions seemed to be essential. Van de Walle et al. (2013) highlights that knowing and understanding different instructional strategies in mathematics is an important component in learning to teach (see chapter 2, section 2.3). The lecturers in this study indicated that they use different instructional techniques to teach their student teachers. They said:

LF1/1: *“Bringing in the slides, that is how we present our lessons with most of the people in this university. We normally load in the module, that is the resources they use on line, ....err....looking at what will be done on that particular day, if they have questions and also readings on that topic that they will be doing, they will check it out and research about it so that when they come into the class they will know what we will be teaching. Then bring in the real resources....err...err... movies in terms of technology”.*

LM1/2: *“There are different teaching methods, lectures, assignments, the discovery methods and so on, but the view is that the best teachers always combine these methods in such a way that people won’t recognise because it is so well merged together and this that is what we try to teach them that there is no single method that is regarded as the most effective, a good teacher should be able to mix all these and come up with effective lesson”.*

It became clear from the above-mentioned statements that the lecturers in this study integrate different teaching strategies when presenting mathematics lessons to their student teachers. It was evident that the lecturers in my case study clearly integrated different teaching strategies during mathematics teaching and learning. During the focus group interviews, student teachers supported the lecturers and revealed how they experienced mathematics instruction in their institutions. They stated that:

SFF1-1: *“The lecturer used slides to present in class. We researched from the internet and books from the library, watching videos that the lecturer provided”.*

SFF2-5: *“We go to class prepared, the lecturer present lessons with slides then we discuss the scenarios that are presented to us through videos. Read articles, different books, discuss in groups and watch different videos on how to teach maths to young children”.*

These remarks suggest that student teachers in this study are exposed to different instructional strategies. They mentioned that they read, investigate and watched videos to reinforce their mathematics pedagogical knowledge. The lecturers further indicated the importance of student teachers collaboration in enhancing their learning. They said:

LF1/1: *“I make sure that the content and theories that we did they cover it in activities of their self-study and groups, then on Friday we will interact with the activities they did and check if there is a link between the three”.*

LM1/2: *“They are expected to read articles on instruction before their tutorials. There, they discuss in their groups and share what they have learnt about that topic then they do the practical component”.*

The lecturers' statement above seemed to indicate that interaction is key in the construction of student teachers mathematics pedagogical knowledge. During focus interviews, the student teachers in this study expressed their experiences when they collaborate and learn with each other, especially when they attend tutorials to scaffold to discuss and share information with each other. They said:



SFF2-5: *“Wow! Mam, it is interesting during our tutorials, we solve maths problems in our groups, discuss, argue, and share what we have read. We leave that room confident knowing that we have learnt from each other”.*

SMF1-1: *“What I can say in module (...) they should have practical classes where we will physically teach, maybe like in tutorials, to teach the whole class, share our experiences and understanding because in class (...) they are not interested do it”.*

SFF1-2: *“We were only given a chance to discuss and present lessons in our first year otherwise the past two years we only listened to the lecturer in the class”.*

From the account of the two lecturers in this study, it seemed that they regard communication as an essential component of knowledge construction in the teaching and learning of mathematics. Both lecturers highlighted that student teachers are involved in their learning as they read, communicate and discuss their findings. However, their approaches are different. Institution two is more practically focused whereas institutions one is not. This is because student teachers from institution two revealed that during tutorials they learn together, present lessons and discuss their presentation in order to change and improve their practices. In contrast, institution one student teachers longed for the same opportunity to practically practise in front of their peers and lecturer with the hope to receive feedback that could improve their mathematics pedagogical skills. However, student teachers from Institution One blamed the contact time allotted to their mathematics module, which is equivalent to one semester that may be shortened by other outside factors as well. SMF1-2 disclosed this and said:

SMF1-2: *“Our maths programme is supposed to be for 12 weeks but it depends on how long the semester is, considering the strikes it may be less”.*

In contrast to Institution One, institution Two has three years of mathematics teaching. Each year has mathematics content and pedagogy modules which gives enough room for practical sessions and knowledge to solve mathematical problems.

➤ **Problem solving as a strategy to teach mathematics in Foundation Phase**

Problem solving emerged as an important instructional strategy for the lecturers in this study. The two lecturers articulated how problem solving forms part of their teaching and learning. They said:

LF1/1: *“Activities in the classroom, for example let say we developing concepts, they will have to do things that deals with problem solving even though it is a story it will be converted to problem solving part of a situation”*

LM1/2: *“Look, problem solving requires student teachers to investigate, reason and think critically about maths. It is therefore included in all our maths lessons. They are encouraged to work in groups to share their experiences and different strategies to solve maths problems”.*

These responses indicate that the lecturers seemed to integrate problem solving in the teaching and learning of MPCK in their modules. This means that student teachers are encouraged to find their own solutions to mathematics problems and discuss their strategies with their peers. The student teachers in this study confirmed that problem solving is indeed included in their programme. They said

SMF1-2: *“Module X, calculators are not encouraged, even in our test we are not allowed to use calculators. We know the strategies even if we are given big numbers we can solve the problems”.*

SMF1-3: *“Let’s say 8000-670 then you know that you convert 670 to 700 then you know that you add 30 to 670 to make it 700 and you minus”... (giggles from participants).*

Even if both lecturers agreed on the importance of problem solving, the institution’s two lecturer seemed to have a deeper understanding of the concepts as he explained that the process involved includes reasoning and critical thinking. Therefore, it won’t be surprising for institution two student teachers to have a deeper grasp of problem solving. This is supported by the response by SFF2-6 when she said:

SFF2-6: *“Hallo, (raising hands)..., you remember what Dr (...) said about problem solving in maths? He said we need to listen, understand what the next person is trying to say, ask questions and then think of ways to improve or support that opinion”.*

From the responses above, it seemed that the student teachers understood and valued the importance of problem solving in their learning. They revealed that their programme prepared them to use different problem solving strategies to think critically and discuss all the time. This suggests that the lecturers in my case study embrace problem solving and critical thinking in the construction of their mathematics programmes besides the different levels at which it was dealt with. Both institutions seemed to emphasise that student teachers should collaborate, discuss and share ideas in their teaching and learning. The next theme is on mathematical language of learning and teaching in the initial teacher education programmes.

#### **4.4 MATHEMATICAL LANGUAGE OF LEARNING AND TEACHING**

Language of learning and teaching (LoLT) in the South African context “means the language chosen by a school’s governing body in consultation with parents. It is the language teachers use to instruct and assess” (DBE, 2013: 4). This theme focused on mathematical language of learning and teaching in the two initial teacher education institutions. This theme helped me to understand the relationship between mathematics language of learning and teaching in these two institutions with regards to mathematics teaching and learning and their effect in FP classroom in the South African schools.

During the interviews with participants, it became clear that mathematics language of learning and teaching is a challenge for the student teachers. Participants indicated that mathematics is offered in English in the initial teacher education institutions while the South African school curriculum policy (CAPS) emphasise that FP learners should be taught in their home languages. Two categories emerged under this theme during data analysis:

- Lack of mathematics concepts in African languages;
- Code switching as a technique for mathematics teaching.

#### 4.4.1 LACK OF KNOWLEDGE OF MATHEMATICAL CONCEPTS IN AFRICAN LANGUAGES

Participants in this study seemed to be concerned about the lack of mathematics language to describe and teach some mathematical concepts when teaching in the medium of African languages. The institution one lecturer revealed that there is a gap in mathematics language of learning and teaching in the initial education institutions and the FP classrooms in South African schools. She said:

LF1/2: *“We have diverse groups of student teachers here and the institutions guiding framework or policy states that the offering language is English. Hence, English is the language we are teaching them with. However, I acknowledge that it’s a challenge for these student teachers because English is not compatible with the school curriculum in our context as they are required in the real classrooms...eh ... I mean teaching and learning is in home language”*

From the LF1/2 account, it seems that teaching and learning of mathematics in English during initial teacher education programme does not provide them with appropriate mathematics terminologies in African languages. The student teachers are expected during teaching practice to transform their mathematics knowledge from English to their home languages which is African languages in the context of this study. This language challenge exacerbates the problem as according to them (student teachers) African languages do not have some mathematical technical terms to explain simple mathematical processes. Student teachers are therefore forced to code-switch between English and home languages, to simplify the mathematical content and make sure that their explanations reach home. Code-switching as a strategy will be explained in the next category. Despite the fact that the institution one lecturer alluded to the challenges faced by students when teaching in their mother tongue, the institution two lecturer was silent in this regard. However, the student teachers from these two institutions expressed their concern and shared their experiences. Compare their remarks:

SFF1-1: *“In my case, I have a big problem in teaching mathematics in home language. There are certain parts in English like 3D, I find it difficult to explain to a learner what is the difference between 2D and 3D objects*

*in home language as we normally use English to communicate maths concepts at home.*

SFF2-2: *“Yes, here at varsity there is an option of Sesotho or isiZulu but we do just the basics. I do maths in English here. I think maths is simple in English. For example, number name 8 in isiZulu is...mmm...(wrote on a piece of paper, counted the letters and read the name) 17 letters, ‘isishiyagalombili’ and in English there are only five letters ‘ eight’. Hayi, it is boring, I think English is simple and easy for this kids.*

SFF1-3: *“Kufana nanini? besenza jesi...ama 3D nabo baye lapha phasi babhale ukuthi... angazi angisho i...isilinda inaphezulu la kuwuround nala ngaphansi maye..., bakubibuze..., eyi! angazi yini lokhuya, bakubizile, bakubize ngesiNdebele angikwazi yini, sekufanele ngichaze, mangenza so abantwana babuza terug kimi ukuthi mam, yini lokhu kufanel ngithini?”. (It’s like when, we were doing 3D with them they went down and wrote, I don’t know what. Isn’t a cylinder has a round top part at the bottom. They asked me, hayi...! I don’t know what’s that, they named it..., they named it in isiNdebele and I don’t know that. I had to explain, when I explained these children asked questions, that mam, what is this and then what am I supposed to say?”*

SMF1-1: *I am an isiNdebele speaker, some of the things I don’t know in my language, so I found it difficult to explain some of the maths concepts I have learnt from the university”.*

The student teachers’ narratives above seem to reveal that inadequate mathematical words in their home language hamper them to transfer their mathematical knowledge to the level of learners. SFF1-3 relates her frustration of not knowing how to express, clarify and transform her mathematical knowledge to benefit learners. These student teachers seem to suggest that their mathematical programme should equip them to teach and learn in their home languages. They said:

- SFF2-4: *“I think the university should teach us mathematics concepts in our mother tongue but I don’t know how because here we are multiracial and speaking different languages”.*
- SFF1-3: *“At varsity they don’t provide us with mother tongue terminology, how are we going to teach at schools, in English?”*
- SMF1-2: *“That is why you find that the development of mathematics is delayed by language we are going to struggle out there because here at the varsity they teach us mathematics in English”.*
- SFF2-3: *“There are some maths terms that I don’t even know in my home language, let alone how to pronounce the word or explain the word to the learners. So the university should try and prepare us to teach maths in our home languages as it is a requirement at schools”*

The respondents in my study indicated that the mathematics programme during initial teacher education should expose them to teach and learn mathematics in their home languages. However, it is evident that the two initial teacher education institutions in my study; cater for diverse student teachers speaking different languages, hence the teaching and learning of mathematics is in English. South Africa has eleven official languages therefore this seems to be a challenge that has a lot of implications towards preparing student teachers to teach FP mathematics. These student teachers are expected to transfer their MPCK in a language they themselves are not comfortable to speak. The question I asked henceforth is; how are these student teachers going to teach mathematics to the best of their ability if they struggle with the language of learning and teaching in their home language which in this context is African languages?

In addition to the concerns expressed above regarding mathematics language of learning and teaching in the initial teacher education institutions, student teachers revealed that even though CAPS stipulates that FP learners be taught in their home languages, Grade R learners are taught mathematics in English. They said:

- SFF1-2: *“During my TP (Teaching Practice) in my first year, I was in Grade R class, I observed that those learners are taught maths in English, but in Grade 1 they are expected to learn in their mother tongue, why?”*

SMF1-1: *“Ja, you are right, I remember. Where I was as well Grade R learners were taught in English. The kids were singing and counting maths in English but from Grade 1 they speak isiZulu”.*

The respondents in the study seemed to suggest that there is no continuity and progression of learning and teaching of mathematics from Grade R to Grade 1. During the focus group interview, student teachers further indicated that they observed that the vocabulary in the mathematics learners’ workbooks provided by the South African Department of Basic Education seems to be deficient. Elaborating on the above, student teachers from the two institutions in this study said:

SFF2-3: *“I was teaching number line in SiSwati but in the learners workbooks it was written as ‘namba liyini’ of which for me, it is English direct translation. In my knowledge number line in SiSwati is **umugaca we timombolo**”.*

SFF1-3: *“I realised during teaching practice that some of the isiNdebele words in the learners books, are not the same ones I know and it’s a challenge because we as teachers we don’t know those words. May be they should look for people who are speaking that language to assist in writing the workbooks that will be easy for everyone you see”.*

SMF1-2: *“The development of mathematics is delayed by language and that there are no people who will translate IsiZulu or Sesotho in real words”.*

The statements above seem to suggest that the language of learning and teaching in mathematics has a great influence in mathematical knowledge construction. Lack of mathematics vocabulary of student teachers and incorrect use of language in the learners’ workbooks also seem to have an impact in the teaching and learning of FP mathematics in South Africa. A lack of mathematical language of learning and teaching is sometimes dealt with by code-switching, between mother tongue and English. This is dealt with in the next category.

#### **4.4.2 CODE-SWITCHING**

As indicated in section 2.3.1, code-switching is the proficiency to communicate and teach while changing from home language to another language in the teaching and

learning of mathematics (Cantone, 2007). The student teachers in this study indicated during their focus group interviews that lack or insufficient home language in mathematics promotes code-switching. This suggests that student teachers' lack or insufficient mathematical language comprehension seems to affect the teaching and learning and their confidence to teach mathematics in the FP schools. The student teachers revealed this when they said:

SFF1-3: ***“U thole sometimes ukuthi u fanele kuthi u switche u sibenzise English kancani and uthole ukuthi isiNgesi abasazi.”*** (You find sometimes that you are supposed to code switch to English a little bit, and you find that these learners are not conversant with English).

SFF2-3: ***“When I was teaching line of symmetry in Siswati, (ilayini lelisemkhatsini) in Grade 1, I realised it was difficult for these kids to understand. I tried to explain in English but still it was the same”.***

The student teachers remarks above seem to suggest that code-switching does not necessarily enhance learners' learning in mathematics. The problem seems to be that mathematics uses abstract language which is not catered for in African languages. Translating the abstract concepts does not make understanding easier. Therefore, teaching mathematics is compounded by the language of instruction and the mathematical language.

However, some student teachers expressed their views differently and indicated that code-switching to English seems to be a better option as they feel competent teaching mathematics in English. They supported this by saying:

SMF2-3: ***“Starting from last year, after the introduction of CAPS in Grade 1, actually in the FP, there is English at least I can teach the learner maths in English and not struggle with home language”.***

SFF1-2: ***“Actually I don't think teaching them in English is quite a problem because you find that one day during the week they come across English term, so migrating them to English is not affecting me or them at all”.***



The respondents above seemed to suggest that code-switching from home language to English in the teaching of FP mathematics is essential. They revealed that they feel confident to teach mathematics in English. Another interesting dimension to this conversation is that some student teachers indicated that they attended school in English medium schools and therefore they have a challenge to teach in African languages. They said:

SFF2-4: *“You know I am Sotho and I was never taught in seSotho, I cannot teach anyone seSotho, so for me I must just be employed in an English medium school or otherwise I will be learning with my learners to write and speak seSetho, **ijoo!** this is embarrassing **bathong** (people)... (giggles)”.*

SMF1-3: *“I only speak my home language with my grandmother at Venda, but at home we communicate in English ever since I started my schooling. So teaching in maths in English is a better option. That is why I love CAPS”.*

SFF2-6: *“I grew up in a township and my home language is (sePedi) Northern Sotho. The Northern Sotho in the books is different from what we speak (**mo**) here, we mix different languages around when we speak. So sometimes when I teach maths I end up speaking mixed languages and these kids understand better because that is how we communicate at home and in our (**kasie**) area. Is that wrong guys?”*

It emerged that some student teachers can communicate but cannot read or write in their home languages. This means that these student teachers seem to have a challenge to teach mathematics in African languages. In addition, SFF2-6 seems to suggest that the local vernacular should be taken into consideration in the teaching of mathematics. Therefore, it is important that preparation of student teachers should take into consideration language variables that impact upon the understanding and teaching of mathematics.

## 4.5 STUDENT TEACHERS' PERCEPTIONS ABOUT THE MATHEMATICS PROGRAMME

Kleickmann et al. (2013) revealed that student teachers enter initial teacher education with preconceived and negative ideas about mathematics content and pedagogical knowledge from their school years (see chapter two, section 2.10.1). This theme speaks about student teachers' perceptions about mathematics content and pedagogy. The theme brought to the fore the student teachers' experiences and views regarding their mathematics modules. More importantly the theme helped me understand student teachers views regarding their preparation against the four following categories.

- Knowledge of mathematics content and
- Knowledge of the school curriculum
- Teaching and learning mathematics to learners experiencing mathematics difficulties (Inclusive education)
- Experience gained through teaching practice

The categories are subsequently discussed.

### 4.5.1 KNOWLEDGE OF MATHEMATICS CONTENT AND PEDAGOGY

This category revealed student teachers' perceptions about their mathematics content knowledge. Most of the student teachers seemed to appreciate the fact that their mathematics content knowledge has improved significantly during the programme. They expressed their experiences and knowledge of mathematics content during their focus group interviews. They said:

SMF1-1: *"We know how to teach Mathematics you see...err...! err! Because when I was at school we were just given calculations and I did not know how to solve those calculations but I came to the solution and get marks. So for now, I can be given a class and I can be able to teach exactly step by step until you reach the solution on how that thing is done. I know how to make it easy for everyone to understand".*

SFF2-5: *"I didn't do pure maths at school and didn't like it at all. For example I remember in grade 2, when they gave us sums I will copy what was on the board and not write the answer...(giggles)....., as we were many in*

*the class so we had to queue so I will join the line but when I am number five or so (laughing) I will return to my seat. I only joined the queue so that my classmate can see me on the line, I think my book was marked only 2-3 times, that is how much I hated maths from primary but now I gained a lot of knowledge, the presentations and discussion and the books we made for each concept I think they helped me understand maths”.*

Student teachers in this study revealed that their mathematics programme improved their mathematics content knowledge. They indicated that they now know the strategies and procedures to solve mathematical problems. However, SMF1-3 seemed to have a different view from all other student teachers. He said:

SMF1-3: *“Actually, you won’t teach me one plus one (1+1) but you will teach me how to teach mathematics”.*

From SMF1-3 utterances above it seems to suggest that he underplays the significance of learning mathematics content including conceptual and procedural knowledge during initial teacher education programme (see Chapter Two, section 2.2.1). He holds the opinion that the teaching and learning of pedagogy is more important than mathematics content knowledge during initial teacher education programme. Maybe his level of mathematics content knowledge is above other student teachers, however, during the focus group interview with the student teachers from the two institutions, they expressed their confidence in their pedagogical knowledge. They said:

SMF1-1: *“I can say coming from high school having done pure maths, you only have those difficult methods that they used to teach maths. So having done (...) module, I can say has developed us in terms of methodology, how to teach maths in a simpler version to the younger ones than jumping because when coming from high school you are just using easier methods for you to just get done, you know”.*

SFF2-6: *“I am so confident; our methodology module opened our eyes. I know that learners are different and I must use different methods to teach them. The theories of learning are so real, during our teaching practice*

*we see how these learners are, and you can see how important it is to know and understand your learners”.*

From the responses above it emerged that the student teachers were positive that their mathematics pedagogical knowledge was enhanced during their initial teacher education programme. The student teachers seemed to know that they should use different teaching strategies to cater for learner differences. However, based on the contrasting views from the student teachers, it is important for me to highlight that student teachers in this study have different mathematical backgrounds. Some student teachers passed pure mathematics in matric and the others did basic mathematics. That is why student teachers like SMF1-3 pointed out that he only needs to know how to teach mathematics and not the content.

Nevertheless, the student teachers who participated in my case study regard MPCK as essential in their preparation to become teachers. As much as they view MPCK important they also indicated their perceptions about the South African school curriculum, CAPS. The next category focused on student teachers knowledge of the curriculum.

#### **4.5.2 Knowledge of the school curriculum**

Curriculum is the core plan for lessons. It highlights the content, sequence, instructional strategies and assessment requirements for each grade (Lattuca & Stark, 2009) (see section 2.10.2). In this category student teachers expressed their experiences and perception about the curriculum; the Curriculum and Assessment Policy Statement (CAPS). In South Africa, CAPS is an essential policy document that stipulates the skills and knowledge that learners should acquire in each Grade (DBE, 2012). During the focus group interview with the student teachers in this study, they indicated that CAPS brought some relief to them in terms of planning and preparation to teach. They said:

SMF1-3: *“CAPS is better because now we don’t have to do those learning outcomes and critical outcomes. In CAPS I just take one topic and everything is there and see to it how am I going to add my knowledge to teach this learners”.*

SFF2-5: *“RNCS had about seven or nine critical outcomes and then now you had to fit them along the way and make sure they link with the learning outcomes it was difficult. Now with CAPS no critical and learning outcomes you teach straight away”.*

These student teachers seemed to relate to the positive aspect of CAPS. They revealed that they are no longer faced with the challenge of determining learning outcomes and critical outcomes as it was in the previous curriculum; the Revised National Curriculum Statement (RNCS). Additionally, during the interview it was evident that these student teachers had a clear understanding of the role of CAPS in the teaching and learning of mathematics. This was revealed in the following conversation.

SMF1-3: *“It is good that CAPS planned everything, I know what learners must know in each grade”.*

SFF2-2: *“With CAPS teachers go straight to class and teach they don’t have to sit down and plan, all the lessons are ready for all the grades. I love that part with CAPS”.*

The responses above show that these student teachers are aware that CAPS specifies the mathematical content and progression to be learnt in each grade. However, they also expressed their concerns regarding the curriculum. They related their sentiments by saying:

SMF1-2: *“CAPS does not allow teachers to be themselves in a way, because there are lesson plans in CAPS for each week, week 1, 2, so as a teacher if they are done teaching whatever was on week 1 and it is Wednesday or Thursday, what must the teacher do from then onwards? Must he or she continue teaching what is to be taught in week 2 or must he or she start again? So for me it does not allow them to be”.*

SFF2-4: *“CAPS expects learners in the whole country to learn for instance, 1 on a particular day and move to number 2 on the next day, so what about those learners struggling with 1? Teachers at schools are complaining*

*about this but they follow what is written there because they say they have to cover everything before the... the...this tests...mmm...ANA”.*

Besides the student teachers highlighting the strengths in CAPS they were also cognisant of the flaws in the curriculum which make it exclusive. They revealed that the curriculum does not cater for all the learners needs. These student teachers further pointed out that CAPS prescribes the contents that should be learnt daily by learners at schools disregarding learners understanding of concepts. For this reason some student teachers seem to suggest that CAPS should be used as a guiding tool and should not be too prescriptive. They illustrated their points by saying:

SFF2-4: *“I think personally I will use CAPS as a guide and I will not rush my learners if they do not understand. I am as well willing to stand up and challenge anyone who will force me to move on even though my kids are struggling”.*

SFF1-6: *“The problem is that learners are different and don’t learn at the same pace so it’s like we have to accommodate them. I am going to cover all maths concepts as per CAPS but guided by my learners pace and understanding. For as long as my learners don’t understand I won’t move to the next level until I am satisfied that they do”.*

The responses above seem to suggest CAPS is fast tracking learners’ mathematics learning. This means that learners are required to learn mathematics concepts rapidly and sometimes without understanding. This disregards the learners’ paces for learning but at the same time CAPS requires teachers to be inclusive in their teaching and accommodate learners with mathematics learning difficulties.

#### **4.5.3 TEACHING AND LEARNING OF MATHEMATICS TO LEARNERS WITH MATHEMATICS DIFFICULTIES**

According to Landsberg et al. (2011) catering for learners with mathematics learning difficulties is essential as it honours inclusion and diversity (see Chapter Two, section 2.10.3) (DoE, 2001). This category comprises of student teachers’ views and opinions regarding teaching and learning mathematics to learners experiencing mathematical difficulties (inclusive education) during their initial

teacher education programme. During the focus group interview with the student teachers it was evident that these student teachers are aware of the importance of teaching of learners with diverse needs. However, some student teachers in my case study expressed that they somehow feel ill-prepared when it comes to inclusive education. The student teachers remarked by saying:

SFF1-6: *“You know one thing I realised about the university is that they tell you that there are certain things that you are going to come across but they don’t tell you how to overcome those things. They just say, okay, in schools you gonna find out that, there are some learners who fail to understand mathematics but they don’t give you strategies on how to make those kids understand mathematics”.*

SFF1-3: *“This inclusive education thing, they tell you **uguthi** (that) you gonna come across learners **banema**” (with) learning disabilities, like a kid who has epilepsy, they don’t really train you or give you the necessary skills to deal with that particular child when you are in the classroom and from **wena** (you) as an educator you will have to accommodate them as much as you can. **Kunzima** (it is difficult)”.*

SFF2-5: *“My main concern is that varsity does not teach us to deal with medical disabilities, like children using wheelchairs. Inclusive education is a good thing but it is not practical at all, especially when you are alone with fifty to sixty learners in a classroom”.*

Student teachers seem to suggest that their initial teacher education programme has introduced them to the theoretical aspects and not to the practical aspects of dealing with learners experiencing mathematics difficulties and other learning barriers. However, some student teachers had contradicting views from their counterparts. They revealed that:

SFF2-3: *“We learnt that we are dealing with different human beings that are from different backgrounds and working differently so we need to know how to teach and treat these learners”.*

SFF2-4: *“You know, assessing your learners is important, you can choose correct teaching methods and accommodate all your children in class, you know, it is easy. Some methods we did showed us how do you*

*teach in different levels and accommodate all the children in the class....giggles”.*

The comments above seem to suggest that these student teachers are aware that they should assess their learners in order to understand their learning needs. Institution two document analysis of the textbook in their pedagogy module seems to corroborate with the student teachers views. The textbook seems to emphasise that assessment is essential in the teaching and learning of mathematics. The study guide and readers of institution one, lacked proper assessment requirements in order to determine learners’ learning needs. During teaching practice student teachers are exposed to the practical and professional experience or working with learners with different needs. This is discussed in the next category which deals with student teachers’ teaching practice experiences.

It is evident that student teachers in this study do not have the same understanding of teaching and learning of learners experiencing mathematical difficulties. Their focus was mainly on inclusive education and learners with severe medical difficulties. Some of the student teachers referred to severe disabilities and others to learning barriers or disabilities. However, learners with severe learning difficulties in South Africa, are not placed in mainstream schools, nonetheless the focus was on inclusive teaching and learning of mathematics.

#### **4.5.4 EXPERIENCE GAINED THROUGH TEACHING PRACTICE**

Teaching practice provides student teachers with an opportunity to teach in a real classroom and observe and learn from various resources such as videos, mentor teachers and peers (see section 2.9.4.) (Cheng et al. 2010; DHET, 2011). During the focus group interview with the student teachers in my case study, it was clear that these student teachers were involved continuously in teaching practice from the very first year of their training. The purpose of teaching practice is to demonstrate to these student teachers how mathematics theory can be put into practice. Student teachers observe and learn the skills of teaching mathematics from practising teachers or mentor teachers. The student teachers, in this study, however, expressed concerns about the way their mentor teachers teach FP mathematics. They said:



- SMF1-1: *“When you look at most teachers teaching FP are our mothers and grannies who have been teaching for years with traditional teaching methods and it is not easy for them to change to new strategies”.*
- SMF1-2: *“I think the teachers there are not adhering to the requirements of CAPS or whatever curriculum is there, because they are using the old methods, they say count, 1, 2, 3, they scream and when you use other methods to teach they discourage you and say you confuse yourself and learners at the end of the day you have to be quiet for the whole month”.*
- SFF2-4: *“What I have experienced now in my TP in Grade 3 is that my mentor teacher is using one strategy to teach every day. Learners are not given a chance to do things on their own. She tells them how to solve maths problems. I did ask why, and she said she has to follow CAPS daily so if she delays she is going to be behind”.*

Even though teaching practice is perceived to be a platform whereby student teachers are meant to put theory into practice, it emerged during focus group interviews with student teachers that it might not always be possible. Some of the student teachers seemed to suggest that they do not learn much from their mentor teachers, as it is the purpose of teaching practice. They revealed that their mentor teachers seem to know and understand different teaching strategies to teach mathematics but fail to apply them in their classrooms due to time constraints and pressure to comply with the curriculum requirements.

It emerged as well during the focus group interview with the student teachers that it seemed as if some mentor teachers take leave of absence during their teaching practice. These student teachers are then expected to take over the role of the teacher for the period that their mentor is absent from school. The student teachers highlighted this by saying:

- SFF2-3: *“My mentor teacher was absent for eight days, I was left with the learners and I used the teaching methods that I learnt from varsity but there was no one to guide me as I was reflecting on my lessons”.*
- SMF1-3: *“Last year my mentor had a problem so she had to go away on certain days of the week so then she left me with learners and used my*

*methods and they are working, meaning next year when I will be teaching I will use the strategies I learnt, I will definitely use my methods”.*

From the above-mentioned statement, it is clear that the purpose of teaching practice is defeated due to various reasons. However, some student teachers revealed that they used the opportunity offered by absenteeism of mentor teachers to practice instructional strategies that they have learnt from their institutions without the interference from their mentor teachers. Another aspect that seemed to be of great concern for the student teachers was assessment. Student teachers in my study indicated that the thought of knowing that they are supposed to be assessed by their lecturers during their teaching practice was terrifying. They remarked by saying:

SFF1-1: *“It is scary when you know that your lecturer is coming to check if you are able to implement what she has taught you. So you work hard to prepare for her coming, you prepare the learners so that they behave”.*

SFF2-6: *“I spent sleepless nights thinking of the visit. I worry about how am I going to present, how are the learners going to behave and my teaching media? I love teaching practice after assessment not before because it is frightening not knowing what to expect”.*

The student teachers’ comments above seemed to suggest that they feel very unsettled by the knowledge that their lecturers have to come and assess them as part of their practical teaching practice experience. In my opinion it seemed that these student teachers view the process of assessment during their teaching practice as a punitive measure by lecturers on them (student teachers) and not as a support session for their development in the teaching and learning of mathematics.

Another aspect that emerged during the focus group interview with institution one student teachers, is that not all student teachers are assessed by their lecturers. They revealed that student teachers speaking other languages other than the one spoken in the vicinity of their institution are assessed by curriculum implementers. These curriculum implementers are the employees of the provincial departments of basic education in South Africa. This is how they related their views:

- SFF1-3: *“For us from Mpumalanga and other provinces, they send curriculum implementers from the district office as we are expected to teach in our mother tongue and in that province there is only one dominant language and that will be a challenge for us to teach. So we don’t know the curriculum implementers and it is easy to teach in front of a person you don’t know than your lecturer”.*
- SMF1-2: *“I excel in front of the curriculum implementers, I don’t worry much because I teach what the lecturer has taught me, and they are always impressed with the way we teach”.*

Student teachers assessed by district officials expressed that they felt more comfortable to teach mathematics during their assessment than their peers assessed by their lecturers. This seems to suggest that student teachers view the curriculum implementers as outsiders who may not be familiar with the latest pedagogy of teaching mathematics. Hence, they are impressed with the student classroom practices. I therefore ask, what is the quality of feedback do the district officials offer these student teachers and does that feedback scaffold student teachers mathematics content and pedagogical knowledge? This question may be answered by another study emanating from this one.

#### **4.6 CONCLUSION**

The purpose of this chapter was to present comprehensive report of participants’ responses with regards to the construction of FP mathematics pedagogies through initial teacher education programme. The presentation and analysis of findings focused on three main themes and categories which emerged during the analysis process as outlined in chapter three.

I used participants’ exact quotations from interview transcripts to support my explanations of the lecturers and student teachers experiences, views and concerns. There were commonalities and differences from both the lecturers and student teachers views and experiences with regards to their mathematics programme and the construction of FP mathematics programme.

Chapter five presents the discussion of the research findings with reference to the literature on the construction of FP mathematics pedagogies through initial teacher education programme.

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## **CHAPTER FIVE OVERVIEW, DISCUSSIONS OF FINDINGS AND RECOMMENDATIONS OF THE STUDY**

### **5.1 INTRODUCTION**

In chapter four, I reported the findings from the respondents according to the themes and categories as they emerged during data analysis. Participants in this study shared their experiences and views with regards to the construction of FP mathematics pedagogy during the initial teacher education programme. Data were gathered through document analysis, semi-structured interviews with lecturers and focus group interviews with the student teachers to enhance triangulation (Creswell, 2012). Data analysis was guided by what literature regard as essential in the construction of FP mathematical knowledge for teaching and the process of mathematical knowledge acquisition and transmission.

This chapter presents the discussion of the findings in relation to the concepts, theories and the relevant literature as stated in chapter two. The discussion is further grounded on the research questions as stated in chapter one. Suggestions for future research are presented. Recommendations are made based on the findings of this study.

### **5.2 SYNOPSIS OF THE STUDY**

A brief summary of the findings conveying participant's experiences' with regards to the construction of mathematics pedagogy during the initial teacher education programme is presented. This summary provides participants detailed practices.

Table 5.1 below comprises of the themes and participants' responses from institution one and institution two.

**Table 5.1: Summary: A brief sample of participants views about their experiences in the construction of FP mathematics pedagogies in their programmes.**

THEMES	PARTICIPANTS' RESPONSE INSTITUTION ONE	PARTICIPANTS' RESPONSES INSTITUTION TWO
Mathematics content and pedagogical knowledge in Foundation Phase	<ul style="list-style-type: none"> <li>“Bringing in the slides, we normally load in the module, which embrace the resources they use on-line and readings on that topic that they will be doing as they will check it out and research about it so that when they come into the class they will know what we will be teaching. Then bring in the real resources for them to see so that they need to bring them in class even if they are out teaching or teaching practice and also ....err...err.. movies in terms of technology (LF1/1).”</li> </ul>	<ul style="list-style-type: none"> <li>“We use and make them to look at the different teaching methods which I have covered in my book. There are different teaching methods, lecturers, assignments, the discovery methods and so on but the view is that the best teachers always combine these methods (LM1/2).”</li> </ul>
Mathematical language of learning and teaching	<ul style="list-style-type: none"> <li>“If it was possible the university should teach us mathematics in our mother tongue so that it will be easy for us to know and understand these concepts (SFF1-1).”</li> </ul>	<ul style="list-style-type: none"> <li>“Home Language is a problem...some of the mathematical terms you do not know and how do you to explain them to children (SFF2-3).”</li> </ul>
Student teachers' perceptions about mathematical modules	<ul style="list-style-type: none"> <li>“I can say that coming from high school having done pure maths you only have those difficult methods that they used to teach. So having done (...) module, I can say it has developed us in terms of methodology, how to teach maths in a simpler version to younger children (SMF1-1).”</li> <li>“You know one thing I realise about the university is that they tell you that there are certain things that you are going to come across but they don't tell you how to overcome those things. They just say, okay, in schools you are going to find out that, there some learners who fail to understand mathematics but they don't give you strategies on how to make those kids understand mathematics (SFF1-6).”</li> </ul>	<ul style="list-style-type: none"> <li>“I didn't to maths at school and didn't like it at all. For example I remember in grade 2, when they gave us sums I would copy what was on the board and not write the answers...giggle...., as we were many in the class so we had to queue and I would join the line but when I am number five or so ...(laughs) I would return to my seat. I only joined the queue so that my classmate can see me on the line, I think my book was marked only 2-3 times, that is how much a hated maths from primary but now I gained a lot of knowledge, the presentations and discussion and the books we made for each concept I think they helped me understand maths (SFF2-5).”</li> </ul>

The above-mentioned participants' experiences can be considered to be reflecting positive and negative experiences. Both student teachers and lecturers from the two initial teacher education programmes seemed to be positive towards the teaching and learning of mathematics pedagogy in their modules. This was supported by SMF1-1 and SFF2-6 who revealed that their mathematics pedagogy module changed their misconceptions about the teaching and learning of mathematics pedagogy in the Foundation Phase. They stated that they feel positive and confident to teach mathematics in FP classrooms.

SFF1-1 and SFF2-5 pointed out that the different mathematics teaching approaches such as; lectures, investigations and presentations helped them to engage in mathematics. They stated further that as they collaborated with their peers, had discussions and critically reflected on their practices, that they constructed new mathematics pedagogical knowledge.

However, SFF1-1; SFF1-3 and SFF2-2 highlighted some negative aspects in their modules as well. They mentioned that the language of learning and teaching in their programme is disconnected to mathematics language of learning of schools where they are going to practise in future. Furthermore, it seems that student teachers are not adequately prepared to teach learners experiencing mathematical difficulties (SFF1-6 & SFF1-3).

### **5.3 LITERATURE CONTROL**

In this section I start my discussion by presenting a summary of the findings in relation to the literature. Table 5.2 below presents the themes, summary of the literature and my interpretation. The literature agrees with the findings of the study undertaken. The discussions were guided by the themes and subsequently I responded to the research questions.

**Table 5.2: Present the themes, literature review and interpretations**

Category	Author and year	Existing knowledge	Interpretive discussion
<b>THEME 1</b>			
<b>MATHEMATICS CONTENT AND PEDAGOGY KNOWLEDGE IN FOUNDATION PHASE</b>			
Mathematics content knowledge	Kilpatrick (2001); Rowland et al. (2010); Shulman (1987); Van de Walle et al. (2013)	Comprehension of mathematical concepts knowledge, rules and processes of doing mathematics	In this study, the lecturers indicated that student teachers were supported with mathematical content, rules and processes of doing mathematics (see section 4.3.1.1).
	Thanheiser et al. (2011)	Student teachers are taught the five mathematics concepts as learners	In this study student teachers are prepared to teach the five concepts of mathematics as reflected in CAPS (see section 4.3.1.1).
	Hill et al. (2008); Markworth et al. (2009); Suzuka et al. (2009).	Student teachers should possess mathematical knowledge and reasoning that surpass that of the learners	Student teachers are taught mathematics at the higher level (see section 4.3.1.1).
	Walshaw (2012); Kleickmann et al. (2013)	Comprehensive mathematics content knowledge is a prerequisite to the construction of mathematics pedagogy	In this study, the lecturers revealed that student teachers should know the mathematics content and know how to teach mathematics LF1/1 said: "With the content I don't know whether they have much knowledge of what they need to know and know how to teach". (see section 4.3.1.1).
Mathematics content and pedagogical content knowledge	Ford & Strawhecker, (2011); Shulman (1986); Zaskis & Zaskis (2011).	Pedagogical knowledge is regarded as the combination of different types of knowledge of pedagogy, research, theories, curriculum, mathematics content	In this study, student teachers were taught the different aspects of pedagogy, including pedagogy, research, theories of learning and the curriculum (see section 4.3.1.2). SFF2-4 said: "In our methodology course we learnt about how learners learn, different teaching strategies, about what Vygotsky and Piaget are saying, the aims and objectives of teaching mathematics".
	Bernstein (2000); Rowland et al. (2010); Shulman, (1987)	Pedagogical knowledge is the capacity to transform acquired mathematics knowledge to the level of learners.	In this study, student teachers revealed that they acquired skills to transform their mathematical content knowledge in ways that are accessible to learners.
	McCrary & Cannata (2011).	Pedagogy is delivered through lectures,	In this study, lecturers indicated that they use integrated



Category	Author and year	Existing knowledge	Interpretive discussion
		student presentations, video presentations, small group work, whole group discussions	teaching strategies to teach mathematics (see section 4.3.1.1).
	Fuentes (2011); McCrory & Cannata (2011); Nason et al. (2012); Shulman (2000); Stigler & Hiebert (2009); Van de Walle et al. (2013)	Mathematics pedagogy involves reformed based methods	The study revealed that student teachers collaborate, investigate, communicate and reflect to construct new mathematics knowledge. This is supported by SFF2-5 in section (4.3.1.3): "We go to class prepared, the lecturer presents lessons with slides then we discuss the scenarios that are presented to us through videos. We read articles, different books, discuss in groups and watch different videos on how to teach maths to young children".
Comprehensive instructional strategies used in mathematics teaching and learning	Siemon, et al. (2013); Suzuka et al. (2009); Van de Walle et al. (2013).	Delivery of mathematics in different instructional strategies and representations such as inquiry-based learning, problem-solving and traditional teaching methods is essential in the teaching of mathematics.	In this study, different instructional strategies were employed in the teaching and learning of mathematics. LM1/2 said: "There are different teaching methods, lectures, assignments, discovery methods and so on, but the view is that the best teachers always combine these methods in such a way that people won't understand, because it is so well-merged and this that is what we try to teach them that there is no single method that is regarded as the most effective, a good teacher should be able to mix all these and come up with an effective lesson" (section 4.3.1.3).
<b>THEME 2</b>			
<b>MATHEMATIC LANGUAGE OF LEARNING AND TEACHING IN FOUNDATION PHASE</b>			
Lack of mathematical concepts in African Languages	Spaull (2013)	Lack or insufficient knowledge of language of learning and teaching impact learner performance	In this study, student teachers revealed that teaching mathematics at schools through home language is challenging as they lack the vocabulary needed to do mathematics in their home languages (see section 4.4.1) SFF1-1 said "It's like when, we were doing 3D with them they went down and wrote, ' I don't know what. Doesn't a cylinder have a round top part at the bottom?' They asked me, ' hayi...! I don't know what's that,

Category	Author and year	Existing knowledge	Interpretive discussion
			they named it...’, they named it in isiNdebele and I don’t know that. I had to explain. When I explained these children asked questions, ‘that mam, what is this?’ and then what am I supposed to say?”
	Cambourne in Killen (2010)	Sufficient language skills enhance learners to make connections, identify patterns, and to organise previously unrelated bits of knowledge, behaviour and action into new patterned wholes”.	In the study, student teachers struggled to make connections using the mathematical language of learning and teaching in their initial teacher education programme and battled to match their knowledge with that of the schools. SFF1-3 mentioned in (section 4.1.1) that: “At varsity they don’t provide us with mother tongue terminology. How are we going to teach at schools, in English?”
	NEEDU (2012); Nkambule (2012)	The lack of mathematical concepts in home languages poses a challenge in teaching mathematics.	In this study student teachers expressed that a lack of mathematical concepts in their home language hampers their teaching and learning (section 4.4.1).
Code-switching as a technique for mathematics teaching	Needu (2012); Nkambule (2012).	Code-switching helps learners to make connections, and also to accommodate all the learners.	In this study, student teachers revealed that code-switching was challenging because some learners did not understand English as well. SFF2-3 revealed this when she said: “When I was teaching line of symmetry in Siswati, ( <b>ilayini lelisemkhatsini</b> ) in Grade 1, I realised it was difficult for these kids to understand. I tried to explain in English but still it was the same” (section 4.2.2).
	Moto in Chauma (2012)	Knowledge to speak a language does not mean you can teach it and code-switch effectively	The study found that some student teachers know their home languages in a conversational level only “SMF1-3: “I only speak my home language with my grandmother at Venda, but at home we communicate in English ever since I started my schooling. So teaching maths in English is a better option. That is why I love CAPS”. (See section 4.4.2).

<b>THEME 3</b>			
<b>STUDENT TEACHERS' PERCEPTIONS ABOUT MATHEMATICS PROGRAMME</b>			
Interpretation and implementation of the school curriculum in the South African context	Fang & Clarke (2014). Makeleni & Sethusha, (2014); Moodley (2013).	The curriculum reduced teachers' workload.	In this study student teachers expressed that CAPS provides lesson plans therefore their workload is reduced (section 4.5.2).
	Ramatlapana & Makonye (2012); Fang & Clarke (2014).	The curriculum is content-orientated and fast-paced	The study revealed the curriculum is fast-paced and does not accommodate all learners.
	Makeleni & Sethusha, (2014)	The curriculum should be used as a guide and should not be seen as cast stone	In this study, student teachers expressed that CAPS should be used as a guide.
	Fang & Clarke (2014).	Curriculum reform is normally disregarded by teachers	In this study student teachers revealed that teachers were still using traditional teaching methods to teach mathematics.
Teaching mathematics to learners' experiencing mathematical difficulties (Inclusive education) in Foundation Phase	Hemmings & Woodcock (2011)	Insufficient training hampers proper inclusion.	The student teachers in this study revealed that their programme had not sufficiently prepared them to teach in an inclusive environment (section 4.5.3).
	Sharma, Forlin & Loreman (2008); Oswald & Swart (2011)	Sufficient teaching is needed about inclusive education and exposure to teach learners with learning disabilities.	In this study student teachers expressed that knowledge about learners' learning needs improves inclusion.
Student teachers experiential learning experiences	Maphosa, Shumba & Shumba (2007)	Mentors taking leave during teaching practice	In this study student teachers mentioned that they had insufficient pedagogical support and guidance from their mentors because of their absence (section 4.5.4).
	Hudson & Hudson (2007); Mukeredzi & Mandrona (2013)	Mentor teachers do not guide student teachers with regards to selection of different instructional strategies.	The student teachers in this study revealed that their mentor teachers used traditional teaching methods to teach mathematics.
	Fang & Clarke (2014).	Not enough pedagogical lecturers to evaluate student teachers	In the study conducted, some student teachers were evaluated by district officials (see section 4.5.4); this raises the question about feedback given to student teachers. Is it informative?

## **5.4 DISCUSSIONS OF FINDINGS AND ANSWERING THE RESEARCH QUESTIONS**

In section 5.4, I discuss the findings in relation to the research questions underpinning this study. The research findings were done in corroboration with the literature review and the conceptual framework to support this study. The research questions that guided this study are as follows:

### **The main research question**

How does the Foundation Phase initial teacher education programme prepare student teachers to teach Foundation Phase mathematics?

### **Secondary Research Questions**

1. How do Foundation Phase student teachers perceive their mathematics module in their teacher education programme?
2. What is the role of the mathematics language of learning and teaching in the construction of Foundation Phase mathematics pedagogy?
3. What factors influence the construction of Foundation Phase mathematics pedagogy during initial teacher education programme?

From section 5.4.1, I answer the secondary research questions and conclude with them main research question.

#### **5.4.1 HOW DO FOUNDATION PHASE STUDENT TEACHERS PERCEIVE THEIR MATHEMATICS MODULES IN THEIR TEACHER EDUCATION PROGRAMME?**

In Chapter Four section 4.4.1 I reported that student teachers felt that their mathematics module changed their negative perception towards mathematics teaching and learning. They indicated that the different teaching strategies and approaches that their lecturers applied allowed them to collaborate, discuss and critically reflect on their practices and this made them to acquire and construct new mathematical content and pedagogical knowledge. This is supported by (Fadde & Sullivan, 2013; Harford & MacRuairc, 2008; Korthagen et al. 2006; Shulman, 2000) that interaction and active participation in one's learning, contributes to new knowledge construction and confidence to teach mathematics.

However, as much as these student teachers portrayed to be confident in teaching and learning of FP mathematics, I found that their knowledge to support learners experiencing mathematical difficulties is lacking (section 4.4.2). SFF1-6 mentioned that: “You know one thing I realised about the university is that they tell you that there are certain things that you are going to come across but they don’t tell you how to overcome those things. They just say, okay, in schools you gonna find out that, there are some learners who fail to understand mathematics but they don’t give you strategies on how to make those kids understand mathematics”.

SFF1-6 statement is an important aspect that I pondered on because mathematics pedagogical knowledge includes the knowledge to teach all learners in the classroom especially to identify and support learners experiencing mathematical difficulties. This is supported by DHET (2011); Landsberg et al. (2011); Morin and Franks (2009) as well as Son and Crespo, (2009) by emphasising the importance of the knowledge to identify and support learners with learning difficulties especially in Foundation Phase mathematics. This is also stated in the school curriculum (CAPS, DBE, 2012) that it is important that teachers attend to learners with barriers to learning.

It was reported by the student teachers that South African school curriculum (CAPS) does not seem to accommodate all learners in the teaching and learning of Foundation Phase mathematics. This is depicted from SFF2-4 statement when she said: “CAPS expects learners in the whole country to learn for instance, 1 on a particular day and move to number 2 on the next day, so what about those learners struggling with 1? Teachers at schools are complaining about this but they follow what is written there because they say they have to cover everything before the... the...this tests...mmm...ANA”.

This finding is in support of the findings of Fang and Clarke (2014) that CAPS is content orientated and introduces too many topics simultaneously. Practising teachers are regarded as mentor teachers whom student teachers observe in their endeavour to learn the real teaching and learning skills of mathematics in classroom, thus the apathy and indifference shown by teachers may be transferred to student teachers.

However, the findings of this study agree with the findings of (Heeralal & Bayaga, 2011; Maphosa et al. 2007) that practising teachers use traditional teaching approaches in the teaching and learning of mathematics. Furthermore, it was revealed that practising teachers took different kinds of leaves and sometimes ignored their role of mentoring student teachers when planning and preparing to teach FP mathematics (section 4.4.3). It is therefore posited that teaching practice should be effectively planned to serve its main purpose to teach and provide student teachers with the skills to teach FP mathematics pedagogy. I argue that initial teacher education programmes should consider student teachers' perceptions with regards to mathematics teaching and learning as well as the impact of mathematical language of learning and teaching.

#### **5.4.2 WHAT IS THE ROLE OF MATHEMATICS LANGUAGE OF LEARNING AND TEACHING IN THE CONSTRUCTION OF FOUNDATION PHASE MATHEMATICS PEDAGOGY?**

This research question exposed the challenges experienced by the student teachers in this study, with regards to mathematical language of learning and teaching in their programmes and with that of schools. The challenges varied from lack of knowledge of mathematical concepts in African languages; multilingualism in classrooms; code-switching; incorrect use of words in the learners workbooks; inadequate translation skills and insufficient knowledge of African languages; inconsistency of the language spoken and the language used in books.

The language of learning and teaching plays a vital role in the teaching and learning of FP mathematics. A lack of or insufficient mathematical language of learning and teaching has negative consequences as it results in poor performance in mathematics (Spaull, 2013). The findings of this study concur with Spaull's (2013) findings because in (section 4.3.1) SFF1-3 struggled to transpose the knowledge about the topic at hand because of the language barrier. SFF 1-3 was teaching 3D shapes in isiNdebele which is her home language and was the mathematical language of learning and teaching in that classroom. However, it was clear that she lacked mathematical language in isiNdebele to transfer her knowledge efficiently for learners to understand. She even struggled to understand and respond to learners' questions. This is encapsulated in her statement when she said: "It's like when we were doing 3D with them they went down and wrote I don't know what. Isn't a cylinder has a round top part at the bottom. They asked me, (hayi...!) I don't know

what is that, they named it..., they named it in isiNdebele and I don't know that. I had to explain, when I explained, these children asked questions: 'that mam, what is this?' and then what am I supposed say?"

This is evident that the topic was poorly delivered and therefore I argue that it is essential that student teachers should learn mathematics in their home language (African languages) as it is the requirement for teaching and learning in the FP (DBE, 2012). This is important because SFF1-3 frustration was caused by the fact that she learnt the concepts at her institution in English and lacked the skills to translate. Moreover she cannot request help from her mathematics pedagogical lecturer for clarity or assistance to code-switch from English to isiNdebele as the lecturers' home language is not isiNdebele.

Some student teachers indicated that they opted to code-switch (section 4.3.2) in order to try and teach mathematics effectively. However, this study found that the student teachers struggled in this regard, because it seemed that learners in FP classrooms are not yet fluent in either their home language (African languages) or in English. SFF1-3 explained her experience and said: "U thole sometimes ukuthi u fanele kuthi u switche u sibenzise English kancani and uthole ukuthi isiNgisi abasazi." (You find sometimes that you are supposed to code switch to English a little bit, and you find that these learners are not conversant with English).

Another similar finding is that some student teachers attended English medium schools and they only know their home languages at a conversational level (section 4.31) and during teaching practice they go to schools where teaching and learning is mostly in African languages. They alluded that teaching mathematics in African languages is not easy. This finding is important because it should not be assumed that if you are able to converse in a language it means that you can teach and learn in that language effectively. Some mathematical concepts are too technical and one has to be proficient in the language of learning and teaching before attempting to teach mathematics to learners in FP (Chauma, 2012).

As much as the curriculum (CAPS) emphasises that the language of learning and teaching in FP should be through the medium of home languages, this language problem will remain a challenge. South Africa has eleven official languages and it should also be taken into account that FP does not only cater for South African

learners as there are other learners from neighbouring countries speaking different languages as well. Therefore, the selection and use of mathematical language of learning and teaching in FP is critical. With the introduction of CAPS learners were provided with workbooks. However, this study has found that some of the words in the workbooks seem to be incorrect, as the words differ from the language spoken or sometimes the words seem to be a direct translation of English. I argue that the discrepancy between the written and spoken language could cause confusion in the teaching and learning of FP mathematics. How are the learners going to learn and distinguish what is right or wrong? Hence it was suggested that the indigenous African language speakers should be invited to assist in writing the workbooks. SFF1-3 said: “I realised during teaching practice that some of the isiNdebele words in the learners’ books, are not the same ones I know and it’s a challenge because we as teachers we don’t know those words. May be they should look for people who are speaking that language to assist in writing the workbooks that will be easy for everyone you see”.

If the teachers do not know the words, how are the learners going to learn and distinguish between what is right or wrong? Hence, it was suggested that the indigenous African language speakers should be invited to assist in writing these workbooks. From the account above it is evident that proficiency in mathematical language is essential and it should also be acknowledged that mathematical language is an abstract language. Therefore, language is regarded as one of the factors that can influence the construction of FP mathematics pedagogy during initial teacher education training.

#### **5.4.3 WHAT FACTORS INFLUENCE THE CONSTRUCTION OF FOUNDATION PHASE MATHEMATICS PEDAGOGY DURING INITIAL TEACHER EDUCATION PROGRAMME?**

This research question was utilised to understand factors that influence the construction of FP mathematics pedagogy during the initial teacher education programme. Through the lecturers’ and student teachers’ own accounts in (sections 4.3.1, 4.3.1.1, 4.3.1.2, 4.3.1.3, 4.4, 4.4.1) I was able to determine the factors that influence the construction of FP mathematics pedagogical knowledge during B.Ed. FP initial teacher education programme. It was found that factors such as the integration of different types of learning knowledge, the processes involved in



learning mathematics pedagogical knowledge and student teachers' beliefs contribute to how twelve student teachers in this study constructed their mathematics pedagogical knowledge.

➤ **The types of learning knowledge**

In this study the types of learning knowledge to be learnt and the pedagogical reasoning and action process seem to be integrated and an on-going process that influences the construction of FP mathematics pedagogy during FP B.Ed. initial teacher education programmes. The types of learning knowledge to be learnt include mathematics pedagogical content knowledge, instructional strategies, mathematics language of learning and teaching and knowledge of mathematics school curriculum.

➤ **Mathematics pedagogical content knowledge**

Student teachers in this study regarded mathematics pedagogical content knowledge as essential and said that their mathematics modules helped them to gain mathematics content and pedagogical knowledge to teach. Student teachers in both cases said that they felt confident about mathematics content and pedagogical knowledge which they acquired in their modules. This resonates the work of Ford and Strawhecker (2011); Shulman, 1986; Zaskis and Zaskis (2011) which reported that student teachers' pedagogical knowledge is enhanced once they have an integrated knowledge of pedagogy, research, learning and teaching theories, mathematics content knowledge and the curriculum.

➤ **Instructional strategies**

With regards to instructional strategies, the twelve student teachers indicated that their initial teacher education programme exposed them to different instructional strategies. They mentioned that the use reformed based instructional strategies in their initial teacher education programme changed their preconceived beliefs about FP mathematics teaching and learning. Student teachers in both cases indicated that their lecturers allowed them to investigate, discuss and to critically reflect from and in practice and this helped them to gain new mathematics pedagogical knowledge. They also stated that they are prepared to apply the same strategies to teach mathematics to FP learners at schools. The findings of Fuentes, (2011); McCrory & Cannata, (2011); Nason et al. (2012); Shulman, (2000); Van de Walle et al. (2013) concur with the findings of this study that initial teacher education

programme should allow student teachers to take part in their learning in order to change their perceptions and construct new knowledge about the teaching and learning of FP mathematics pedagogical knowledge.

➤ **Mathematics language of learning and teaching**

Mathematics language of learning and teaching was regarded as important in FP mathematics pedagogical knowledge construction. Student teachers in this study indicated that teaching and learning of mathematics in FP is in home language whereas they are taught mathematics in English in their mathematics modules. Home language in the case of this study refers to African languages. Individuals in both participatory groups in this study expressed a concern for the lack or insufficient exposure of mathematical vocabulary in African languages in their initial teacher education programmes as this impedes their pedagogical knowledge construction and they struggle to transmit their acquired mathematics knowledge effectively.

➤ **Knowledge of the mathematics school curriculum**

Curriculum knowledge was significant to the two cases as it provides mathematical content, sequence and teaching strategies for all mathematics topics. In this study, it was found that curriculum document (CAPS) was used to expose student teachers to mathematical content and progression of the content from Grade R-3. This is important because student teachers should know what they are expected to teach in Foundation Phase and learn the strategies, content and concepts relevant to increase their mathematical knowledge and skills. This was also confirmed by Castro (2006); DBE, (2012), Van de Walle et al. (2013). I also found that the curriculum is fast-paced and does not provide teachers to teach mathematics for understanding. Fang and Clarke (2014) corroborate the findings of this study and they stated that CAPS is content orientated and introduces too many topics rapidly.

The secondary research questions above informed me on how to respond to the main research question of the study that follows:

#### **5.5.4 HOW DO FOUNDATION PHASE TEACHER EDUCATION PROGRAMMES PREPARE STUDENT TEACHERS TO TEACH FOUNDATION PHASE MATHEMATICS?**

The study found that the two initial teacher education programmes ensured that their student teachers acquired sufficient mathematical content and pedagogical knowledge during their initial teacher education programme. This was done through the use of learning theories and the application of different instructional strategies to teach FP mathematics. Student teachers are offered opportunities to engage in their learning and encouraged them to read different materials and resources. They researched and watched videos to reinforce their mathematical content and pedagogical knowledge. Whilst all the institutions agreed on the above, the level to which they dealt with content and pedagogy differed based on the credits allocated to the modules and the period of offering the modules which ranged from one semester (institution one) for three years and institution two for the whole for three years as well.

The results of the findings reveal that interactions, investigation, reflection, integration of mathematics pedagogical content knowledge, as well as the mathematical language of learning and teaching are the key pillars in the preparation of student teachers in the teaching and learning of Foundation Phase mathematics.

#### **5.5 THE CONTRIBUTION TO KNOWLEDGE**

Different amounts of time allocated to a module, makes a difference in the amount of knowledge and skills that student teachers may acquire. Institution two, with three years of successive mathematical levels, seemed to be offering the subject at a higher level than institution one. Institution two seemed to offer appropriate skills and knowledge to teach FP mathematics.

#### **5.6 LIMITATIONS OF THE STUDY**

The sample size for this study consisted of a very limited number of participants, two FP mathematics lecturers and twelve final year B.Ed. FP student teachers. Another limitation is the fact that data were only gathered from African language speakers, and maybe the other language speakers' experiences might have

provided a more comprehensive knowledge of how student teachers construct mathematics pedagogical knowledge. Hence, it must be noted that the results are not generalizable. The purpose of this study was not to generalize. Furthermore, institution one gave me some documents for document analysis while institution two provided me with the list of names of some books they are using in the teaching and learning of FP mathematics and this may be because of copy right issues and other reasons.

## 5.7 CONCLUSION

This section presents some conclusions regarding teaching practice, mathematical language of learning teaching and mathematical pedagogical knowledge construction.

### ➤ **Mathematical and pedagogical knowledge construction**

Foundation Phase B.Ed. student teachers should be provided ample opportunity to collaborate, interact and reflect from and in practice in order to construct their mathematics pedagogical knowledge. This means that initial teacher education programmes should ensure that student teachers acquire sufficient mathematics content knowledge during their initial teacher education training so that they are able to apply the same instructional strategies that allow learners to investigate and communicate their findings using appropriate mathematics language.

### ➤ **Mathematical language of teaching and learning**

It essential that initial teacher education programmes, provide student teachers with the appropriate mathematical language of learning and teaching. Mathematics use abstract language, therefore student teachers should be exposed to relevant mathematical vocabulary in their home languages so that they are better equipped to teach FP mathematics. Student teachers' insufficient mathematical language of learning and teaching may lead to poor mathematics teaching.

### ➤ **Teaching practice**

Teaching practicing is an essential component of learning to teach, however, it is important that it is planned for effectively. Institutions of higher education should collaborate with district officials to suggest which schools can best support student teachers to be effective teachers. District officials are best to consult as they

engage and know the schools better. This kind of collaboration should not only be focusing on student teachers placement but should also focus on curriculum matters that are required by the Department of Basic education with the intention to bridge the gap between theory and practice.

## **5.8 RECOMMENDATIONS AND FUTURE DIRECTION FOR RESEARCH**

The findings of this study revealed challenges student teachers encountered with regards to mathematics language of learning and teaching and supporting learners experiencing mathematical difficulties. The following recommendations were made with reference to this finding.

### ➤ **Recommendation one: Mathematical and pedagogical knowledge construction**

This study finds that if student teachers are actively and continuously reflecting on their teaching practice they change their preconceived pedagogical knowledge and construct new knowledge in the teaching and learning of FP mathematics.

This study recommends that initial teacher education programmes should provide student teachers with opportunities to be actively engaged in their learning by observing, discussing and reflecting to learn and construct new knowledge.

### ➤ **Recommendation two: The mathematics language of teaching and learning**

Student teachers reported that they were challenged to teach mathematics in the home language which in this study is (African languages) which is the requirement for teaching and learning in the FP.

This study therefore, recommends that initial teacher education programmes should include the teaching and learning of African languages not as an optional subject but as a language of instruction in their programmes to ensure that student teachers are efficient and confident to teach mathematics in their home language.

### ➤ **Recommendation three: Teaching practice**

The student teachers indicated that teaching practice sometimes is not supporting them sufficiently. They reported that some teachers take leave or they are not welcomed at the schools and it is basically a waste of time to be at those schools.

This study recommends that initial teacher education should collaborate with the district officials who manage schools in a designated area to identify and recommend the schools where students can be placed to observe and learn good practice.

➤ **Recommendations for further research**

The following topics are suggested for further studies. These topics were prompted and identified during the research processes.

- A longitudinal study on the impact of mathematics language of learning and teaching in the construction of FP mathematics pedagogies during the initial teacher education programme.
- A study on the effect of student teacher evaluation during teaching practice by outsiders including lecturers from other departments.

## **5.9 COMPREHENSIVE SUMMARY AND CONCLUSION**

The purpose of this study was to examine the construction of FP mathematics pedagogy during initial teacher education programme. This study conveyed how student teachers acquired mathematics content and pedagogical knowledge. Few challenges were encountered by student teachers during their initial teacher education mathematics preparation. However, the student teachers in this study revealed that they are confident that they acquired the necessary skills to teach mathematics in the FP. They disclosed that they constructed new mathematical knowledge as they interacted, presented lessons, watched videos and reflected on their practices.

Despite the fact that student teachers are positive that they can teach mathematics successfully, the findings of this study reveal a deficit in their teacher training with regards to the language of learning and teaching mathematics. The construction of mathematics pedagogical knowledge with the language that is not used in schools may not develop student teachers pedagogical knowledge successfully. Initial teacher education programmes need to utilise the language of learning and teaching applicable in schools for effective mathematics knowledge construction and for teaching and learning of mathematics.

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## **APPENDICES**

**APPENDIX A  
PERMISSION LETTER TO CONDUCT RESEARCH**

**APPENDIX B  
LECTURERS CONSENT LETTER**

**APPENDIX C  
FINAL YEAR STUDENTS CONSENT LETTER**

**APPENDIX D  
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## APPENDIX A PERMISSION LETTER TO CONDUCT RESEARCH



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

Dear Dean

### RE: REQUEST FOR PERMISSION TO CONDUCT A RESEARCH PROJECT AT YOUR INSTITUTION

I hereby wish to apply for permission to conduct a research project at your institution. I am a Master of Education student at the Education Faculty of the University of Pretoria and a junior lecturer at Tshwane University of Technology (TUT), as part of the European Union (EU) funded project. As part of my studies and the EU project, I am required to conduct a research project to complete this degree. The Topic of my research is: **The construction of Foundation Phase Mathematics pedagogy through initial teacher education programmes.**

The purpose of this study is to explore how universities in South Africa construct Foundation Phase Mathematics pedagogy in order to prepare student teachers to teach Foundation Phase Mathematics. Data will be collected through semi-structured interviews with foundation phase mathematics lecturers, focus group interviews with final year foundation phase students and document analysis of the year book and any another relevant documents. The information obtained from these will be strictly confidential and will only be used for the purpose of this research project. Participants' responses will be recorded, although their identity will not be revealed in any way. Please note that, should you grant me permission to carry out this research at your institution, you are free to withdraw from this study at any point.

If you are willing to allow me into your institution, and give permission to conduct this research please sign the form below:

Thanking you in advance

Yours Sincerely

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Ms JK Ramollo  
[jenkyramollo@gmail.com/083 311 6891](mailto:jenkyramollo@gmail.com/0833116891)

Supervisor: Dr M. Botha  
[marie.botha@up.ac.za / 082 979 2208](mailto:marie.botha@up.ac.za/0829792208)

Co-supervisor: Dr Nkidi Phatudi  
[nkidi.phatudi@up.ac.za / 0724961285](mailto:nkidi.phatudi@up.ac.za/0724961285)

I \_\_\_\_\_ as the \_\_\_\_\_ of [institution name] \_\_\_\_\_ have been fully informed about the purpose of this research and give permission for the study to be conducted. I reserve the right to withdraw this permission, thus withdrawing from this study at any time.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

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## APPENDIX B LECTURER'S CONSENT LETTER



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

### THE CONSTRUCTION OF FOUNDATION PHASE MATHEMATICS PEDAGOGY THROUGH INITIAL TEACHER EDUCATION PROGRAMMES

Dear Lecturers,

I am a Master of Education student at the Education Faculty of the University of Pretoria and a junior lecturer at Tshwane University of Technology (TUT). As part of my studies, I am required to conduct a research project to complete the degree. The Topic of my research is: **The construction of Foundation Phase Mathematics pedagogy through initial teacher education programmes.**

The purpose of this study is to explore how universities in South Africa construct Foundation Phase Mathematics pedagogy in order to prepare student teachers to teach Foundation Phase Mathematics.

I would like to invite you to take part in a semi-structured interview for this study by sharing your experience, documents and your views about the construction of Foundation Phase Mathematics programme. Data collection will take place for about forty five minutes in the months of May and June 2013. Data from this session will be tape recorded. There are no potential benefits derived from participating other than adding new knowledge to the existing body of knowledge regarding the construction of Foundation Phase Mathematics programmes.

Participation in this research is voluntary and you are free to withdraw from the study at any time, without explanation and negative or undesired impact by so doing. Participants' responses will be recorded and their identity will not be revealed in any way. The information and data collected will be strictly confidential, will be kept in a safe place and will only be used for the purpose of this research project.

For more information feel free to contact me or my supervisor on the contact details below:

Thanking you in advance

Yours sincerely

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Ms JK Ramollo  
[jenkyramollo@gmail.com](mailto:jenkyramollo@gmail.com)/083 311 6891

Supervisor: Dr Marie Botha  
[Marie.botha2@up.ac.za](mailto:Marie.botha2@up.ac.za) / 082 979 2208

Co-supervisor: Dr Nkidi Phatudi  
[nkidi.phatudi@up.ac.za](mailto:nkidi.phatudi@up.ac.za) / 0724961285

I \_\_\_\_\_ am aware of the purpose and procedures of this study and hereby agree to participate. I am also aware that the results will be used for course purposes only and that my identity will remain confidential, and that I can withdraw at any time if I so wish.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

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## APPENDIX C FINAL YEAR STUDENTS CONSENT LETTER



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

### THE CONSTRUCTION OF FOUNDATION PHASE MATHEMATICS PEDAGOGY THROUGH INITIAL TEACHER EDUCATION PROGRAMMES

Dear Participant,

I am a Master of Education student at the Education Faculty of the University of Pretoria and a junior lecturer at Tshwane University of Technology (TUT). As part of my studies, I am required to conduct a research project to complete this degree. The Topic of my research is: **The construction of Foundation Phase Mathematics pedagogy through initial teacher education programmes.**

The purpose of this study is to explore how universities in South Africa construct Foundation Phase Mathematics pedagogy in order to prepare student teachers to teach Foundation Phase Mathematics.

I would like to invite you to take part in the focus group interview for this study by sharing your experience and views about the Foundation Phase Mathematics programme. Data collection will take place for about forty five minutes in the months of May and June 2013. Data from this session will be tape recorded. There are no potential benefits derived from participating other than adding new knowledge to the existing body of knowledge regarding the construction of Foundation Phase Mathematics programmes.

Participation in this research is voluntary and you are free to withdraw from the study at any time, without explanation and negative or undesired impact by so doing. Participants' responses will be recorded and their identity will not be revealed. The information and data collected will be strictly confidential, will be kept in a safe place and will only be used for the purpose of this research project.

For more information feel free to contact me or my supervisor on the contact details below:

Thanking you in advance

Yours Sincerely

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Ms JK Ramollo  
jenkyramollo@gmail.com/083 311 6891

Supervisor: Dr M. Botha  
Marie.botha2@up.ac.za/ 082 979 2208

Co-supervisor: Dr Nkidi Phatudi  
[nkidi.phatudi@up.ac.za](mailto:nkidi.phatudi@up.ac.za) / 0724961285

I \_\_\_\_\_ am aware of the purpose and procedures of this study and hereby agree to participate. I am also aware that the results will be used for course purposes only and that my identity will remain confidential, and that I can withdraw at any time if I so wish.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

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## APPENDIX D LECTURER'S SEMI-STRUCTURED INTERVIEW SCHEDULE



### INDIVIDUAL SEMI-STRUCTURED INTERVIEW SCHEDULE

- What is the purpose statement for your B.Ed. Foundation Phase Mathematics programme?
- How is your FP Mathematics programme structured?
- Which instructional strategies do you promote for teaching FP Mathematics?
- Which assessment strategies does your Mathematics programme promote in preparing students to teach FP?
- How does the Mathematics programme prepare students with regard to mathematical teaching and learning resources?
- How does your FP Mathematics programme prepare students to teach Mathematics in their mother tongue?
- How do you prepare your students to address Mathematics barriers to learning and/or diversity?
- What are the challenges associated with the Foundation Phase Mathematics programme?
- Are there any other challenges associated with the Foundation Phase Mathematics student teacher preparation?

For example:

- Logistical challenges
- Student challenges
- Programme curricula challenges
- Any other issues
- How are these challenges being addressed?
- What issues do your students raise regarding their teaching practice experiences in teaching Mathematics?
- Do you have any suggestions from your students on how these challenges (if any) could be addressed?

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## APPENDIX E FINAL YEAR STUDENT FOCUS GROUP INTERVIEW SCHEDULE



### FOCUS GROUP INTERVIEW QUESTIONS

- How do you feel about the FP Mathematics programme?
- How confident are you in teaching FP Mathematics?
- Which instructional and assessment strategies has the Mathematics programme prepared you to use in your Mathematics classroom?
- How well are you prepared with regard to mathematical teaching and learning resources?
- How has the programme prepared you to teach Mathematics in your mother tongue?
- How has the programme prepared you to address Mathematics barriers to learning?
- What are the challenges associated with the Foundation Phase Mathematics programme?
- What is your teaching practice experience with regard to Mathematics?
- Do you have any suggestions on how these challenges (if any) could be addressed?

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## APPENDIX F DOCUMENT ANALYSIS



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

### DOCUMENT ANALYSIS

- What is the purpose statement for your B.Ed. Foundation Phase Mathematics programme?
- Which theories of learning and teaching are applied in this programme?
- How is the Mathematics programme structured?
- What content and pedagogical knowledge is promoted in this programme?
- Which Mathematical teaching and learning resources are applied?
- How are barriers to learning and/or diversity in the Mathematics classroom addressed?
- How is teaching practice structured in the programme?
- What is the weighting of mathematics and contact time teaching period?
- Which assessment strategies are used for the Mathematics programme?
- Which resources are used and promoted in the programme?

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