THE PROFESSIONAL MATHEMATICS TEACHER IDENTITY OF NON-SPECIALIST MATHEMATICS PRIMARY SCHOOL TEACHERS

By

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DISSERTATION

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DECLARATION OF ORIGINALITY

I, **Zanele Dibane (04419995)**, declare that this Master's dissertation entitled: **"The professional mathematics teacher identity of non-specialist mathematics primary school teachers"**, which I hereby submit for the degree Magister Educationis is my own work, and has never been submitted at any other institutions before. Where work from other sources has been used it has been acknowledged.

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DEDICATION

I dedicate this research to my wonderful parents Sondela Dibane and Noah Filligiano Dibane. You were interested in my progress all through this journey and motivated me to persist.

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ABSTRACT

The importance of subject knowledge and teaching skills has been emphasised by a number of studies. This study examined the Professional Mathematics Teacher Identity (PMTI) of non-specialist mathematics primary school teachers in terms of two aspects - the teacher as subject specialist and as teaching and learning specialist. A case study research design using a qualitative method was employed in this study. Three Grade 6 non-specialist mathematics teachers were purposively and conveniently selected as participants of the study. Their PMTI was revealed through interviews, lesson observation and the way in which they used the lesson plans.

The focus of the study was on the teachers' subject matter knowledge (including an explanation of the concept, asking higher-order questions and the correcting of misconceptions) and teaching skills (including the application of different teaching approaches and using representations when teaching). Themes were pre-determined from the conceptual framework, which was a deductive analysis. Furthermore, codes and categories emerged from the semi-structured interview transcriptions conducted with the participants in this study. The findings from this study revealed that non-specialist mathematics primary school teachers have inadequate subject matter knowledge and teaching skills, which have an influence on the teaching and learning of mathematics. The findings also indicated that non-specialist mathematics teachers find it difficult to employ learner-centred teaching approaches. Thus, it is suggested that primary schools employ mathematics specialists from the Intermediate Phase upwards. Lastly, it was concluded that mathematics teaching requires specialised training.

Keywords: Professional Mathematics Teacher Identity, subject specialist, teaching and learning specialist.

EDITING CERTIFICATE

Exclamation Translations

To whom it may concern

The dissertation entitled, "The Professional Mathematics Teacher Identity of non-specialist mathematics primary school teachers" has been edited and proofread as of 21 September 2018.

As a language practitioner, I have a Basic degree in Languages, an Honours degree in French and a Master's degree in Assessment and Quality Assurance. I have been translating, editing, proofreading and technically formatting documents for the past seven years. Furthermore, I am a member of the South African Translators' Institute (SATI) and the Professional Editors' Guild (PEG).

Please take note that Exclamation Translations takes no responsibility for any content changes made to the document after the issuing of this certificate. Furthermore, Exclamation Translations takes no responsibility for the reversal or rejection of the changes made to this document.

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LIST OF ABBREVIATIONS

ANA - Annual National Assessment

ATP - Annual Teaching Plan

CAPS - Curriculum and Assessment Policy Statement

DBE – Department of Basic Education

FET – Further Education and Training

HOD – Head of Department

NCS - National Curriculum Statement

PMTI - Professional Mathematics Teachers Identity

SMK – Subject Matter Knowledge

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CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION AND BACKGROUND

"Mathematics teaching is a specialised profession, requiring content knowledge, knowledge of the curriculum, knowledge about how to teach mathematics and knowledge about how learners learn mathematics" (Botha, 2012, p. 47). Several research findings have outlined the importance of subject matter knowledge and teaching skills in mathematics teaching (Ball, Lubienski, & Mewborn, 2001; Ball, Thames, & Phelps, 2008; Baumert et al., 2010; Hill, Rowan, & Ball, 2005; Hobbs, 2013). A concrete mathematics foundation should be laid at primary school level so that learners can develop confidence and interest in mathematics and continue with mathematics in high school with improved Matric results. Mathematics in primary schools is mostly taught by non-specialist teachers (Spaull, 2013). Moreover, non-specialist mathematics teachers influence the learning of mathematics as well as learners' performance. Du Plessis (2018, p. 1) defines non-specialist teaching as a phenomenon where "teachers teach subjects or year levels outside their fields of qualification or expertise." This study examines the ways in which non-specialist mathematics teachers teach and assess learners' understanding.

Mathematics plays an important role in guiding how individuals deal with the various spheres of their lives (Anthony & Walshaw, 2009). In South Africa, mathematics education is a serious concern because, despite the curriculum changes since 1994, very little seems to have changed in primary school mathematics classrooms (van Putten, Stols, & Howie, 2011). The teachers use more teacher-centred approaches - they have knowledge of learner-centred approaches but they do not apply these (Du Plessis, 2018; van Putten, Stols, & Howie, 2014). Mathematics education enables the learner to develop critical thinking and problem-solving skills. As such, a concrete mathematics foundation should be laid at primary school level so that learners can develop expertise, confidence and interest in mathematics and continue successfully with mathematics at high school level.

The National Curriculum Statement (NCS) was amended into the Curriculum and Assessment Policy Statement (CAPS) with effect from 2012 (DBE, 2011). The mathematics Intermediate phase CAPS document requires a balance of teacher-centred and learner-centred approaches (DBE, 2011). Jita and Vandeyar (2006) state that a learner-centred approach focuses on reasoning, problem solving and other process skills in mathematics. This is unlike a teacher-centred approach where the emphasis is on fixed procedures or steps, the manipulation of symbols and operations and less on problem solving and reasoning. However, it is clear, even from casual observation, that teachers do not comply with this requirement as they still use a more teacher-centred approach, which does not encourage critical thinking and flexibility in learning mathematics (van Putten et al., 2014).

The Minister of Basic Education reported that South Africa is significantly underperforming in education in general, and particularly in mathematics teaching and learning (DBE, 2016a). The Annual National Assessment (ANA) is the annual nationally standardised test of achievement for Grade 1 to 6, and Grade 9. The ANAs provide an indication of learners' mathematical knowledge and problem-solving skills, and also assist with early identification and remediation of learning deficits. The ANA results between 2012 and 2014 show that learners are underperforming in mathematics in the Intermediate and Senior Phases (DBE, 2014). The Intermediate Phase spans Grade 4 to 6, and the Senior Phase is from Grade 7 to 9. The results showed that the Grade 9 learners failed to meet the presidential targets of at least 60% of the learners achieving an acceptable level of performance, as was announced in 2010 (DBE, 2014).

South African learners' poor performance in mathematics can be ascribed to a variety of factors. One of which is that the majority of public primary school mathematics teachers are non-specialist, which influences the teaching and learning of mathematics as the teachers lack subject content knowledge and appropriate teaching skills (Venkat & Spaull, 2015). There is limited research in South Africa regarding primary schools' non-specialist mathematics teachers' subject matter knowledge and teaching skills. Mathematics teaching knowledge is important as Ball (1988) indicates that knowing mathematics for oneself is not the same as knowing how to teach it.

Several researchers have found that teachers' mathematical knowledge and teaching skills have influenced learners' mathematical achievement (Hill et al., 2005; Hobbs, 2013; Venkat & Spaull, 2015). This is relevant to the South African context because learners perform poorly in mathematics as a result of their teachers' inadequate mathematics knowledge and teaching skills (Hobbs, 2013; Venkat & Spaull, 2015). A lack of mathematics content knowledge and skills may compromise the quality of teaching, which can influence the learners' performance (Anthony & Walshaw, 2009; Ball & Bass, 2002; Ball, Hill, & Bass, 2005; Ball et al., 2008). Teachers need to demonstrate reasonable confidence with regard to their subject matter knowledge, skills, and ability to facilitate teaching and learning (Delport & Mufute, 2010). Researchers have indicated that it is important for a mathematics teacher to undergo specialised teaching training for the effective teaching and learning of mathematics (Ball et al., 2001; Ingersoll, 2001b; Van Zoest & Bohl, 2005).

Professional teacher identity is made up of personal and social aspects that encompass knowledge and beliefs, emotions and relationships, contexts and experiences (van Putten, 2011). Professional teachers' identity is not stable, it is an ongoing process of interpretation and reinterpretation of experiences (Beijaard, Meijer, & Verloop, 2004). Beijaard, Verloop, and Vermunt (2000) describe professional teacher identity in terms of three aspects, namely, being: subject matter experts, didactical experts, and pedagogical experts. This study was based on the first two aspects, as indicated by van Putten (2011): the subject specialist and the teaching and learning specialist. The subject specialist in this study manifests as the mathematics expert. According to van Putten (2011), the teaching and learning specialist manifests through evidence of learners' understanding, teaching approaches applied in the classroom, and either flexibility or rigidity in teaching. A rigid style of teaching is characterised by following steps and rules or procedures with no room for critical thinking and discussions. A flexible style of teaching allows for critical thinking and enables teachers to answer learners' questions on other topics that they may not have prepared to teach. This study explored the ways in which non-specialist mathematics teachers teach in their classrooms in relation to their subject matter knowledge and teaching skills.

1.2 PROBLEM STATEMENT

A public primary school is a state-funded and non-fee-paying school that offers Grades R to 7. Public primary schools are divided into three phases: Foundation Phase (Grades 1 to 3); Intermediate Phase (Grades 4 to 6); and Senior Phase (Grades 7 to 9). Most public primary schools end at Grade 7. Mathematics education in public primary schools is of poor quality as it is mostly taught by non-specialist mathematics teachers (Bosse & Törner, 2015; Du Plessis, 2013; Onwu & Sehoole, 2015; Spaull, 2013). The Annual National Assessment (ANA) is used to monitor the achievement of learning outcomes and the quality of education in the schooling system. The ANA reports have shown that learners in the Intermediate and Senior Phases perform poorly in mathematics (DBE, 2014). However, few studies have investigated the role of non-specialist mathematics teaching as one of the contributing factors to the poor performance of learners in mathematics. Mathematics teachers need specialised knowledge because of the skills and high-quality instruction demanded by mathematics teaching (Ball et al., 2008). This is acquired by completing a mathematics teaching qualification, which provides information and skills in planning lessons that facilitate the construction of new knowledge using learners' existing proficiencies, interests and experiences.

Numerous studies show that the teacher's subject matter knowledge influences the learners' achievement in mathematics and that there is a correlation between teachers' mathematical knowledge and student achievement (Anthony & Walshaw, 2009; Ball & Bass, 2002; Ball et al., 2008; Hill et al., 2005). How mathematics is taught depends on the teachers' subject content knowledge, their beliefs about mathematics, and their understanding of mathematics teaching and learning (Anthony & Walshaw, 2009). Ball et al. (2001) claim that students can learn mathematics better when they are taught by teachers who studied mathematics. Baumert et al. (2010) claim that teachers must know the mathematical content knowledge that they are teaching, and even beyond the level that they are assigned to teach. Spaull (2013) indicates that teachers cannot teach what they do not know, so non-specialist mathematics teachers may have inadequate subject content knowledge and teaching skills, which influences the learners' achievement. Unfortunately, this is the case in South African schools (Caldis, 2017; Donaldson, 2012; Hobbs, 2013; Venkat & Spaull, 2015). As a result, the South African economy slows down because of the decline in the number of individuals who enter professions requiring mathematics such as engineering and medicine, for example.

The concept of non-specialist teaching has been researched by a number of researchers globally in different contexts and countries, including Germany (Bosse & Törner, 2015), Nigeria (Aina, 2016), the United States of America (USA) (Ingersoll, 2001b; Reys & Fennell, 2003), Western Australia (McConney & Price, 2009), and England (Crisan & Rodd, 2011). van Putten (2011) studied the Professional Mathematics Teacher Identity (PMTI) of secondary school pre-service teachers who were trained at tertiary level to teach mathematics. PMTI differentiates between teachers who were trained to teach mathematics and teachers who teach mathematics without the tertiary qualification to teach mathematics. A literature survey did not yield any similar studies that were conducted in South African primary schools. It is therefore not known how the PMTI of non-specialist mathematics teachers' manifests as subject and teaching and learning specialists. This study sought to find out how South African public primary school non-specialist mathematics teachers execute their role of subject and teaching and learning specialists. The problem has been indirectly mentioned by the Minister of Basic Education, who reported that mathematics education is a primary concern that needs intervention, particularly in light of the fact that teachers often cannot answer questions in the curriculum that they are teaching (DBE, 2016a).

There is a paucity of information about how Grade 6 non-specialist mathematics teachers teach learners. The reason why it is important to study Grade 6 non-specialist mathematics teachers it that it is the terminal grade for the Intermediate Phase and is where a strong foundation should be laid. According to Venkat and Spaull (2015), 79% of South African Grade 6 mathematics teachers lack the mathematics content knowledge to teach Grade 6.

Carnoy and Chisholm (2008) indicate that Gauteng has well-qualified teachers, but they are often appointed to teach subjects that they did not specialise in during teacher training because of the existing post-provisioning systems for the allocation of teachers to schools. The post-provisioning system is how a post is filled, and is determined by a variety of factors. The first one is redeployment, where the teacher to learner ratio results in teachers being redeployed because of the number of the learners in a school. When the teacher is redeployed, they can be placed in any school that needs teachers without considering the teachers' area of specialisation. These teachers are then allocated to teaching subjects in which they have not specialised, however, they have no choice as they are government employees. The second factor could be that the school has appointed a teacher in a temporary post, and when the school gains a permanent post, that teacher is placed in that post regardless of his or her area of specialisation. The last reason for non-specialist mathematics teaching could be the result of a shortage of qualified mathematics teachers

1.3 RATIONALE

Mathematics specialist knowledge in teaching is essential "primarily because teaching mathematics requires drawing upon a much broader range of knowledge and experiences than does learning mathematics itself" (Van Zoest & Bohl, 2005, p. 318). It is imperative for mathematics teachers to undergo specialised training in order to provide reliable result-orientated teaching and learning circumstances (Van Zoest & Bohl, 2005). In support of this, Mewborn (2001) indicates that obtaining a certified tertiary qualification in mathematics teaching contributes to effective lesson delivery.

In the literature, professional teacher identity has been defined as the way in which teachers see themselves as subject matter experts, pedagogical experts and didactical experts (Beijaard et al., 2000, p. 751). van Putten (2011) has interpreted this in terms of pre-service mathematics teachers' PMTI, focusing on three aspects: subject specialist, teaching and learning specialist, and carer. However, there is a paucity of information on the PMTI of non-specialist primary school mathematics teachers as subject and teaching and learning specialists respectively.

Being a mathematics teacher has made me realise the importance of teachers' specialised subject knowledge and teaching skills in enabling learners to develop an understanding of the concepts alongside critical thinking skills. Teachers' subject knowledge should enable them to correct learners' misconceptions and misunderstandings. Venkat and Spaull (2015) report that Grade 6 mathematics teachers lack subject knowledge, which influences the learners' performance.

As a Grade 4 and 5 mathematics teacher myself, this study could also add to the enrichment of my own practice as a primary school mathematics specialist teacher. This may ensure that the learners that I teach have a better chance of mastering the knowledge and skills that they need to have in order to proceed to the next grade. The findings will provide me with a broader understanding of the importance of subject matter knowledge and teaching skills for the effective learning of mathematics and for improving learners' performance.

1.4 PURPOSE OF THE STUDY

The purpose of the study was to investigate the Professional Mathematics Teachers' Identity (PMTI) of non-specialist primary school mathematics teachers. Beijaard et al. (2000) identified three domains of PMTI, namely: subject matter knowledge, didactics, and pedagogical knowledge as important for effective teaching and learning. The study will investigate non-specialist mathematics primary school teachers' PMTI in terms of their subject matter and didactics knowledge. This is described by van Putten (2011) as the subject expert and teaching and learning expert. These domains are supported by the two domains of Van Zoest and Bohl (2005) that the teacher should know "what is to be taught, who is to be taught and how they should be taught". The domains indicated above are important for a mathematics teacher to ensure effective teaching-and-learning, and can be acquired through training (Darling-Hammond, 2000; Reys & Fennell, 2003). The researcher wanted to develop an understanding of how a non-specialist mathematics teacher executes their roles as subject specialist and as a teaching and learning specialist.

1.5 RESEARCH QUESTIONS

The following primary and sub-research questions guided the study:

1.5.1 Primary research question

How can the Professional Mathematics Teachers' Identity (PMTI) of non-specialist mathematics primary school teachers be described?

1.5.2 Sub-research questions

1. How does the non-specialist mathematics teacher's PMTI manifest as a teaching and learning specialist?
2. How does the non-specialist mathematics teacher's PMTI manifest as a subject specialist?
3. What are the characteristics of the PMTI of non-specialist mathematics teachers?

1.6 CONCEPT CLARIFICATION

The following table represents the operational definitions of the terms used in this study.

Table 1.1: Concept clarification

CONCEPT	CLARIFICATION
Mathematics specialist	Refers to individuals with tertiary training in subject matter knowledge and teaching approaches for effective teaching and learning (van Putten, 2011).
Non-specialist mathematics teachers	Teachers who are not trained at tertiary level to teach mathematics. They have inadequate subject content knowledge and teaching skills (Caldis, 2017).
Professional Teacher Identity (PTI)	This comprises a teacher's sense of self, as well as their knowledge, beliefs, dispositions, interests and orientation towards work (Jansen, 2001). In this study, PTI refers to the teacher's beliefs, commitment and motivation, professional training and development, and teaching experience.
Professional Mathematics Teacher Identity (PMTI)	In this study, this refers to mathematics teachers as subject specialist and teaching and learning specialists (van Putten, 2011).
Subject knowledge	Knowing mathematics and what to teach in a specific grade is of primary importance for a qualified teacher (Ingersoll, 2001b).
Teaching-and-learning expert	Knowing how to teach and having knowledge of the different teaching strategies (Ingersoll, 2001b).

1.7 DELIMITATIONS OF THE STUDY

This study is restricted to public township primary schools. The scope of this research was limited to teachers employed by the South African Government in the Johannesburg East district. Therefore, teachers working in the private sector were not included in this research. This choice was due to the assumption that teachers employed in township primary school might be able to give answers to the questions posed in this study, while private schools, in general, are unlikely to employ a teacher to teach mathematics if they are not qualified to do so.

1.8 SIGNIFICANCE OF THE STUDY

Despite the research already carried out, there is no evidence of in-depth empirical research that has been conducted on the PMTI of non-specialist mathematics teachers as subject and teaching and learning specialists in primary schools. This study might therefore be a starting point to conceptualise the PMTI of non-specialist mathematics teachers. Furthermore, this study suggests how non-specialist teachers could be supported during in-service training interventions.

This study reveals the challenges that non-specialist mathematics teachers may face, which could shape future in-service teacher training programmes. The findings could be used to narrow the gap that exists between specialist and non-specialist mathematics teachers. The Department of Basic Education could use the findings to encourage non-specialist mathematics teachers to enrol at universities for the development of their professional mathematics teachers' identity in terms of subject matter knowledge and teaching-and learning knowledge.

The Department of Basic Education (DBE) can also use the findings to review the post-provisioning system for the allocation of teachers to schools. The findings could also help the Department of Basic Education to distribute mathematics specialist teachers equitably in primary schools. It could help the mathematics Head of Departments (HODs) at primary schools to assign mathematics specialist teachers to teach mathematics only. The findings of this study may further help the DBE with information about the importance of primary school mathematics teachers who are specialists.

1.9 OUTLINE OF THE DISSERTATION

This study comprises five chapters, a reference list, and appendices. The chapters are arranged in the order provided in Table 1.2.

Table 1.2: Outline of the dissertation

CHAPTER	CONTENT
Chapter 1	Contains the introduction and background, the rationale, problem statement, purpose of the study, research questions, concept clarifications, quality criteria, delimitations of the study, possible contributions of the study to knowledge in the field, limitations, and an outline of the dissertation.
Chapter 2	Consists of the literature and conceptual framework, which provides an in-depth analysis and synthesis of the relevant literature and explains the conceptual framework on which this study is based.
Chapter 3	The methodology used in this study is explained. The selection of the participants, data collection methods, and data analysis are discussed, as well as the trustworthiness of the study and ethical considerations.
Chapter 4	The findings are discussed in detail based on the data obtained by way of semi-structured interviews, lesson observations and document analysis. The findings are discussed based on the themes and categories that emerged from the data, and also categories that were predetermined from the conceptual framework. Both deductive and inductive analysis were employed to analyse the data.
Chapter 5	The findings are discussed in the light of the literature review and conceptual framework, and then the research questions are answered. The recommendations and conclusions that were arrived at are presented, as well as a discussion of their implications. Lastly, reflections on the limitation of the study are discussed.

1.10 CHAPTER SUMMARY

This chapter presented an overview of this study. An introduction and background have been provided, along with a problem statement regarding what was investigated in this study. Moreover, the research questions, the rationale, the significance of this study, and the structure of the dissertation have been provided. The next chapter presents the literature relevant to this study and the conceptual framework that guided this study.

CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION

In the first chapter, it was established that there is a paucity of knowledge on the PMTI of non-specialist primary school mathematics teacher in the South African context. van Putten (2011) defines PMTI as the professional identity of people who have trained to be mathematics teachers. This study explored the PMTI of teachers who are teaching mathematics but have not trained to teach mathematics. PMTI, in this study, is defined as the teacher's mathematical knowledge used for teaching. This research aims to gain insight into the subject matter knowledge and teaching skills of the non-specialist mathematics teacher. van Putten (2011) has described the three aspects of PMTI in terms of the pre-service subject specialist, teaching and learning specialist, and the role of carer. The present study focused on the first two aspects as I am interested in the teachers' subject matter knowledge and teaching skills since these two aspects are imperative for the effective teaching and learning of mathematics (Ball et al., 2008; Beijaard et al., 2000; Hill et al., 2008b; Rollnick & Mavhunga, 2016; Van Zoest & Bohl, 2005; Williams, 2008).

In this chapter, the concepts of professional teacher identity, mathematics teacher identity, Professional Mathematics Teacher Identity (PMTI), and specialist and non-specialist mathematics teachers is discussed. The concept of Professional Mathematics Teacher Identity (PMTI) is discussed in terms of subject specialist and teaching and learning specialist and how they are actualised in the classroom. I further discuss the teaching approaches applied in the classroom. The conceptual framework for the study is also presented in this chapter.

2.2 PROFESSIONAL TEACHER IDENTITY

van Putten (2011) claims that PTI is complex as it is made up of personal and social aspects that encompass knowledge and beliefs, emotions and relationships, contexts and experiences. Jansen (2001) describes teachers' identity as the way teachers feel about themselves professionally, emotionally and politically given the conditions of their work. It also includes the ways in which teachers understand their capacity to teach as a result of subject matter competence, levels of training, preparation and formal qualification (Jansen, 2001). Jansen (2001) describes PTI as teachers' subject matter competence, which is applicable to this study as we look at the professional teachers' identity in terms of subject specialist and teaching and learning specialist.

Several researchers have defined teacher identity as a dynamic process that is unstable, and involves the construction and reconstruction of identity through practice (Beauchamp & Thomas, 2009; Beijaard et al., 2004; Beijaard et al., 2000; Chong & Low, 2009; Day, Kington, Stobart, & Sammons, 2006; Flores & Day, 2006; Hsieh, 2010; Rodgers & Scott, 2008; Vloet & Van Swet, 2010). Professional teacher identity is influenced by internal and external factors. Beijaard et al. (2004); Bjuland, Cestari, and Borgersen (2012); Rodgers and Scott (2008) and Flores and Day (2006) assert that internal factors (biography, emotions, motivation, knowledge, beliefs, self-esteem), and external factors (school climate and culture, resources, and interpersonal relationships with the learners, teachers, school management team, community) relate to teacher identity. The teachers' identity is a key influencing factor of teachers' sense of purpose, self-efficacy, motivation, commitment, job satisfaction and effectiveness (Day et al., 2006). Teachers need their professional teacher identity to be well-developed in order to effectively execute their teaching roles (Grootenboer & Zevenbergen, 2008; van Putten, 2011). According to Rodgers and Scott (2008, p. 732), teacher identity development "involves an interplay between external forces (relationships and contexts) and internal forces (stories and emotions)." Vloet and Van Swet (2010, p. 164), in their study, explored professional teacher identity at a cognitive and emotional level, describing teacher identity as a complex concept with several characteristics. These not only consist of several sub-identities, but develop through a dynamic process where professionals continuously interpret and reinterpret their meaningful experience, as well as the interaction between person and context.

Table 2.1: Overview of the definitions of PTI formulated between 2008 and 2018

Author and year	**Definition of professional teacher identity (PTI)**	**Research methodology**
da Ponte and Chapman (2008)	The way in which teachers see themselves as professionals, their relations with authority, and their professional autonomy.	Case study
Rodgers and Scott (2008)	Involves an interplay between external (relationships and contexts) and internal forces (stories and emotions).	Empirical study
Beauchamp and Thomas (2009)	It is dynamic, and it shifts over time under the influence of the range of both internal and external factors. It is also shaped and re-shaped in interaction with others in a professional context.	Literature review

Chong and Low (2009)	The core beliefs that one has about teaching and being a teacher. Beliefs that are continuously formed and reformed through experience.	Quantitative survey questionnaire and interviews.
Hsieh (2010)	An on-going process that develops in various ways and is the response to multiple discourses of teaching. It is also the beliefs, values and commitment that allow a teacher to identify both as a teacher and as being a particular type of a teacher.	Collaborative inquiry: meeting, interviews and classroom observations
Vloet and Van Swet (2010)	Formed in a dynamic process where teachers continuously interpret and re-interpret their meaningful experiences from biography and practice.	Narrative biographic interviews
Chong, Low, and Goh (2011)	Develops over time and involves gaining insight from the professional practices and the values, skills, and knowledge required.	Open-ended questionnaire
Lutovac and Kaasila (2011)	One component of multiple aspects of a persons' identity. It comes from a persons' professional status or position within society, his or her interactions with others and their interpretations of their experiences.	Qualitative case study, narrative-based approaches
Bjuland et al. (2012)	The way in which teachers see themselves as professionals, their relationship with authority, and their professional autonomy.	Reflective narrative, semi-structured interviews
van Putten et al. (2014)	PTI is the crossroads between the personal and the social self, the "who I am at this moment".	Case study

The above definitions have in common the idea that PTI is dynamic and not static, fixed or stable and that it continuously develops through practice. The table above shows the information of the ten articles that were examined with definitions of PTI from recent studies. These were derived from four case studies, two questionnaires, two narrative studies, one literature review study and one empirical study. The case studies were most common in the ten articles reviewed. It appears then that this study is aligned with most of the studies conducted. From the articles reviewed above, one article used observation as a method of data collection, which shows that there are limited findings that are based on empirical observations. My study is a case study with multiple data collection strategies: lesson observation, document analysis and interviews, and so appears to be in line with current research methodology in this field.

From 2008 onwards, several researchers have defined PTI as a dynamic process (Beauchamp & Thomas, 2009; Chong & Low, 2009; Hsieh, 2010; Lutovac & Kaasila, 2011; Vloet & Van Swet, 2010) involving continuous development (Chong & Low, 2009; Chong et al., 2011); beliefs (Chong & Low, 2009); emotions (Rodgers & Scott, 2008); and is both a personal and a social construct (Bjuland et al., 2012; da Ponte & Chapman, 2008; Lutovac & Kaasila, 2011; Rodgers & Scott, 2008; van Putten et al., 2014).

Beijaard et al. (2000, p. 751) named three aspects of PTI: subject, didactic and pedagogical experts. This study is based on two aspects of Beijaard et al. (2000) study: being a subject matter expert (being able to change programmes, develop effective tasks, explain things at a high-quality level, and diagnose students' understandings and misconceptions adequately); and being a didactical expert (the knowledge for lesson preparation, presentation and the evaluation of effective teaching and learning). In support of this view, Van Zoest and Bohl (2005, p. 333) indicate three domains: the content curriculum domain, pedagogy domain and professional participation domain. This study focused on the first two domains of the teachers' knowledge of "what is to be taught, who is to be taught and how they should be taught" (p. 333). It is imperative for mathematics teachers to possess the aspects mentioned above in order to execute their roles effectively. van Putten (2011) discusses three categories of PMTI: being a subject specialist, teaching and learning specialist, and a carer. Her study was a qualitative case study and used multiple data collection strategies: a questionnaire; interviews; and observations. A number of studies did not use document analysis; however, this study looks at PMTI from different angles by employing multiple data collection strategies. The document analysis may bring to light information on the teachers' subject matter knowledge in relation to the curriculum policy document with regard to the Annual Teaching Plan (ATP) and the development of assessment tasks. There is a paucity of information on the PMTI of non-specialist primary school mathematics teachers.

According to Canrinus (2011, p. 18), the teacher's professional identity can be described in terms of the following factors: job satisfaction, occupational commitment, motivation and self-efficacy. Day et al. (2006) state that this is a role player as:

> *"Identity is a key influencing factor on teachers' sense of purpose, self-efficacy, motivation, commitment, job satisfaction and effectiveness". (p.600)*

These aspects of professional teacher identity are relevant to my study since a teacher with a sense of purpose and self-efficacy will be motivated, committed to execute his or her roles and have job satisfaction as he will achieve his goals. Mojavezi Ahmad (2012) found that the higher the level of teachers' self-efficacy, the higher the learners' achievement and motivation. Teachers with high self-efficacy also use different teaching methods to explain the concept when learners are confused (Kuusinen, 2016). Therefore, it can be argued that teachers' self-efficacy depends on their subject matter knowledge and teaching skills. The professional mathematics teacher needs to be qualified in order have high self-efficacy because of subject matter knowledge and teaching skills that they have acquired through teacher training. They also have a positive impact on the learners' learning and understanding of mathematics concepts. I also argue that self-efficacy plays a crucial role in the teaching and learning of mathematics. Bandura and Wessels (1997, p. 2) define self-efficacy as "people's beliefs about their capabilities to produce effects". Alderman (1999, p. 16) states that self-efficacy is the "beliefs about one's competency to perform a task". As a teacher, you need confidence in your capability to teach learners with understanding and to produce good results. Bandura (1997, p. 19) claims that "creating environments conducive to learning rests on the talents and self-efficacy of teachers". Moreover, teachers' self-efficacy influences what is done in the classroom.

Bandura (1995, p. 4) asserts that the "higher levels of self-efficacy are accompanied by higher performance attainments". This implies that teachers with a strong sense of self-efficacy set goals for their learners' achievement and they strive to assist learners to achieve these goals. A teacher with high self-efficacy creates a classroom environment for optimal classroom interaction and effective learning. These teachers plan lessons that accommodate the diverse needs of learners and different cognitive levels. The learners are motivated by the classroom environment and teachers' (action) instructional practice to learn, which can result in higher achievement. Furthermore, the teacher helps the learners to develop mathematical higher-order thinking skills and problem-solving skills. The teacher believes in the learners' potential to learn effectively and excel in mathematics (Alderman, 1999). A teacher's occupational commitment is reflected in many positive outcomes, including lower absenteeism, work engagement, and higher job satisfaction (Klassen et al., 2013). Occupation commitment is as a result of high self-efficacy, job satisfaction and motivation. The intrinsic or extrinsic motivation of the teacher contributes to their higher self-efficacy. When the teacher is motivated, he or she will be highly committed to delivering subject content knowledge in a way that will enhance the learners' understanding of content.

The converse is true of teachers with low efficacy. Learners taught by teachers with low self-efficacy may perform poorly and these teachers "attribute poor achievement to a student lack of ability or unwillingness to work or learn" (Alderman, 1999, p. 161). The blame for learners' poor performance is always shifted to the learners, but the teacher fails to explain the concept thoroughly, apply different teaching methods, make use of manipulatives and create a learning environment conducive to effective learning. Their instructional practice is more teacher-centred, and shows a reluctance to have learners apply their own knowledge to solve problems, and so learners learn mathematics with fixed rules and procedures. Furthermore, low self-efficacy teachers “lack a secure sense of instructional efficacy and show weak commitment to teaching, spend less time to subject matters” (Bandura, 1997, p. 20). The teachers with low self-efficacy are also unable to employ a learner-centred approach as this involves problem solving and is challenging in that it requires subject matter knowledge in order to answer the learners’ questions or correct any misconceptions. It also requires teaching skills to use different teaching strategies to positively influence learners’ learning. We can conclude that the teacher’s level of efficacy predetermines the learners’ achievement (Alderman, 1999).

2.3 MATHEMATICS TEACHER IDENTITY

Several researchers have studied pre-service and in-service mathematics teacher identity development from a negative to a positive perspective, and from incompetent knowledge of mathematics and teaching skills to competent knowledge through in-service training (Bjuland et al., 2012; Chong et al., 2011; Hodgen & Askew, 2007; Hodges & Cady, 2012; Lutovac & Kaasila, 2014; Nel, 2012). Other researchers studied mathematics teacher identity in practice in their classrooms (Hobbs, 2013; Leatham & Hill, 2010; Lutovac & Kaasila, 2011, 2014; Pausigere, 2015; van Putten et al., 2014; van Putten et al., 2011; Van Zoest & Bohl, 2005).

However, teacher identity in mathematics education has mostly been studied regarding pre-service and in-service mathematics specialist teachers. Different terms were used to describe the teachers’ identities, these will now be explored. Lutovac and Kaasila (2014) used the term “mathematical identity” referring to narratives that teachers create to explain themselves in relation to mathematics and their mathematical lives. Leatham and Hill (2010, p. 226) also used the term “mathematical identity”, which they define as “an individual’s relationship with mathematics”. Van Zoest and Bohl (2005) used “mathematics teacher identity” to refer to any teacher who teaches mathematics. Lastly, van Putten (2011) used the term ‘professional mathematics teacher identity’ to refer to mathematics specialist teachers who studied mathematics with the intention of teaching it.

Shulman (1986) specifies the categories of knowledge required for teaching that are imperative to mathematics teacher identity, namely: subject matter knowledge, pedagogical knowledge and curriculum knowledge. In addition, there are a number of studies on mathematics teacher identity that indicate different categories of mathematical knowledge for teaching (Ball et al., 2005; Ball et al., 2008; Beijaard et al., 2000; Hill, Ball, & Schilling, 2008a; Hobbs, 2013; Van Zoest & Bohl, 2005). These studies indicate the importance of subject matter knowledge and teaching knowledge. Donaldson (2014) studied the subject knowledge and teaching and learning knowledge of specialist primary school mathematics teachers and indicates the importance of the combination of subject knowledge and teaching skills. Williams (2008) supports the importance of the combination of subject knowledge and teaching knowledge for effective teaching and learning. Thus, specialised subject content knowledge is important for a mathematics teacher to possess (Ball et al., 2008; Rollnick & Mavhunga, 2016).

Mathematics teacher identity has been studied mostly with pre-service and in-service mathematics teachers (Chong et al., 2011; Kasten, Austin, & Jackson, 2014; Leatham & Hill, 2010; Lutovac & Kaasila, 2011, 2014; van Putten et al., 2014). It has also been studied with regard to teacher identity development (Beauchamp & Thomas, 2009; Beijaard et al., 2000; Rodgers & Scott, 2008) and influencers of mathematics teacher identity (Beauchamp & Thomas, 2009; Beijaard et al., 2004; Beijaard et al., 2000; Bjuland et al., 2012; Flores & Day, 2006). Therefore, it seems that researchers have studied the concept in relation to all mathematics teachers irrespective of their qualifications per se. van Putten (2011) developed the concept of PMTI to make a distinction between teachers who were trained to teach mathematics and those who are not trained mathematics teachers.

2.4 PROFESSIONAL MATHEMATICS TEACHER IDENTITY (PMTI)

The literature gives the definitions discussed below in terms of teacher identity and Professional Mathematics Teacher Identity (PMTI) (Bishop, 2012; Graven, 2004; Pausigere, 2015; van Putten, 2011). Beijaard et al. (2000) define Professional Teachers Identity (PTI) as the way in which teachers see themselves. This is based on three aspects: being a subject expert, pedagogical expert, and didactical expert. van Putten (2011) used the concept of PMTI to distinguish between professional teachers who are teaching mathematics, and those who studied mathematics with the intention of teaching it. The professional mathematics teacher identity involves becoming confident in relation to one's mathematical knowledge required for teaching and experience (Graven, 2004, p. 185). Moreover, "Their perceptions of and beliefs about the subject and themselves as learners of mathematics also constitute an important dimension of this professional teacher identity" (Jita & Vandeyar, 2006, p. 41). It is important for teachers to have a well-developed mathematical identity, which includes mathematical knowledge and skills, positive attitude, and a sense of joy and satisfaction in undertaking mathematical practices (Grootenboer & Zevenbergen, 2008, p. 246)

Pausigere (2015, p. 81) defines PMTI as a way of talking about how primary teachers know and name themselves relating to the subject (mathematics) and its corresponding activities. PMTI is different from mathematics teacher identity. Bishop (2012, p. 39) equally supports that mathematics identity refers to the ideas that one has about oneself with respect to the subject of mathematics and its corresponding activities. Mathematics teacher identity includes teachers who teach mathematics but are not professional mathematics teachers, or are not qualified mathematics teachers (van Putten et al., 2011). These teachers teach mathematics due to the shortage of mathematics teachers, or possibly even due to the post-allocation provisioning systems (Carnoy & Chisholm, 2008).

PMTI differentiates mathematics teachers from mathematicians. For this study, PMTI is defined as teachers who have studied mathematics and were trained in mathematics teaching during their teaching training programme with the purpose of teaching it. In this study, teachers with PMTI are assumed to have the required subject content knowledge and teaching skills.

Beijaard et al. (2000) and Van Zoest and Bohl (2005) have identified three domains in professional teachers' identity that are relevant to my study as they are imperative for mathematics teachers. This study focused on two domains, as mentioned by Beijaard et al. (2000) and Van Zoest and Bohl (2005) studied in the classroom setting, these being Subject Matter Knowledge (SMK) (the teacher as a subject specialist) and didactics (the teacher as the teaching and learning specialist). The above-mentioned researchers' studies were based on secondary school mathematics teachers. This study explored the above-mentioned domains by Beijaard et al. (2000) and Van Zoest and Bohl (2005) with non-specialist primary school mathematics teachers.

van Putten (2011) examined the aspects that influence the development of PMTI and how the PMTI of pre-service mathematics was actualised during their teaching practicum. Her study of Professional Mathematics Teacher Identity (PMTI) was in the context of pre-service mathematics teachers, and the influences and actualisation of the PMTI of pre-service mathematics teachers in the Further Education and Training (FET) phase. She assumed that these students had developed PMTI through their teaching training and that it would be actualised in the classroom during their teaching practice. For my study, however, I assume that the participants in this study have not developed PMTI as they have not trained as mathematics teachers. Furthermore, I could identify no instance where the concept of PMTI has been used to conceptualise the teacher identity of non-specialist, in-service primary school mathematics teachers.

According to van Putten (2011), PMTI is developed through a mathematics teacher training programme. In her study, several participants suggested that the mathematics methodology modules became more practical so that tertiary training could make a huge difference in PMTI development. In support of this, Kasten et al. (2014) assert that mathematics identity is constructed from many sub-contexts, for example, mathematics courses and teachers’ interactions with mathematics in the real world. I agree that a mathematics identity can begin to develop while one is a learner at school, continue to develop during a tertiary teaching training programme, and then when one practices as a mathematics teacher (Chong & Low, 2009).

Grootenboer and Zevenbergen (2008) claim that the teacher must have a well-developed mathematical identity to help learners develop mathematical knowledge and skills. PMTI is developed through training, as Bosse and Törner (2015, p. 4) indicate that identity is something that has to be developed. I assumed that these non-specialist primary school mathematics teachers may not have had a strongly developed PMTI even though they taught mathematics and may have encountered mathematics while they were still at school as learners themselves. In this study, the PMTI of non-specialist primary school mathematics teachers was investigated with the focus on the teachers' mathematical knowledge and teaching skills. The researcher focused on the teachers' SMK and teaching skills, which they employed through instructional practice in their classrooms.

2.5 TEACHING MATHEMATICS AS A SPECIALIST OR NON-SPECIALIST

2.5.1 Mathematics specialist teacher

According to Botha (2012, p. 47), "Mathematics teaching is a specialized profession, requiring content knowledge, knowledge of the curriculum, knowledge about how to teach mathematics and knowledge about how learners learn mathematics". This quote implies that mathematics teachers require specialist education in their profession and cannot rely solely on instinctive knowledge or talent. In support of this, Hill et al. (2005) explain that mathematics specialist teachers have unique mathematical knowledge for teaching, which includes explaining terms and concepts to students; interpreting students' statements and solutions; judging and correcting textbook treatments of particular topics using representations accurately in the classroom; and providing students with examples of mathematical concepts, algorithms, or proofs. Reys and Fennell (2003) assert that mathematics specialist teachers understand mathematics content, know how learners learn mathematics, and are able to use instructional and assessment strategies that help learners to learn mathematics.

Junqueiraa and Nolanb (2016) define mathematics specialist as:

> *One who acts as a catalyst for promoting and supporting good attitudes and good pedagogical practices in mathematics classrooms in schools and in school divisions. Mathematics specialists may act as mentors or coaches to their colleagues, or they may take on the exclusive role of mathematics teacher in many classrooms, while other teachers take on the responsibility for teaching other subjects (p. 977).*

A mathematics specialist teacher, in the context of this study, is defined as a teacher who has obtained a tertiary qualification in teaching mathematics. Moreover, it is a teacher who has mathematics as one of their major subjects at tertiary level and had a mathematics methodology module where they were taught how to plan mathematics lessons; how to teach mathematics applying different teaching strategies to accommodate the diverse needs of learners; how to use mathematics manipulatives for effective teaching and learning; and how to assess the learners' knowledge and understanding of the content being taught. The mathematics specialist teachers should have knowledge of what to teach and how to teach it thoroughly to cater to learner understanding. Learners can learn more from a mathematics specialist teacher because of the subject knowledge that they have (Ball & Bass, 2002). Darling-Hammond (2000, p. 4) indicates that learners of fully certified mathematics teachers experience significantly larger gains in achievement than those taught by teachers not certified in mathematics.

Ball et al. (2001) argue that mathematics specialist teachers plan mathematics lessons that allow learners to build on their existing proficiencies, interests and experiences. Reys and Fennell (2003) state that mathematics specialist teachers have a particular knowledge interest and expertise in mathematics content and pedagogy, and can create the best environment for learning opportunities. Mathematics specialist teachers know more than enough to just explain the content, they can explain why it is so, why it is worth knowing, and how to relate to other learning outcomes and other disciplines both in theory and practice (Botha, 2012). They represent the concepts in more varied ways that encourage learners to engage in classroom discussions, and they are responsive to learners' questions and responses (Junqueiraa & Nolanb, 2016). These teachers engage learners in the learning process by giving them problem-solving tasks and the opportunity for classroom discussions with the intention of developing learners' understanding of concepts in ways that foster their mathematical critical thinking and problem solving skills (Swars, Smith, Smith, Carothers, & Myers, 2016).

The mathematics specialist teachers are characterised by deep mathematical knowledge and teaching skills (Junqueiraa & Nolanb, 2016; Williams, 2008). They also possess subject expert knowledge, knowledge about the relevant teaching approaches, curriculum, how learners learn best in mathematics, and are able to identify the misconceptions that learners have and correct them in a manner so that they can understand it better. They are able to change the lesson planned and adapt teaching to suit the individual needs of their learners (Donaldson, 2012). In support of this, Swars et al. (2016) state that mathematics specialist teachers have the potential to significantly influence the teaching and learning of mathematics in the classroom.

It is also vital that mathematics teachers have knowledge above their grade level and are able to explain concepts thoroughly to the learners by using practical examples. They might also be able to determine the learners' level of understanding and any misconception that they might have regarding a certain concept. They may further also be able to teach learners different methods of solving mathematical problems and not teach mathematics with fixed rules that learners need to memorise. They can make mathematics interesting, come alive and challenging for learners. They also understand that mathematics is not about rote and abstract learning, and they know that learners at primary level learn mathematics well with concrete objects (Ma, 1999).

In most South African primary schools mathematics is taught by non-specialists mathematics teachers (Onwu & Sehoole, 2015). It is important that the school system explores ways to ensure that learners are taught mathematics by teachers who understand mathematics content, and are able to use teaching strategies that help learners to understand mathematics (Reys & Fennell, 2003). Ball et al. (2001) argue that subject specialist teachers can use mathematics teaching and learning material such as textbooks, mathematics manipulatives and assessments effectively to ensure the effective teaching and learning of mathematics. These teachers may identify any errors in textbooks, and use a variety of resources for the teaching and understanding of mathematics. Reys and Fennell (2003) also indicate that learners can only learn what their teacher knows because what is learned in the classroom strongly depends on the teachers' specialised knowledge in facilitating the instruction. Mathematics specialist teachers can create effective learning opportunities that challenge the learners' critical thinking and encourages learners' interest in mathematics. The learners need to know that mathematics is fun and is not about memorising rules, facts and procedures.

There is a saying - “primary teachers know how to teach children and secondary teachers know how to teach subjects” (Rollnick & Mavhunga, 2016). Regarding the above saying, any qualified teacher can teach any subject in a primary school, but high schools needs subject specialist teachers. The focus of this study is on primary school Grade 6 mathematics teachers because teachers in primary schools do not specialise, whereas teachers in secondary school specialise in their discipline in order to disseminate knowledge. In support of the above saying, Du Plessis (2013, p. 94) asserts that “primary school learners depend on the pastoral guidance of a suitably qualified teacher for the specific year level while secondary school learners need specialist teachers with sound pedagogical knowledge”. Primary schools teachers are mostly non-specialist mathematics teachers (Swars et al., 2016). Brown and McNamara (2011) support this statement by showing that mathematics teachers in primary school are generalists, not specialists. I assume that this is on of the reasons why we experience problems with mathematics because if a teacher is to teach mathematics and is not a specialist, this will hinder the learners' opportunities to learn mathematics effectively.

Williams (2008, p. 3) recommends that "there should be at least one mathematics specialist in each primary school". In support of this, Reys and Fennell (2003) suggest that elementary school mathematics instruction is directed by mathematics specialists beginning in Grade 5. Mathematics teachers who have been trained at tertiary level have good subject matter knowledge and knowledge of different teaching approaches to enforce effective learning of mathematics. While non-specialist mathematics teachers will compromise learners' learning and understanding of mathematics concepts as they themselves encounter mathematical challenges in understanding other concepts. Spaull (2013) indicates that you cannot teach what you do not know, which implies that subject matter knowledge is important.

2.5.2 Non-specialist mathematics teachers

Non-specialist in this study is defined as "teachers assigned by school administrators to teach subjects which do not match their training or education (Ingersoll, 2002, p. 5). Non-specialist teaching is similar to out-of-field teaching. Hobbs (2013, p. 271) defines out-of-field teaching as "teachers teaching outside their subject areas". According to Du Plessis (2016, p. 42), the out-of-field phenomenon is where teachers teach outside their field of expertise, add complexity to the educational environment, and affect effective teaching and quality of learning. The phenomenon of non-specialist teaching, where teachers are placed in teaching positions in which they have to teach subjects outside their field of expertise, occurs mostly in public schools in South Africa (Steyn & du Plessis, 2007). The concept of non-specialist teaching has been researched by a number of researchers in different contexts and is not a problem peculiar to South Africa. In particular, non-specialist teaching has been studied in countries including Germany (Bosse & Törner, 2015); Ireland (Ríordáin, Paolucci, & O'Dwyer, 2017); Nigeria (Aina, 2016; Kola & Sunday, 2015); United States of America (USA) (Ingersoll, 2001a); Western Australia (McConney & Price, 2009) and in England (Crisan & Rodd, 2011).

Scholars use various terms that correspond with or relate to the concept of non-specialism, such as out-of-field or un-trained mathematics teachers (Caldis, 2017; Hobbs, 2013; Ingersoll, 2001b; Kola & Sunday, 2015; Ríordáin et al., 2017). The above-mentioned studies defined non-specialist teaching as having a teaching qualification but being assigned to teach a subject outside of your area of specialisation, and have found that non-specialist teaching has an impact on learners' achievement. These scholars indicate that non-specialist teaching is most likely found in public schools. Ingersoll (2001a) claims that newly appointed teachers are often assigned to teach subjects that they were not trained to teach at tertiary level. In contrast to this statement, McConney and Price (2009) found that most of the teachers who are regarded as non-specialist teachers had more than 20 years in teaching.

Ríordáin et al. (2017, p. 172) assert that school administrators rely on non-specialist teaching in order to facilitate staffing and timetabling issues. For example, with timetabling, the principal should use his or her discretion for the timetabling guided by the Personnel Administration Measures (PAM) (DBE, 2016b). According to this document, the teachers' workload should be shared based on the post levels and the number of learners in the classroom. Therefore, principals may rely on non-specialist teaching: for instance, a social science or life skills teacher can be allocated to teach mathematics while they are not qualified mathematics teachers because it is convenient and less costly (Ingersoll, 2001a). For example, if in the school there is a temporary or substitute teacher and then the school receives a permanent post from the Head of Department, the principal can simply take that teacher to fill the post regardless of their specialisation. The particular teacher has worked in the school for some time in a temporary position and may get first priority to fill the post.

The literature has shown that non-specialist teaching occurs both in primary schools (Bosse & Törner, 2015; Du Plessis, 2013), and secondary schools (Bosse & Törner, 2015; Crisan & Rodd, 2015; Du Plessis, 2013; Ingersoll, 2001a; Ríordáin et al., 2017; Weldon, 2016). For this study, I focused on primary schools, however, due to the scarcity of research on this topic, I also considered studies from secondary schools during my literature survey. Du Plessis (2013, p. 50) states that schools in low socio-economic environments have a higher level of non-specialist teaching. Private schools, because of their high socio-economic status, are more able than public schools to employ highly qualified teachers based on their school's needs. Carnoy and Chisholm (2008, p. 10) indicate that the appointment process in existence enables richer schools to choose their teachers on the basis of advertisement and interviews, while poorer schools select from the list of teachers considered by other school principals as being in excess.

One reason for this is that there is a shortage of teachers trained in primary mathematics (Carnoy & Chisholm, 2008). Another reason might be that there is a tendency of moving the qualified mathematics teachers to high schools at the expense of primary schools, which are then filled with unqualified mathematics teachers (Du Plessis, 2013). This results in an increasing number of non-specialist mathematics teachers in most government public primary schools.

In terms of the negative impact on teaching, Donaldson (2012) found that non-specialist teachers lack confidence due to a lack of content knowledge and mathematical anxiety because of their own inadequate experience of learning mathematics. Maxwell (2001) further states that non-specialist teachers rely heavily on teaching rigidly from a textbook and therefore cannot use practical examples or make learning interesting for the learners. Furthermore, they are unable to use manipulatives to explain the subject content in teaching and learning contexts. Thus, such non-specialists are unlikely to produce learners who will have confidence in mathematics. Most non-specialist teachers teach mathematics as a set of rules to be memorised and a procedure to be followed, which causes learners not to understand the content being taught (Donaldson, 2012). These teachers do this based on their incompetent mathematics understanding and the way in which they learnt mathematics. Therefore, it seems important to have teaching and learning knowledge apart from content knowledge so that teachers can transfer subject content knowledge systematically and methodically to learners. This implies that non-specialist mathematics teachers could contribute to students' underachievement in mathematics.

It is unrealistic to expect non-specialist teachers to have specialised knowledge in all of the disciplines that they are allocated to teach (Junqueiraa & Nolanb, 2016; Reys & Fennell, 2003). For example, qualified social science teachers are assigned to teach mathematics while their degree or diploma does not contain mathematics, and lacks adequate competences in terms of subject knowledge and teaching skills (Ingersoll, 2001b). This is a crucial factor because highly qualified teachers may actually become highly unqualified if they are assigned to teach subjects for which they have little training or education (Ingersoll, 2002, p. 5). Therefore, assigning non-specialist mathematics teachers to teach mathematics from Grades 4 to 12 may have a negative effect on the learners' learning and understanding of mathematics (Ríordáin & Hannigan, 2011).

Specialist mathematics teachers acquire PMTI through their teacher training programme (van Putten, 2011). From the above discussion, it can be seen that non-specialist teachers may lack content knowledge and teaching skills to interact with learners during the teaching process. According to the Norms and Standards for teachers (DoE, 2000), mathematics specialist teachers are required to be:

- A specialist in a particular learning area, subject or phase;
- A specialist in teaching and learning;
- A specialist in assessment;
- A curriculum designer and developer;
- A leader, administrator and manager;
- A scholar and lifelong learner; and

- A professional who plays a community, citizenship, and pastoral role.

The first two teacher roles are statutory for a professional mathematics teacher, and directly relevant to my study as I focused on the non-specialist mathematics teachers as subject specialists and teaching and learning specialists. The first role is based on the teachers' subject matter knowledge (being that of an expert) and the second role is based on how the teacher facilitates learning if he demonstrates good teaching skills as an expert. The mathematics teachers who have the opportunity to be trained in mathematics have the potential to develop the seven qualities expected of PMTI teachers (DoE, 2000).

2.6 SPECIALISATION

Shulman (1986, p. 10) indicates three categories of knowledge that teachers should possess to guarantee effective teaching: (i) Subject matter knowledge, (ii) Pedagogical content knowledge, and (iii) Curricular knowledge. It is on these three categories of knowledge that my study is focused in terms of the non-specialised teacher. The Norms and Standards of South African teachers DoE (2000) claim that the teacher as a subject specialist:

> *Will be well grounded in the knowledge, skills, values, principles, methods, and procedures relevant to the discipline, subject, learning area, phase of the study, or professional or occupational practice. The educator will know about different approaches to teaching and learning, and how these may be used in ways which are appropriate to the learners and the context. The educator will have a well-developed understanding of the knowledge appropriate to the specialism* (p.14).

Moreover, several researchers have indicated that subject matter knowledge is important for effective teaching (Ball et al., 2008; Hill et al., 2008a; Rollnick & Mavhunga, 2016; Williams, 2008).

2.6.1 Subject Matter Knowledge (SMK)

The teacher's subject matter knowledge refers to the mastery of the content that the teacher is expected to teach, and the ability to demonstrate knowledge of mathematics content. Rowland (2009) contends that SMK is the knowledge of subject concepts and calculation strategies. It is important for primary school teachers to have both substantive pieces of knowledge (which are the facts, concepts and processes of mathematics and the links between them), and syntactic knowledge (which includes the process of doing mathematics, knowing how to prove an idea through deductive reasoning or knowing to disapprove the conjecture).

For instance, a teacher cannot explain to her learners the principles underlying the multiplication algorithm if she does not explicitly understand them herself (Ball, 1988). Beijaard et al. (2000) assert that teachers need to possess SMK so that they can change programmes, develop tasks, explain concepts at a high-quality level, and adequately diagnose students' understanding and misconceptions adequately. In support of this, Donaldson (2014) indicates that the mathematical knowledge required for teaching involves lesson planning, developing tasks and activities, and dealing with errors and misconceptions. Davis and Renert (2013) define mathematics knowledge for teaching as:

> *A way of being with mathematics knowledge that enables a teacher to structure learning situations, interpret student actions mindfully, and respond flexibly, in ways that enable learners to extend understanding and expand the range of their interpretive possibilities through access to powerful connections and appropriate practice* (p.11).

Rollnick and Mavhunga (2016) indicate that SMK is developed through three stages of learning: pre-college, college, and practice. It follows that it is not possible to develop a concrete SMK beginning from practice as a teacher.

It is important that a teacher should have competent subject matter knowledge. This view is supported by Davis and Renert (2013), who find that teachers should know how to relate mathematics concept to real-life examples when explaining to learners in order for the learners to understand the concept being applied. Venkat, Rollnick, Loughran and Askew (2015) assert that the teacher’s subject matter knowledge influences how lessons are planned and presented. In this vein, Baumert et al. (2010) explain that:

> *The repertoire of teaching strategies and the pool of alternative mathematical representations and explanations available to teachers in the classroom are largely dependent on the breadth and depth of their conceptual understanding of the subject, and that an insufficient understanding of mathematical content limits teachers’ capacity to explain and represent that content to students in a sense-making way* (p. 138).

Lesson presentation and assessment are very much dependent on the teacher’s subject matter knowledge and beliefs about mathematics teaching and learning (Anthony & Walshaw, 2009). A number of researchers have found that mathematics teachers need a tertiary qualification in mathematics to have the subject matter knowledge and skills required for the effective teaching of mathematics (Ball et al., 2001; Baumert et al., 2010; Hill et al., 2005; Ríordáin et al., 2017). Ríordáin et al. (2017) indicate that teaching mathematics without a formal qualification is challenging and has a negative effect on learners' mathematics learning.

Ball et al. (2008) report that the subject matter courses for teachers and teacher education courses, in general, have little effect on the improvement of teaching and learning. I disagree with the above statement as teacher education courses do have an impact on the teachers' day to day practice and this has been revealed in studies done by (Bjuland et al., 2012; Hodgen & Askew, 2007; Nel, 2012). From the above-mentioned studies, the findings reveal that teachers who attended short courses on teaching mathematics found these to positively influence their day to day practice.

Venkat and Spaull (2015), in their study of mathematics teachers' subject matter knowledge, found that there is a crisis relating to primary school mathematics teachers' subject matter knowledge in South Africa. From the South African Consortium for Monitoring Educational Quality (SACMEQ) 2007, the mathematics performance test score of mathematics teachers from South Africa showed that 79% of the Grade 6 mathematics teachers' subject matter knowledge was below their grade level. It was found that many primary school mathematics teachers lack the subject matter knowledge and teaching skills required to provide learners with mathematical skills (Venkat & Spaull, 2015).

The teacher’s subject knowledge predetermines their learners’ achievement. It may be difficult for teachers to teach knowledge that they have not acquired, thus, learners may not benefit from such teachers who are deficient in the mathematical knowledge required for teaching (Spaull, 2013, p. 24). In support, Carnoy, Gove, and Marshall (2007, p. 40) report that Cuban primary school learners perform well in mathematics because they are taught by highly qualified teachers and their teachers seem to know more about the subject matter and have a good idea of how to teach it effectively. “No matter how good their pedagogical skills, teachers’ who lack SMK in their discipline manifest unpreparedness” (Du Plessis, 2013, p. 33).

My argument is that the teachers’ mathematical knowledge alone is not sufficient for effective teaching, teachers need both subject matter knowledge and teaching skills, which can be obtained through tertiary training (Williams, 2008). Ball et al. (2001, p. 451) indicate that knowing mathematics for yourself is not the same as knowing mathematics for teaching. It implies that teachers need tertiary training in mathematics so that they can develop their PMTI. The literature has also indicated that the subject matter knowledge required for teaching is imperative, but alone it is insufficient for the effective teaching of mathematics (Du Plessis, 2013; Huang, 2012; Thames & Ball, 2010; Turnuklu & Yesildere, 2007; van Putten, 2011). The mathematics teacher needs both subject matter knowledge and teaching skills in order to teach effectively.

2.6.2 Knowledge of teaching and learning

Beijaard et al. (2000) speak of didactical expertise as the knowledge that a teacher has about teaching and learning. Hill et al. (2005) indicate that this knowledge includes explaining terms and concepts to students, interpreting students' statements and solutions, judging and correcting textbook treatments of particular topics, using representations accurately and providing learners with examples of mathematical concepts, algorithms or proofs. Mathematical knowledge for teaching is different from other professions as it requires subject matter knowledge. Mathematical knowledge includes an aspect of proficiency, such as understanding the role of definitions and choosing and using them skilfully; knowing what constitutes an adequate explanation or justification and using the presentation with care (Ball & Bass, 2002, p. 13). It is not only about calculating correctly, you need to know how to use pictures or diagrams to represent mathematical concepts and procedures to learners, and provide learners with explanations in order for them to understand the concept being taught.

Botha (2012) opines that teachers need to apply appropriate instructional strategies to provide learners with opportunities to develop their critical thinking and problem-solving skills. Franke, Kazemi, and Battey (2007, p. 229) explain that to teach for understanding, all learners need opportunities to develop both concept and skills, develop flexibility in their ability to engage with mathematical ideas, and engage in what some may call higher-order or critical thinking. It is important to know the learners and their levels of understanding so that when a lesson is prepared and presented, the diverse needs of learners and different cognitive levels are accommodated. Asking questions while teaching will enable the teacher to determine learners' understanding, while listening attentively to their responses allows the teacher to build on them by explaining the content thoroughly using their ideas. Franke et al. (2007, p. 230) claim that "developing mathematical understanding requires that learners have the opportunity to present problem solutions, make conjectures, and talk about a variety of mathematical problem-solving procedures and solutions." Williams (2008, p. 64) states that teaching and learning must be learner-centred, and thus responsive to the needs of the children being taught through the effective use of diagnostic assessment and a broader adoption of assessment for learning. It must be truly interactive, giving children time, for example, to think, to question as well as to answer, discuss and try out their own ideas and strategies. This teaching approach is supported by the new CAPS document. The situation in the primary schools in townships differs as most mathematics teachers lack mathematical knowledge competence and teaching skills (Venkat & Spaull, 2015). Reys and Fennell (2003) indicate that:

> *Learners at elementary schools experience a narrow mathematics curriculum that consists only of rules, facts and procedures and who learn mathematics by memorizing and mimicking are*

unlikely to understand the power of mathematics or be interested in it in a middle and high school" (p. 278).

This may result in learners avoiding mathematics as their subject choice in the FET phase (Du Plessis, 2013). The above statement implies that learners need to understand the content being taught so that they can apply this knowledge when they are asked to solve a certain problem. If learners understand mathematics, they can develop an interest in continuing with mathematics up to Matric because a strong foundation is laid at primary level. Learners can then easily develop mathematical problem-solving skills.

2.6.2.1 Teaching approaches applied in class

Hiebert and Grouws (2007, p. 372) define teaching as "classroom interaction among teachers and students around content directed toward facilitating students' achievement of learning goals." This definition implies that the teacher teaches through interaction with learners, asks questions, and the learners answer or vice versa. According to the Norms and Standards of educators, "the subject specialist will use key teaching strategies such as higher level questioning, problem-based tasks, and appropriate use of group work, whole class teaching and individual self-study" (DoE, 2000, p. 15). In a mathematics classroom, the teacher should create a classroom environment that encourages critical and creative thinking (DoE, 2000).

There are different teaching approaches that teachers can apply in their classroom, for instance, individual or cooperative teaching approaches with learning as an active construction of knowledge as opposed to a passive reception of knowledge. In this way, learning is an active process where learners construct their own knowledge from their own experiences, peers', adults' and teachers' instruction and feedback (Swars et al., 2016). Li and Lam (2013, p. 1) define cooperative learning as a learner-centred approach where learners interact with each other in a group to acquire and practice the elements of a specific subject matter in order to solve a problem, complete a task or achieve a goal. Cooperative learning can thus be regarded as an active learning process.

For effective teaching and learning, understanding can be established through the teaching approaches applied when teaching, how the teacher presents his or her lesson, and if the learners were encouraged to participate in the classroom. The teacher as a teaching and learning specialist can adjust teaching strategies to cater to different learning styles and preferences. Baumert et al. (2010, p. 145) mentions three components of instructional strategies that are important for effective learning, namely:

(1) Cognitively challenging and well-structured learning opportunities.
(2) Learning support through monitoring of the learning process and individual feedback.

(3) Efficient classroom and time management.

I share the opinion of Baumert et al. (2010) that, as a mathematics teacher, one needs knowledge and teaching skills for presenting and explaining the content thoroughly. This should be done by asking higher-order questions to draw on learners' prior knowledge of the content to be taught. The teacher should develop learning opportunities by encouraging classroom discussion through, for example, asking questions and not simply indicating that the learners' answers are correct or incorrect, but asking learners to explain their answers and asking further questions based on the learners' answers (Baumert et al., 2010). Also, teachers can use the learners' answers to further explain the content and clarify any misconceptions. Teachers can support individual learners who experience difficulties in understanding the content. Learners' work should be corrected, and corrections can be done together with the learners so that they can also learn from the corrections. The learning opportunities created and the teaching strategies applied in the classroom are dependent on the teachers' subject matter knowledge and teaching skills (Reys & Fennell, 2003).

However, through a teacher-centred approach, learners are expected to assimilate what they are taught the way it is, there is no room for flexibility (Jonassen, 1991). The learning process is often fixed, with rules and procedures, and is more of rote learning and memorisation. The teacher is the centre of learning and the classroom interaction between the teacher and learners is limited. The mathematics teacher should use both learner and teacher-centred teaching strategies, and ensure a balance between these teaching approaches for effective teaching and learning. For instance, the teacher should present the concepts to the learners and then give the learners a task to work on as an individual or in groups, then they should report their solutions. The solutions can be discussed in the classroom to further elaborate on the concept or correct any misconceptions.

The teacher may use mathematical manipulatives to explain the new concept or use a practical example. They may also ask questions in order to determine the learners understanding or misconception of the concept, and be aware of the diverse needs of the learners. Some learners might understand the concept faster while other learners take longer to understand, which is why the teacher needs a strategy to accommodate all the learners' levels (for example, explain to the learners with learning difficulties individually while the other learners are working on mathematical sums given to them). The teacher should always ask the learners questions while teaching as a way of interaction and also to determine the learners' level of understanding.

Therefore, I believe that in order for teachers to employ both learner- and teacher-centred approaches to learning, and also to use manipulatives for effective teaching and learning, the teacher must have concrete subject matter knowledge and teaching skills. It is important for a mathematics teacher to know different teaching strategies so that he can apply these in different lessons for effective teaching. In support of this, Hiebert and Grouws (2007, p. 374) indicate that there is no single best or most effective teaching method. The mathematics teacher should be able to use the different teaching strategies appropriately. Golafshani (2013) supports the above claim, and states that the use of a variety of teaching strategies enables effective teaching and learning as every classroom has learners with different levels of mathematical ability and different learning styles. The conceptual framework that guided this study will be discussed in the next paragraph.

2.7 CONCEPTUAL FRAMEWORK

A study conducted by van Putten (2011) introduced a conceptual framework featuring PMTI characteristics. van Putten (2011) described PMTI in terms of three aspects: subject specialist, teaching and learning specialist, and carer. The mentioned study looked at the PMTI of pre-service mathematics teachers, its influence, and how it is actualised in the classroom. Figure 2.1 illustrates the conceptual framework regarding the influences of PMTI and its actualisation in the classroom as taken from van Putten (2011) conceptual framework.

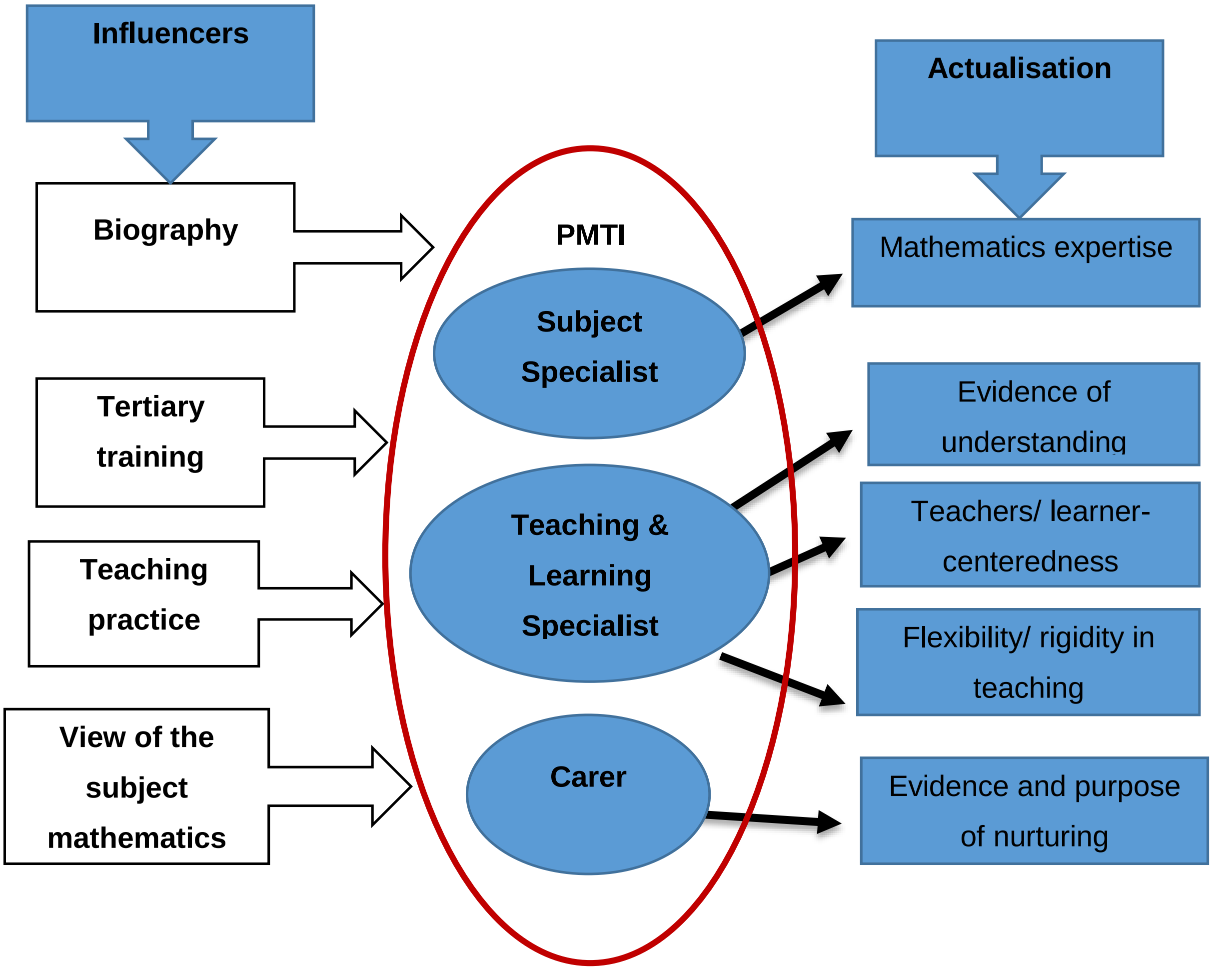

Figure 2.1: Conceptual framework for PMTI (van Putten, 2011)

My study focuses on non-specialist primary school mathematics teachers' PMTI in terms of being a subject specialist, and a teaching and learning specialist. Figure 2.2 shows the adapted conceptual framework from van Putten (2011), premised on the works of (Beijaard et al., 2000; Ernest, 1988; Thompson, 2009). My study focused on two of the aspects of PMTI described by van Putten (2011): subject specialist and teaching and learning specialist, and how it actualised in the classroom of these non-specialist mathematics teachers. These aspects are also important teacher roles as indicated by the Norms and Standards of Educators (DoE, 2000).

This conceptual framework below (Figure 2.2) was used to address the research question "How can the Professional Mathematics Teacher Identity (PMTI) of non-specialist primary school mathematics teachers as subject specialists and teaching and learning specialists be described?" I used the same approach to look at non-specialist primary school mathematics teachers as I was interested in exploring the non-specialist mathematics teachers' subject matter knowledge and teaching skills.

The domains indicated above are important for a mathematics teacher for effective teaching and learning, and can be acquired through training. Mathematics specialist teachers need to demonstrate their understanding of subject matter knowledge and how to teach it. In the following paragraphs, I explain the two PMTI subject specialist and teaching and learning actualisation factors.

2.7.1 Subject specialist

This PMTI aspect deals with the teachers' subject matter knowledge (van Putten, 2011), and has a great impact on the learners' achievement. The mathematics specialist teacher should have expert mathematics knowledge in order to be able to explain the concepts properly, respond to learners questions correctly, identify learners misconceptions and correct them, and develop assessment tasks, which include all the cognitive levels. The subject specialist should also demonstrate knowledge of the mathematics CAPS policy document guiding them. Hill et al. (2005) indicate that the expert knowledge includes:

> *Explaining terms, and concepts to learners, interpreting students statements and solutions, judging and correcting textbook treatments of particular topics, using representations accurately in the classroom, and providing learners with examples of mathematical concepts algorithms, or proofs"* (p.373.).

The mathematics expert teacher knowledge, as indicated above, manifests in the classroom through practice. The teacher needs to have both subject knowledge and teaching skills as teaching and learning specialist, which will be discussed below.

2.7.2 Teaching and learning specialist

In this aspect of PMTI, it is important to have knowledge and skills for teaching mathematics, representing the concepts effectively, using manipulatives, using real-life examples, and employing different teaching strategies. Ernest (1988) and Thompson (2009) claim that there is a link between teachers' beliefs, understanding of mathematics and the way in which they teach. Thus, the teachers' belief and subject knowledge have a great impact on instructional practice. Teachers should employ both a learner-centred and teacher-centred approach, being flexible in teaching and be able to determine learners' understanding of the content taught (Thompson, 2009). Teachers should employ different teaching strategies and make use of manipulatives for effective teaching and learning. Furthermore, teachers should ask questions during the lesson in order to determine the learners' understanding of the concept being taught and further elaborate on the concept if they identify any misunderstanding. Asking questions during the lesson may assist the teacher to determine the learners' understanding of the concept and correct any misunderstanding during the lesson.

The cooperative learning approach may be employed where learners work in groups in order to learn from each other and develop problem-solving skills. In the learner-centred approach, the learning process is more active than passive. Ernest (1988) asserts that the teacher should execute three roles for effective teaching and learning, that of: instructor, explainer and facilitator. Through cooperative learning, the teacher's role is that of being a facilitator. Beijaard et al. (2000, p. 752) state that "a teacher must be more of a facilitator of learning and less of the transmitter of knowledge". This implies that the teachers must use both teaching approaches but employ more of learner-centred approach and less of a teacher-centred approach for the learner to construct knowledge effectively. The teaching strategies applied in the classroom determine the effectiveness of teaching and learning in the classroom. Flexibility in teaching is when a teacher is able to explain a question asked by the learners that was not part of the planned lesson and being able to adapt the lesson based on the learners understanding, and clarifying any misconception. The teacher also needs to be flexible and adjust instruction in order to be able to accommodate different learning styles. Rigidity in teaching is when a teacher sticks to the prepared lesson even when the need arises, for instance, a learner has asked something that is not relevant to the lesson of that particular day.

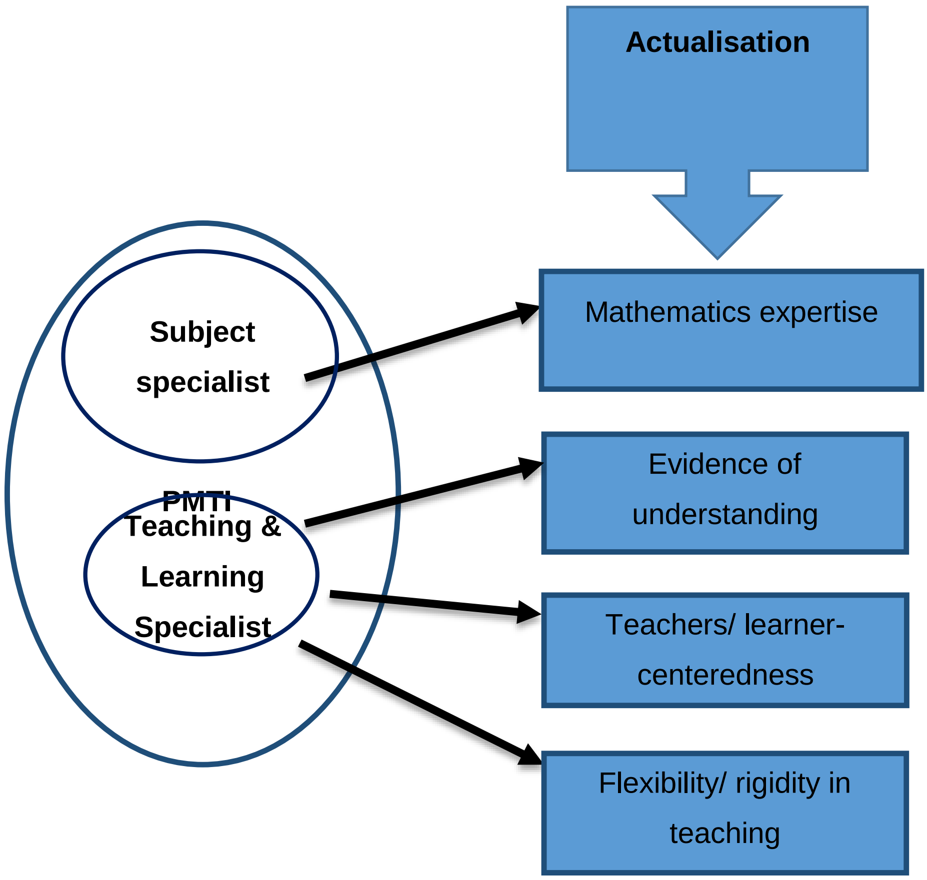

Figure 2.2: Conceptual framework adapted from van Putten (2011)

2.8 CHAPTER SUMMARY

In this chapter, a summary of the definitions of professional teacher identity was given and it was determined what is common among the provided definitions and studies. The differences between the specialist and non-specialist mathematics teacher were explained. The concept of Professional Mathematics Teacher Identity (PMTI) was discussed with reference to the work of other researchers. The two elements of PMTI selected for this study, namely, subject specialist and teaching and learning specialist were discussed. The subject content knowledge and teaching and learning strategies were also presented. The importance of each PMTI aspect of the teaching of mathematics was also considered. The chapter ends with a presentation of the conceptual framework that was used for both the collection and analysis of the data. Chapter 3 provides a discussion of the research design and methodology of this study.

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research methodology of this study, including the research philosophy guiding this study, the research approach, research design and sampling. Moreover, this chapter comprises an explanation of how the data was collected and analysed. This chapter concludes with the consideration of the trustworthiness of the study and the ethical considerations of this research.

3.2 RESEARCH PHILOSOPHY

There are two basic philosophies distinguished in research: positivist and interpretivist (Cohen, Manion, & Morrison, 2011). According to Krauss (2005, p. 759), in the positivist paradigm, "knowledge is discovered and verified through direct observations or measurements of phenomena, and Interpretivist paradigm knowledge is constructed through the meanings attached to the phenomena studied; researchers interact with the subjects of study to obtain data." The research philosophy underpinning this study was an interpretivist paradigm. I used the interpretive paradigm lens to understand the subjective world of the teachers' experience (Cohen et al., 2011, p. 17).

Ontology comprises "beliefs about the nature of reality", what constitutes reality, or how people construct reality (Nieuwenhuis, 2016b, p. 52). From the positivist approach, the reality is objective (external) and in the interpretivist approach reality is subjective (internal) (Cohen et al., 2011). The focus of this study (the professional teacher identity of non-specialist primary school mathematics teachers) and the research approach (qualitative research approach) were related to a subjective and not an objective approach. According to Krauss (2005, p. 761), positivism concerns a single concrete reality, whereas in the interpretivist paradigm, multiple realities exist. The philosophical assumptions underpinning the ontology of this study was an interpretivism, where a multiplicity of diverse people interpret events differently, leaving multiple perspectives of reality (Nieuwenhuis, 2016b). As an interpretivist, I believe that reality is not objectively determined, but is subjectively constructed. From this perspective, the participants' reality of PMTI was interpreted from the perspective of their classroom practice. The researcher interpreted the participants' PMTI based on their instructional approaches, subject matter knowledge, and pedagogical skills. According to this philosophy, the way of knowing reality is by exploring the experiences of participants regarding the teaching and learning of mathematics (Nieuwenhuis, 2016b). Adapting the interpretivist approach enables the researcher to interpret the participants' perspectives and experiences in order to construct reality from those interpretations, and not from the researcher's own experience. In this study, the reality was constructed as this study investigated how non-specialist primary school mathematics teachers execute their roles for effective teaching and learning. This research philosophy results in multiple realities as the participants are unique and have different perspectives and experiences, which change over time (Cohen et al., 2011).

Epistemology "concerns the very bases of knowledge its nature and forms, how it can be acquired, and how communicated to other human beings" (Cohen et al., 2011, p. 6). According to Krauss (2005, p. 760), in the positivist epistemology, "science is seen as the way to get the truth, to understand the world enough that it be predicted and controlled." PMTI is a social construct that mathematics teachers should possess in order to teach mathematics effectively. As a qualitative researcher viewing the world through the lens of the interpretivist perspective, I set out to elicit information from the participants by meeting them one on one in their natural setting. I thus collected the data from the participants' in their classrooms. For this study, I had access to knowledge by going to the teachers' classroom to observe their lesson presentation. In this way I could ascertain how they teach, analyse their lesson plans and assessment tasks, and have them talk through semi-structured interviews where they shared their experiences based on the subject of inquiry. However, positivist researchers have access to information from an objective dimension by using surveys or experiments as a strategy of data collection (Cohen et al., 2011). This means that the researcher inductively develops an in-depth understanding of the phenomenon of the study from the participants' perspectives.

I chose an interpretivist approach as I was not interested in generalising the findings of the study, but sought an in-depth understanding of the PMTI of non-specialist mathematics teachers. I was limited to the information obtained from the research setting and thus the findings are only applicable to those sampled participants. The purpose of the study was to interpret the participants' meanings rather than to generate a theory (Creswell, 2014, p. 8). The meaning of the PMTI of non-specialist mathematics teachers as subject and teaching and learning specialists was further interpreted by the researcher. This claim is supported by Merriam (2009, p. 8), who finds that in qualitative research, reality is constructed. Thus, the data was interpreted based on my understanding of the literature reviewed, and the conceptual framework on which this study was based. The knowledge gained is communicated through this dissertation and will be available in the library repository of the University of Pretoria.

3.3 RESEARCH APPROACH

This study applied a qualitative research approach (Nieuwenhuis, 2016b), as I sought to explore how non-specialist mathematics teachers' PMTI manifests as subject specialists and teaching and learning specialists. I therefore focused on their subject matter knowledge and teaching skills. I also sought to investigate how they used the intermediate phase mathematics CAPS document for the planning and designing of assessment tasks; how they presented their lessons; and what instructional practices they applied in their classrooms for the learners to develop mathematical understanding.

Qualitative research is defined as “an approach that attempts to collect a rich descriptive data with an intention of developing an understanding of what is being studied from the participants’ perspective or experience” (Nieuwenhuis, 2010, p. 50). My purpose in this study was to develop an understanding of the PMTI of non-specialist mathematics teachers as subject and teaching and learning specialists from the participants' experiences and perspectives. “Qualitative research approach emphasizes that the world or reality is not fixed, single, agree upon or measurable phenomenon that is assumed to be in quantitative research” (Merriam, 2002, p. 3). In the qualitative research approach, there are multiple constructions and interpretations of reality at a particular point in time, however, these change over time (Merriam, 2002, p. 4).

In this study, I constructed meaning from the participants lived experiences and perspectives. Merriam (2009, p. 9) states that reality is socially constructed, and that there is no single observable reality. Rather, there are multiple realities or interpretations of a single event. In this regard, each and every participant has its own description of reality, which might result in the research finding multiple realities from the participants since in qualitative research there is no single fixed reality. In this case, each participant has constructed his or her own reality based on their perception or experience of teaching mathematics while they are not qualified mathematics teachers.

3.4 RESEARCH DESIGN

Since the study used an interpretivist lens, a case study research design was employed. Table 3.1 below provides a summary of the research methodology that was followed in this study.

Table 3.1: An outline of the research methodology of this study

Research method	Qualitative		
Research strategy	Case study design		
Main research question	How can the Professional Mathematics Teachers' Identity (PMTI) of non-specialist mathematics primary school teachers be described?		
Sub-research questions	How does the non-specialist mathematics teachers' subject knowledge manifest as a teaching and learning specialist?	How does the non-specialist mathematics teachers' PMTI manifest as a subject specialist?	What are the characteristics of the PMTI of non-specialist mathematics teacher?
Participants	Three Grade 6 non-specialist mathematics teachers from three different primary schools in Johannesburg East.		
Data collection techniques	Lesson observation (two lesson observations per participants, video recordings and field notes in order to capture data during observation.	Document analysis (lesson plans and assessment tasks).	Semi-structured interviews (one semi-structured interview per participant in order to clarify the data collected from the lesson observation and document analysis).

Yin (2014, p. 16) defines a case study as an "empirical inquiry that investigates a contemporary phenomenon within its real-life context." The case study research design enabled me to be immersed in the research site to collect rich data (Merriam, 2009, p. 39). A case study provides the researcher with an opportunity to study the participants in their classrooms during their practice (Baxter & Jack, 2008). The qualitative case study here provided me with an opportunity to use multiple data collection strategies (semi-structured interviews, lesson observation and document analysis), and ensured that the study's phenomenon was not explored through one lens only, but multiple lenses, which allowed for multiple understanding of the phenomenon being studied (Nieuwenhuis, 2016c, p. 83). A case study design was deemed appropriate for this study as it allowed me to develop an understanding and interpret the individual teachers' experiences of teaching the subject while being non-specialist mathematics teachers. In other words, a case study was used to gain an in-depth understanding of the PMTI of non-specialist mathematics teachers. The case or unit of analysis was Grade 6 non-specialist mathematics teachers, and the phenomenon under study was their PMTI (Baxter & Jack, 2008).

3.5 RESEARCH SITE AND SAMPLING

This study employed both convenient and purposive sampling (Nieuwenhuis, 2016c). According to Maree (2016, p. 197), "Convenience sampling the participants are selected based on the fact that they are easily and conveniently available, and purposive sampling is done with a specific purpose in mind." The sampling was convenient in manner as the schools were chosen from schools in the Johannesburg East district that were easily accessible and the least costly. Three Grade 6 mathematics teachers were chosen. The purposive sampling criteria were non-specialist mathematics teachers who were teaching mathematics in Grade 6 at the time of this study and were located in Johannesburg East township public primary schools. The non-specialist Grade 6 mathematics teachers were chosen in consultation with the school principals and mathematics Heads of Department (HOD) since they are familiar with their teachers' areas of specialisation as they worked closely with them. Grade 6 was chosen as it is the final grade of the intermediate phase. As previously mentioned, the intermediate phase is where a concrete foundation should be laid. Thus this grade was chosen with the assumption that learners from this phase should have mastered the mathematics basics that are required in the Senior and FET phase.

3.6 DATA COLLECTION

The qualitative case study afforded me the opportunity to use multiple data collection strategies (Baxter & Jack, 2008). In order to find out how non-specialist mathematics teachers' PMTI manifests as subject, and teaching and learning specialists, data was collected through tape-recorded semi-structured interviews, video-recorded lesson observation, and a document analysis (Creswell, 2014).

3.6.1 Interviews

Patton (2015) states that:

> *We interview people to find out from them those things we cannot directly observe and to understand what we have observed. We cannot observe, feelings, thoughts, intentions and behaviours that took place at some previous point in time. We have to ask people questions about those things* (p. 426).

The purpose of the interviews was to develop an understanding of the participants' worldview, perspectives and experiences in mathematics subject knowledge and teaching knowledge. Three teachers were interviewed before the classroom observations and document analysis. The interviews were conducted face-to-face with semi-structured, predetermined interview questions before the interview in order to keep the interview focused on the study's purpose (Nieuwenhuis, 2016c). The interviews lasted 15 to 30 minutes each. Each teacher was interviewed once before the lesson observations and document analysis were done. The teachers were interviewed in the library during their free periods during school hours, as per our arrangement. The interview responses were recorded using a tape recorder and notes were also taken during the interviews (Nieuwenhuis, 2016c). The interview helped to gather answers to the third sub-research question: What are the characteristics of the PMTI of non-specialist mathematics teachers?

3.6.2 Lesson observation

In this study, lesson observation was the second research method used to collect data. "Observation is the systematic process of recording the behavioural patterns of participants and occurrences without necessarily questioning or communicating with them" (Nieuwenhuis, 2016c, p. 90). In this study, lesson observation was used to explore the ways in which the PMTI of non-specialist mathematics teachers manifests, and thus answers to the first research question of the study: How does non-specialist mathematics teachers' subject knowledge manifest as a teaching and learning specialist?

Patton (2015, p. 331) claims that a major purpose of observation is to see first-hand what is going on rather than simply assuming what we know. Observations enable the researcher to capture the experience of those who are less articulate (Simons, 2009, p. 55). The purpose of using the lesson observation technique in this study was to develop an in-depth understanding of the PMTI of non-specialist primary school mathematics teachers as it manifests in the classroom. The teachers' subject content knowledge and teaching skills was determined through observing them in practice. Six lessons were observed, and each teacher was observed twice. The classroom observations were prearranged with the participants. The lesson observations were videotaped, and I also used a lesson observation schedule, which was developed from the literature review and conceptual framework and was adapted from Kekana (2016) observation checklist. During the lesson observation, the researcher was assessing the PMTI of the non-specialist mathematics teachers based on the conceptual framework. The PMTI teaching and learning specialist actualisation was gauged through learners' understanding of the content being taught, the teaching strategies employed, and the teachers' interaction with the learners.

I observed the lesson presentation to describe the teachers’ mathematical content knowledge and teaching skills. I further observed the teaching strategy applied in the classroom, learning opportunities created by the teacher, evidence of learning, the teachers’ interactions with learners and if there was flexibility or rigidity in their teaching. The lesson was observed to capture all the elements of the lesson as reflected in the lesson observation schedule adapted from (Kekana, 2016). The elements reflected in the lesson observation schedule were the teachers’ subject matter knowledge and teaching skills in teaching mathematics. I visited the school on the arranged dates and times that suited each teacher. The teachers were observed presenting different lessons on different topics in their classrooms.

3.6.3 Document analysis

Simons (2009, p. 63) claims that “document analysis has the potential for adding depth to a case that has not perhaps been fully exploited." Document analysis was conducted in order to confirm the evidence obtained through the semi-structured interviews and lesson observations. After the interviews and lesson observations, I analysed the documents in order to validate the data collected. The documents analysed were those used for teaching mathematics, namely: lesson plans were assessed as to whether they were aligned with the Intermediate Phase mathematics Curriculum Assessments Policy Statements (CAPS) document and assessments tasks. The lesson plan was evaluated to see if the lesson plans accommodated the different cognitive levels of the learners that needed to be developed and if the planning did accommodate the diverse needs of learners. The lesson plans were also assessed in terms of the Annual Teaching Plan (ATP) for what needs to be taught in Grade 6 in a specific term. The content to be taught in the Intermediate Phase is reflected in the ATP in the mathematics CAPS document. Mathematics in the Intermediate Phase covers five main content areas (DBE, 2011, p. 9):

- Numbers, operations and relationships;
- Patterns, functions, and algebra;
- Space and shape;
- Measurement; and

- Data handling.

Each content area contributes to the acquisition of specific skills and the following cognitive levels: knowledge, routine procedures, complex procedures, and problem-solving (DBE, 2011, p. 296)). I also analysed the teachers' assessments tasks to see if they were aligned with the CAPS mathematics document's cognitive levels. The document analysis added value to the data gathered from the semi-structured interviews and lesson observations, and thus gathered answers to the second sub-research question: How does non-specialist mathematics teachers' PMTI manifest as a subject specialist?

3.7 DATA ANALYSIS

The data analysis was based on the interpretivist philosophy, which is a systematic process and was aimed at examining the meaningful and symbolic content of the qualitative data (Nieuwenhuis, 2016a). From the interpretivist perspective, I constructed knowledge based on non-specialist mathematics teachers' PMTI, subject content knowledge, and teaching skills. In this vein, Creswell (2007) asserts that:

> *Data analysis in qualitative research consists of preparing and organizing the data for analysis, then reducing the data into themes through a process of coding and condensing the codes and finally representing the data in figures, tables or a discussion*" (p.148).

This study used an inductive and deductive content analysis to analyse the data acquired from the semi-structured interviews, lesson observation, and document analysis (Nieuwenhuis (2016a). The themes were predetermined from the conceptual framework, which comprised a deductive analysis, and codes and categories emerged from the data, which comprised an inductive analysis. A large amount of textual data that was collected through semi-structured interviews, lesson observations and document analysis in this study were summarised. This was then compressed into codes and categories to make better sense of the data (Nieuwenhuis, 2016a). The data were analysed through an ongoing process as after each data collection process I analysed the data. Through the data analysis, meaning was constructed on how these non-specialist teachers executed their roles as subject specialist and teaching and learning specialists. This further allowed me to answer the research questions.

3.8 TRUSTWORTHINESS OF THE STUDY

Lincoln and Guba (1985, p. 290) define trustworthiness as persuading the audience that the findings of the inquiry are worth paying attention to. A qualitative case study research design includes multiple data collection strategies to promote trustworthiness through the triangulation of data (Nieuwenhuis, 2016a). Lincoln and Guba (1985, p. 300) indicate the following four aspects that qualitative researchers should consider to ensure the trustworthiness of their study: “credibility”, “transferability”, “dependability” and “confirmability”.

3.8.1 Credibility

Triangulation of the data was applied, that is, “collecting data from a variety of perspectives, using a variety of methods, and drawing upon a variety of sources so that an inquirer's predilections are tested as strenuously as possible” (Guba, 1981, p. 87). The multiple data collection strategies were used for the triangulation of the data and to ensure the trustworthiness of the data (Nieuwenhuis, 2016c). Through the triangulation process, any code that emerged from one source of data collection was confirmed through the other two data collection methods. The variety of data collection strategies was used to verify the data collected from the different data collection strategies. The findings and interpretation were assessed based on the audio recordings and transcripts for the interviews, field notes, video recordings of the lesson observations and the transcripts for document analysis (Guba, 1981). Nieuwenhuis (2016a, p. 123) indicates that ensuring credibility may include member checking, which implies that “you submit your transcripts to the participants to correct errors of fact.” I integrated the process of member checking by going back to the field and sharing and verifying my interpretations of the data with the participants, and the participants had an opportunity to discuss and clarify any misinterpretations and/or contribute new information to the phenomenon being studied (Baxter & Jack, 2008).

3.8.2 Transferability

According to Nieuwenhuis (2016a, p. 124), transferability does not involve generalised claims but invites the reader to make connections between the elements of a study and their experience or research. The aim of the study was not to generalise the findings since it was a qualitative case study with a small number of participants, thus the findings were only applicable to the studied sample. Transferability was increased by using participants who had the qualities of the sampling criteria, and were suitable participants as they were Grade 6 non-specialist mathematics teachers in public primary schools. I also provided a thick description of the research context, participants, and research design for the study as a way to increase transferability (Nieuwenhuis, 2016a).

3.8.3 Dependability

Baxter and Jack (2008) assert that dependability is:

> *The consistency of the findings from data analysis. The dependability of the data can be promoted by having multiple researchers independently code a set of data and then meet together to come to a consensus on the emerging codes and categories"* (p. 556).

I employed triangulation during the data analysis as the claims made through the semi-structured interviews were confirmed through the lesson observations and document analysis. Through the data analysis from the three different methods, I could see the same emerging codes and categories from the data, hence the data was regarded as trustworthy. I used non-specialist mathematics teachers from different schools to ensure the dependability of the study. The same findings emerged from the different participants and different data collection strategies. I also requested an independent researcher to code the data independently, and we then came together to discuss the codes and categories in order to reach the study's findings. I kept the field notes or transcripts, video recordings and audio recordings and the copies were given to my supervisors and independent researchers who helped with coding the data. My supervisors attested the dependability of the study by examining the data, findings, interpretations, and recommendations (Lincoln & Guba, 1985)

3.8.4 Conformability

Nieuwenhuis (2016a) describes conformability as the extent to which the findings of a study are shaped by the participants and not the researchers' bias, motivation, or interest. I avoided using my own interpretation of the data but used the participants' quotes to prove my point. Conformability was also ensured by employing triangulation. I shared field notes, transcripts, video recordings and audio recordings with my supervisors, and also employed member checking and independent researchers coding to minimise bias in the analysing data. I further also acknowledged my subjectivity with regard to the studied phenomenon.

3.9 Ethical considerations

I sought approval from the University's Faculty of Education ethics committee after meeting the requirements for the research proposal defense. According to Simons (2009, p. 102), "The faculty sought and grant ethics approval depend on the study research proposal if the study is researchable and all the research methodology for the study has been clearly stated." I was granted permission to conduct the study by the ethics committee and the Gauteng department of education. The study adapted the ethical procedures for conducting case study research as stated by Simons (2009, pp. 103-106): informed consent, giving participants a voice and participant control, and ensuring confidentiality and anonymity.

3.9.1 Informed consent

According to Simons (2009, p. 103), "Informed consent is sought through a form, participants are asked to sign prior to being interviewed or observed and taking part in the research." The participants were fully informed about the purpose of the study and the multiple research methods (semi-structured interviews, lesson observation and document analysis) that were employed in the study. The participants were asked to make lesson plans for the observed lessons, and assessments tasks available for document analysis.

The principals of the sampled schools were called to arrange an appointment to ask for permission to conduct the research. The principals of the schools were informed about the study and its purpose. The letter of ethical clearance and letter of permission from the Gauteng department of education were given to them. The principals were given a consent letter to sign as a form of granting permission to conduct the study in their schools. The sampled Grade 6 non-specialist mathematics teachers were also given consent letters to sign. Participation in the study was voluntary, which was fully explained to the participants. It was further explained that they could withdraw from the study at any time and if they chose to do so there would be no negative repercussions. The voluntary participation was further ensured by not sampling participants from the school at which I was teaching at the time of this study. The learners were also given informed consent letters informing them about the researcher who would be in their classroom to observe their teacher while teaching. They were also informed to feel free to absent themselves from the classroom if they did not want to be part of the observed lesson.

3.9.2 Giving voice and participant control

Simons (2009, p. 105) states that it is “essential to offer individuals an opportunity to edit their interviews comments, see and respond to how observations of them are presented in case study reports.” The participants were granted an opportunity to go through the interview transcripts and to edit the data by removing or adding information. They further also corrected any misinterpretations in the interview transcripts.

3.9.3 Confidentiality, privacy and anonymity

The participants were assured of their confidentiality and anonymity throughout the study. Simons (2009, p. 106) explains that “confidentiality as a common principle at the beginning of the research, to gain trust and encourage participants to speak openly and honestly.” He continues that “confidentiality assures the participants that any information they reveal, which is sensitive, personal or problematic, that they wish to keep confidential, will be respected and that they will not be exposed" (Simons, 2009). I assured the participants that any information that they shared would not be shared with their colleagues or the school management team. They were also assured that the information gathered would not be used against them or have an impact on their employment. The purpose of the study was explained to them, which was to obtain a deeper understanding of the Professional Mathematics Teacher Identity (PMTI) of non-specialist primary school mathematics teachers. I established and maintained trust with the participants by showing them respect and developing a good relationship with them. Simons (2009, p. 106) describes "anonymity as using pseudonyms which is a common principle in research reporting to anonymize individuals and offer them some protection of privacy." Therefore, pseudonyms were used for the participants' names and the school names.

3.10 CHAPTER SUMMARY

In this chapter, I outlined the research philosophy on which the study was based, and the research design and method employed to investigate the way in which non-specialist primary school mathematics teachers' PMTI manifests as subject and teaching and learning specialists. The data collections strategies employed in this study were semi-structured interviews, lesson observations and document analysis. This chapter also outlined how the data was validated to ensure trustworthiness and finally, ethical considerations were discussed. Chapter 4 provides the results of the analysis of the data collected from three participants.

CHAPTER 4 DATA ANALYSIS

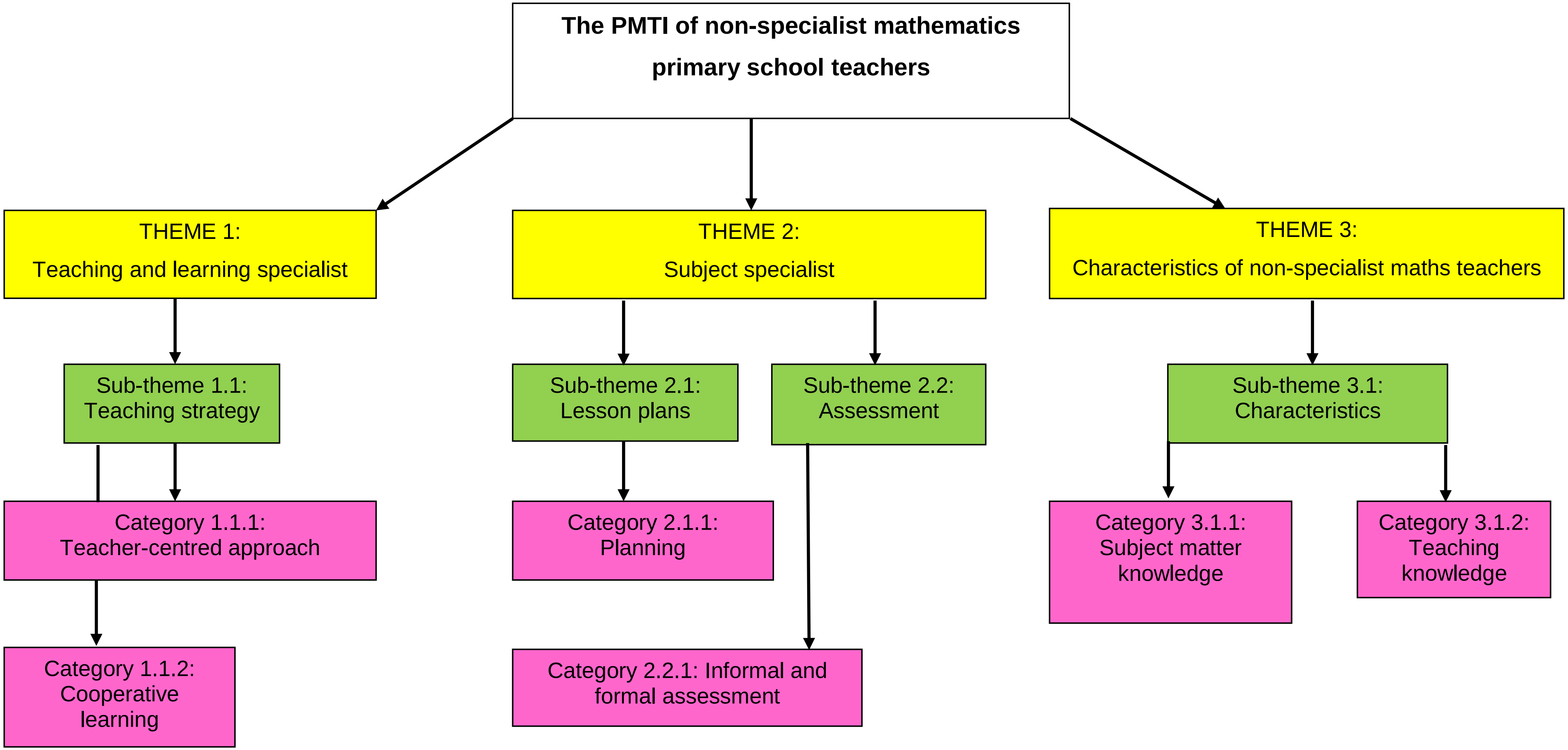

Figure 4.1: Summary of the themes, sub-themes and categories

4.1 INTRODUCTION

In the previous chapter, I discussed the research philosophy, design and methodology underpinning this study. In this chapter, I present the results in the form of the three themes that emerged from the data analysis, namely, being: a teaching and learning specialist; a subject specialist; and the characteristics of non-specialist mathematics teachers. Figure 4.1 above is a diagrammatic representation of the themes to provide an understanding and a link to the results of the multiple case studies. I also present the individual cases below. These cases provide a background on the PMTI of non-specialist primary school mathematics teachers. Table 4.1 summarises the structure of Chapter 4.

Table 4.1: Summary of the structure of Chapter 4: analysis of the data on non-specialist mathematics teachers

Section 4.2.	**Research question 3**	
Individual cases	• The background on the qualifications of non-specialist mathematics teachers.	
Section 4.3.	**Research question 1 to 3**	
Thematic results	• Data analysis based on the predetermined themes from the conceptual framework.	• Presentation of the results and analysis using sub-themes and categories.
Section 4.4.	**Research question 1**	
Theme 1: teaching and learning specialist	• How does non-specialist mathematics teachers' PMTI manifest as a teaching and learning specialist?	• Presentation of the results and analysis using one sub-theme from the conceptual framework teaching strategies and categories that have emerged from the interviews and were also observed.
Section 4.5.	**Research question 2**	
Theme 2: subject specialist	• How does non-specialist mathematics teachers' PMTI manifest as a subject specialist?	• Analysis of the results using two sub-themes and categories that emerged from the interview transcriptions and document analysis.
Section 4.6.	**Research question 3**	
Theme 3: characteristics of non-specialist mathematics teachers	• What are the characteristics of the PMTI of non-specialist mathematics teachers?	• Deductive analysis of the interviews using the two aspects of PMTI from the conceptual framework (non-specialist teachers' subject matter knowledge and teaching skills).

4.2 INDIVIDUAL CASE

4.2.1 Case study 1 – Given

Given is a young adult male teacher with a Bachelor of Education degree in Further Education and Training in Economics and Management Science. He had five years of teaching experience. He was teaching business studies at a secondary school. He explained as follows: *"I was teaching business studies, EMS and economics. I came to primary school due to redeployment. I started to teach mathematics Grade 4, 5, 6 and 7. I have two years of experience teaching mathematics. I started teaching Grade 6 this year"* (Appendix C: lines 7-12, p.1).

4.2.2 Case study 2 – Thato

Thato was a more experienced male teacher who was a qualified Further Education and Training in Economics and Management Sciences teacher. He had never taught at a high school. He started working in a primary school, although he stated, *"my qualifications are for high school. I did commercial subjects, economics, accounting and business economics, and now is called business studies. I started working at a primary school, I taught mathematics though I never have qualifications"* (Appendix C: lines 8-14, p.4). He had a mathematics background as he did mathematics up to Grade 12. He began his teaching career in 1994 and had taught most of the subjects and was teaching mathematics Grade 6 and EMS Grade 7 at the time of this study.

4.2.3 Case study 3 – Musa

Musa is an adult male teacher who was qualified to teach English and Afrikaans. However, he had been teaching mathematics in different schools since he started teaching in 1995 and thus had 23 years of teaching experience. When the school advertised that they want a mathematics teacher, he applied and got the job. He said that he enjoyed teaching mathematics because of his background, *"My background as I told you, I grew up in a family where they were selling tomatoes, so my experience started there that's why when they said they wanted a maths teacher, I jumped and said I am available, I can teach mathematics".* (Appendix C, line 159-162, p.15).

4.3 THEMATIC RESULTS

In this section, the data is analysed according to the three themes that were predetermined from the conceptual framework. The themes are organised according to the sub-research questions. Theme 1 speaks to the first secondary research question, namely, how non-specialist mathematics teachers' PMTI manifests as a teaching and learning specialist. Theme 2 relates to the second research question, how does non-specialist mathematics teachers' PMTI manifest as a subject specialist? Theme 3 links to the third question, what are the characteristics of the PMTI of non-specialist mathematics teachers? The themes are further supported by the sub-themes.

The sub-themes that support Theme 1 are in line with the teaching skills that influence the teachers' lesson presentation. In Theme 1, the sub-theme is (1.1) Teaching strategies applied in the classroom for effective learning. The sub-themes that support Theme 2 are in line with the subject matter knowledge that a teacher needs in order to prepare a lesson, and assess learners' understanding of the content being taught. In Theme 2, the following sub-themes are presented (2.1) Lesson plans and (2.2) Assessment tasks. The sub-theme that supports Theme 3 is in line with the characteristics of non-specialist mathematics teachers. In Theme 3, one sub-theme was identified, namely (3.1) Characteristics. The themes, sub-themes and categories are represented in Figure 4.1 above.

4.4 THEME 1: TEACHING AND LEARNING SPECIALIST

4.4.1 Introduction

The core of this theme centres on the teacher as a teaching and learning specialist. It focuses on the teaching skills used for effective learning. It has emerged that there are contextual factors that hinder teachers from effective teaching such as overcrowding, time limitations and the type of learners they are teaching. In the semi-structured interviews, the participants described the different teaching strategies that they applied in their mathematics classroom. This theme focuses on the data that reflected and addressed the sub-research question - how does non-specialist mathematics teachers' PMTI manifest as a teaching and learning specialist? The sub-theme that supports Theme 1 is teaching strategy. Figure 4.2. is a diagrammatic representation of Theme 1 with its sub-theme and categories.

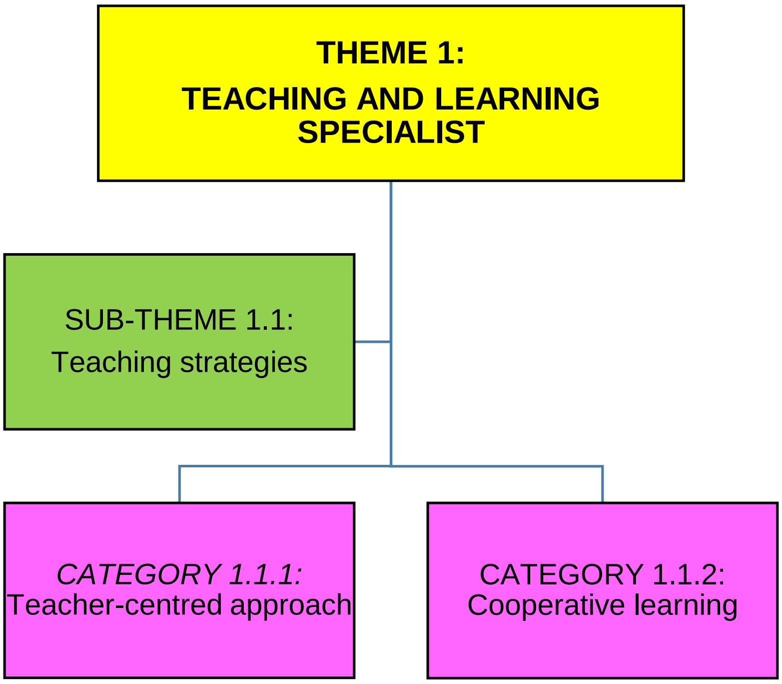

Figure 4.2: Theme 1 with sub-theme and categories

4.4.2 Subtheme 1.1: Teaching strategies

4.4.2.1 Introduction

In this study, teaching strategy refers to the methods that a teacher uses for instruction and to ensure that effective learning is taking place. Sub-theme 1.1 consists of three categories that emerged when the participants were asked about their PMTI as a teaching and learning specialist. This included the teaching strategies that they used to present their lesson and to ensure the effective learning of the content, to accommodate the diverse needs of the learners, and to create learning opportunities. Sub-theme 1.1 includes the following categories: (1.1.1) The teacher-centred approach; and (1.1.2) Cooperative learning. These categories emerged from the interviews and they will be discussed below.

4.4.2.2 category 1.1.1: the teacher-centred approach

When asked about the teaching strategies that they applied when teaching mathematics, the three participants' responses referred to a teacher-centred approach. They explained that the number of learners in the classroom, time limitations and a lack of manipulatives were the factors that forced them to use a teacher-centred approach. Their responses were as follows:

> Given: *"Textbook teaching method, basically the method I am using"* (Appendix C: line 57-60, p. 12).

Thato: *"Question and answer method, I will say I prefer that method because when you teach you to start providing the background, baseline questions, we normally call that. That is where I involve them in question and answer, after that now when I introduce my…my concept if not the topic, that's when I will start involving my narrative method to explain. The narrative method that is when now explanation takes place. After that…After narrative method, I will go back to question and answer"* (Appendix C: lines 67-75, p. 6).

Musa: *"I just ask questions because since we have a limited time of teaching, I just make sure I asked them questions generally so that I can be able to know what the difficult part of what they were doing is"* (Appendix C: lines 44-60, p.11-12).

These quotes refer to a teacher-centred approach as the teacher is in control of learning through the use of textbooks to explain the concept. The teacher asks learners questions and they respond, thus, classroom interaction is limited. The teachers were also asked for alternative methods for teaching mathematics. Two teachers repeated that they used a teacher-centred method and one teacher indicated that his alternative method was a learner-centred method where learners became actively involved in the lesson and worked in groups.

When the teachers were asked if they had other teaching strategies that they used when they taught they said yes, but during the lesson observation, only a teacher-centred approach was evident in their lessons. Musa indicated that he used a discovery method but this was not evident during the lesson observations. During the lesson observations, the teachers dominated the lesson as they asked the learners questions, and while learners responded, not all the learners were actively involved in the lessons. The quotes below are some of the questions that the teachers asked during the lesson observations. The learners never asked the teachers questions and the teachers asked mostly lower-order questions like:

Given*: "how many numbers of sides does the shape has and are the sides of the shape straight or curved? and what is the value of the underlined digit, what is this number?"*

Thato: *"What is 80 × 6 =, what are the factors of eight*; *how many factors does six have and what is the third multiple of 12?"*

Musa: *"He just ask them to name any shapes which they know; name different shapes which you know, how many faces, edges and vertices? asked the learners to name curved objects, prisms and pyramids which they know".*

The teacher-centred approach was evident from all of the participants' lesson observations. The learners' seating arrangements allowed a teacher-centred method and not cooperative learning. The learners were sitting in pairs and faced the chalkboard, not in groups. The learners were also only responding to the teachers' questions and working individually, writing in their books. The learners passively received knowledge from the teacher as they listened to the teacher and did what they were told. In these cases, mathematics was learnt by memorising rules and procedures.

In the interviews, the participants indicated that they used a teacher-centred approach and other methods that were more learner-centred. The lesson observations contradicted the interviews as they did not employ the teaching strategies indicated on the lesson plans. From the interviews, it was evident that they knew about the different teaching approaches but were unable to implement these when teaching.

4.4.2.3 Category 1.1.2: cooperative learning

In this category, quotations are presented that represent another teaching strategy that the participants indicated they employed in teaching mathematics. The participants knew about other teaching strategies that they could use in the mathematics classroom for effective learning. They knew that learners are capable of learning from each other and of constructing their own knowledge. The responses were related to cooperative learning and were as follows:

> Given: "*By engaging learners in group discussion and helping them or monitoring them when they are discussing something"* (Appendix C: lines 38-40, p.2).
>
> Thato: *"After the narrative method, I will go back to question and answer then from there peer grouping. They start doing the questions in groups"* (Appendix C: lines 75-76, p.6).
>
> *"I alternatively use different methods, question and answer, and then grouping peers educating because I love them to teach, I involve them, they come on the chalkboard to write questions or maybe answers. Or the other one's answer"* (Appendix C: lines 88-92, p.6)
>
> Musa: *"Although its difficult ma'am, ehh...I am just trying sometimes. I put them in groups"* (Appendix C: lines 70, p.12).

During the lesson observations, none of the participants employed this strategy. All of the participants employed a teacher-centred approach with learners' individual learning. The participants also indicated difficulties in employing cooperative learning in their classrooms due to overcrowding and time limitations, as well as the learners' lack of willingness to cooperate. Musa indicated that:

> *"I just make sure that they just sit as they are arranged … space is a problem. I teach learners that are sexist in class, learners who cannot participate very well and there*

> *are a lot of desks, you know, tables and those lot of things, it will be time-consuming because of overcrowding"* (Appendix C: lines 75-78, p.12).

The teachers were also asked how they accommodated the diverse needs of the learners in the classroom. Their responses indicated that they were aware that learners have diverse learning needs and they knew of strategies that they could use to accommodate them, but during the lesson observation these were not evident. Throughout the lesson observations, only direct instruction was evident, learners only listening to the teacher explaining the content in an abstract way without using effective representations to support teaching, and not engaging learners in group discussions. The teachers' responses when they were asked about how they accommodated the diverse needs of learners were:

> Given: *"Yes….I give fast learners extra work to do and give slow learners extra time to do their work and complete it. Within a period, I make sure I sit with the slow learners to teach them at least 5 minutes, I show them how to do the work step by step. Sometimes after school, we remain and redo the work we were doing during the lesson. The clever ones, I normally when I give them classwork, I will give them more work to do that they can be busy with something when I am busy with the slower ones"* (Appendix C: lines 55-63, p.2-3).

> Thato: *"Eh… since we have five African languages in our school. Ehh…I think I will allow them by providing them with an opportunity for explaining in their languages. And then from there re-explain for those who did not understand. Ya…I explain in English and I also put it in Zulu and then let them explain to those who do not understand, particularly the Venda and Tsonga"* (Appendix C: lines 119-131, p.7-8).

> Musa: *"Mmm…that one I accommodate, most of the time I use English because of the…the…Ahh…I teach learners sometimes mixed in one class, from different cultures and all those things. In fact, I encourage them to interact with one another, so you know, I hate those groups, you know…where you find the Zulu learners being there and Pedi learners being there. Even when ah…I pass through the plots and see learners grouped in a tribal way. I do not feel happy, I want them to share. In fact, in a class, you may find that I have put a Zulu learner and Pedi learner on the table so that the can be able to interact "* (Appendix C: lines 91-101, p.13).

The participants' responses show that they used cooperative learning methods to support learners with different abilities by grouping the learners into groups or peers so that they could learn from each other. The last teaching strategy that was applied in the classrooms is discussed below.

4.5 THEME 2: SUBJECT SPECIALIST

4.5.1 Introduction

In this section, I present the results relating to Theme 2: subject specialist. A teacher who has curriculum knowledge as a mathematics teacher needs to have, for instance, knowledge for planning lessons, to explain the concepts, subject matter knowledge of what the learners need to be taught in a specific grade, and knowledge for developing assessment tasks. Two sub-themes emerged from this theme, namely, (2.1) Lesson plan supported by one category (2.1.1.) Planning, (2.2.) Assessment, supported by one category, and (2.2.1) Informal and formal assessment. Figure 4.3. below is a diagrammatic representation of theme two, and the supporting sub-themes and categories.

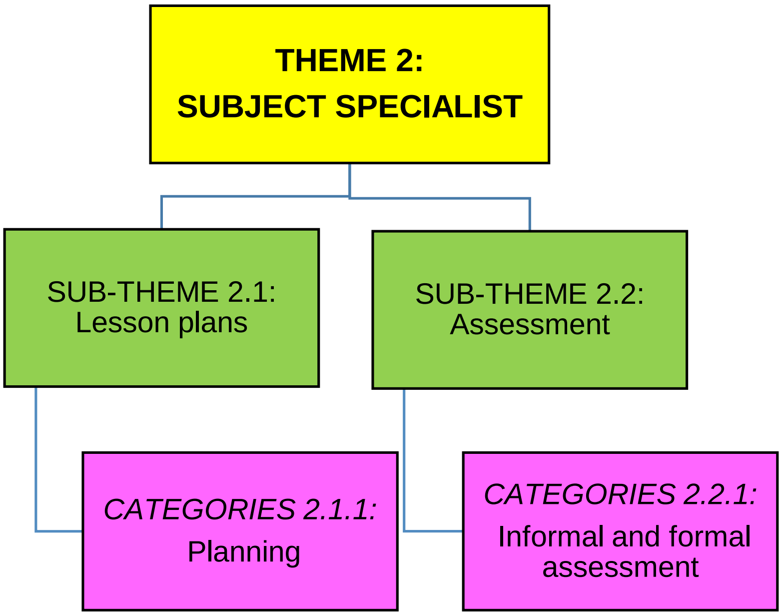

Figure 4.3: Theme 2 with its sub-themes and categories

4.5.2 Sub-theme 2.1: lesson plans

4.5.2.1 Introduction

The lesson plans were requested before the lesson observations in order for me to know what the participants had planned to teach and to analyse these after the lesson observation. Also, this was done to determine if the teachers followed the CAPS document as a guideline for what learners need to be taught and if the lessons were planned in a manner that accommodated the diverse needs of learners.

4.5.2.2 Category 2.1.1: Planning

The participants indicated that the lesson plans were supplied by the district or they downloaded them from the Gauteng Department of Education's website. A lesson plan is a guideline of the lesson presentation, and indicates what the learners will be taught in a specific lesson. The participants were asked how they planned their lessons and their responses were:

> Given: *"The lessons are planned by the department, I do some alteration. I just download them from the internet from the department of education website and do some changes to the lesson plan to suit the needs of my learners and my needs as well, but aligned with CAPS"* (Appendix C: lines 85-89, p.3).
>
> Thato*: "We normally download lesson plans, but it depends, if you go to the internet and you find that the lesson plan has been set is of poor quality, we look at what is best from the lesson plans from the internet"* (Appendix C: lines 205-208, p.10).
>
> Musa*: "Mmm…the lessons, that is the other part I enjoy a lot. We are provided with the lesson plans that are prepared by the Department of Education, but I don't use that lesson as it is, there is where I add my own things in order for the learners to be able to understand what I am teaching them"* (Appendix C: lines 148-152, p. 15).

The participants pointed out that they did alterations to the lesson plans that were supplied. However, based on the lesson plans submitted for this study, the participants did not make any alterations to the lesson plans in order to meet their learners' needs and when they were teaching, they did not cover everything that was indicated in the lesson plans. The participants relied heavily on the lesson plans supplied to them (see Appendix A).

Specifically, Given and Thato's interview responses contradicted what was observed and seen in their lesson plans. No alteration was made to the lesson plans, they were used as they were. Musa planned his own lessons, but he did not cover everything that needed to be taught, as indicated in the CAPS document and the lesson plan did not show exactly how the content would be presented.

The participants' responses indicated that they knew about the CAPS document that they should follow as a guideline for their teaching. They also had the knowledge that CAPS is the document that they need to use for planning their lessons as it has an Annual Teaching Plan (ATP) that they need to follow in order to know what needs to be taught in Grade 6 and for them to not to fall behind. The CAPS document also indicates the hours that the teacher needs to teach a specific concept so that all that needs to be taught can be covered in the right amount of time.

4.5.3 Sub-theme 2.2: assessment

4.5.3.1 Introduction

According to the Intermediate Phase Mathematics CAPS document, the purpose of assessment is to continuously collect information about the learners' understanding in order to improve teaching and learning (DBE, 2011). Assessment is an important tool for teachers to determine the learners' understanding of concepts and for them to plan their lessons. In this on assessment, I have explained how the participants assessed the learners' understanding of the concept taught by using assessment tasks. During the lesson observation, it was observed that all of the participants concluded their lessons by giving learners a class or home activity, which is regarded as an informal assessment. Document analysis was conducted on formal assessment tasks such as assignments and tests, focusing on the types of questions asked.

4.5.3.2 Category 2.2.1: informal and formal assessment

Informal assessment is used for daily monitoring of learners' progress and informs teachers' planning for teaching. Formal assessment comprises School-Based Assessment (SBA) and end of year examination (DBE, 2011). The SBA in mathematics consists of the following forms of assessment: tests, examinations, projects, assignments and investigations (DBE, 2011). The participants indicated that they used both formal and informal assessment to determine the learners' understanding of the content being taught. The importance of assessment is confirmed by verbatim quotations from the three cases when the participants were asked how they assessed their learners' understanding of the content being taught. The following verbatim quotations highlight the participants' remarks about the form of assessments that they used.

> Given: *"By asking questions while teaching, and giving them classwork and homework to find out if they understood the content or not. Actually, informal assessment."* (Appendix C: lines 74-76, p.3)
>
> Thato: *"The…classwork I think, the homework and towards the end, then it will be the controlled assessment task that is going to be marked and then also the test. We have a task and a test. The task is a little bit formal but recorded because is going to form part of the year mark, or maybe the term mark. ("alright, the tasks are the projects and assignments, I inquired").*
>
> Thato: *Ya…projects and assignments that they normally do in class"* (Appendix C: lines 160-166, p. 8).

Musa: *"I give them classwork, sometimes I write problems on the chalkboard, and divide the chalkboard ad I call them in groups of eight, they work on the problem given and all those things and that's when I am going to understand if they got it clearly* (Appendix C: lines 132-136, p.14).

The participants were also asked how they planned their assessment tasks. Their responses were:

Given: *"I look at different provinces' previous question papers and check for questions align with the understanding of the learners, and from the textbook, classwork and homework as well. I do look at the Annual National Assessment* [the ANA is the annual nationally standardised test of achievement for Grade 1 to 6, and 9] *previous question papers. Most of the questions are from ANA. We write common test in June and end of the year"* (Appendix C: lines 78-83, p. 3).

Thato: *"Ehh… I am using the Annual Teaching Plan* [the (ATP) is based on the Curriculum Assessment Policy Statement CAPS, it indicates the skills and content to be taught across the phase and terms*], and also, the textbooks are assisting us, or for a proper recording of assessment, I think we have a policy that is a CAPS document will assist, National Protocol for Assessment* [the NPA is the assessment policy that indicates different forms of assessment to be conducted] *assessment policy assists us so that we must not do assess randomly but follow the policy.*

Researcher: *"Do you sometimes use previous question papers like ANA to set a test?"*

Thato*: "Ya…Ya…definitely we normally do that because when we set the test, we actually pick the questions according to Blooms' taxonomy and then pick the questions because we want to allow every learner in class, and all the levels must be covered. because if you only take one level you are going to have a problem, so Blooms' taxonomy is actually assisting us, that is why we collect all the previous question papers so that we can see the standard of questioning"* (Appendix C: lines 170-185, p. 9).

Musa: *"Mmm…I use different previous papers you know. I come up with my own thing and then after compare ehh…the particular task with other previous question papers that helping me to know, showing Mmm…that ehh…the paper is according to the standard and all those things. But mostly I get information from the CAPS (from mathematics CAPS document, I collaborated)."*

Musa: *Yes.*

Researcher: *"What you need to cover in the test?"*

Musa: *Yes."(*Appendix C: lines 138-146, p. 14).

Their responses revealed that they had knowledge of the CAPS policy document as a guideline. They also indicated the use of previous question papers and textbooks. Thato indicated that he used Bloom's taxonomy to set or choose questions. It shows that he had a clear understanding of how to ask questions in the assessment tasks, not to ask only lower-order questions or only higher-order questions. In the mathematics CAPS policy document, there are four cognitive levels indicated that should be considered when developing an assessment task. These are: knowledge, routine procedure, complex procedure, and problem solving. However, Given and Musa's responses indicated that they lacked knowledge of what questions to use for an assessment task as they relied on previous question papers. This was evident in Musa's assessment tasks as he used previous assessment tasks from the district.

Document analysis of the participants' assessment tasks for Term 1 revealed the following:

Given: On the first assessment task, which was an assignment, he asked questions on two cognitive levels: knowledge and routine procedures. Most of the questions fell under knowledge cognitive level, and a few were on routine procedures. The assignment did not contain questions on complex procedures, which involve problems with calculations or higher-order reasoning. There was no investigation, knowledge application, problem solving or critical thinking required in the assignment, and only the recall of knowledge was necessary to complete the assignment.

In the second assessment which was a test, Given again only asked questions on two cognitive levels: knowledge and routine procedures. Only lower-order questions were asked in the test. The learners' critical thinking and problem-solving skills were not accessed. The teacher could not determine if the learners were able to solve problems or do complex calculations or even apply higher-order thinking skills.

Thato: The first assessment task was the assignment. The questions that were asked were on two cognitive levels: knowledge and routine procedures. The assignment did not have questions about complex procedures and problem solving. Assessment task 2 was a test. The test covered three cognitive levels, namely, knowledge, routine procedure, and complex procedures. Only problem-solving questions were missing from the test.

Musa: The assignment consisted of two types of questions: knowledge and routine procedures. There were no questions requiring higher-order thinking and problem-solving skills. Their questions required recalling information and doing simple calculations. The test had all four cognitive levels of questions: knowledge, routine procedures, complex procedures and problem-solving questions. Musa used the assessment tasks that he received from the district.

In summary, these non-specialist teachers relied heavily on already existing lesson plans and assessment tasks. Little effort was made to alter or redesign these. The assessments were mainly used to assess learning, but not used to improve learning through feedback. Lastly, Theme 3 is discussed below.

4.6 THEME 3: CHARACTERISTICS OF NON-SPECIALIST MATHEMATICS TEACHERS

4.6.1 Introduction

This theme focused on data that reflected and addressed the sub-research question, namely, what are the characteristics of the PMTI of non-specialist mathematics teachers? In Figure 4.4. a diagrammatic representation of Theme 3 and its supporting sub-themes and categories can be seen.

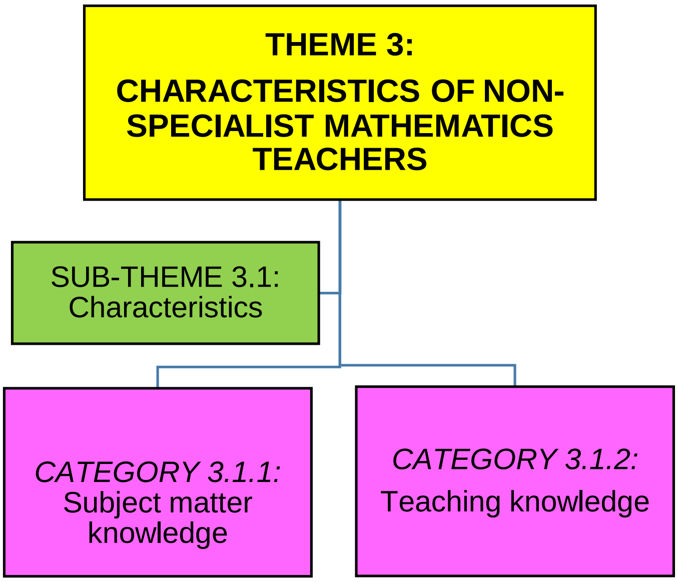

Figure 4.4: Theme 3 with sub-themes and categories

4.6.2 Sub-theme 3.1: characteristics

4.6.2.1 Introduction

Sub-theme 3.1 consists of two categories that emerged from the interviews when the participants were asked about their PMTI as subject, and teaching and learning specialists. Sub-theme 3.1 includes the following categories: (3.1.1) Subject matter knowledge, and (3.1.2) Teaching knowledge.

4.6.2.2 Category 3.1.1: subject matter knowledge

In this category, the participants' experiences of teaching mathematics are presented. When the participants were asked about their teaching experiences, they indicated the following:

> Given: *"….I do not have challenges when teaching mathematics since it's a primary level one"* (Appendix C: lines 15-17, p. 1).
>
> Musa: *"Eish…sometimes is very hard, looking at the kind of children that we are teaching. You will find that there is a lot of learners who cannot understand my language clearly, so I using English most of the time, so sometimes those are the things that give me challenge most of the time. But wherever I meet a problem I just go out and find a teacher who can explain some of the things more clear to the learners. But all in all, teaching maths it is challenging"* (Appendix C: lines 19-28, p.11).

Given indicated that he did not experience challenges with regard to teaching mathematics, but this contradicts what was observed during the lesson presentation. He was textbook-bound and explained certain concepts incorrectly, for instance, in the first lesson observation, he said that they would learn about parallelograms instead of saying quadrilaterals. He explained most of the angles correctly, but he incorrectly explained an obtuse angle. He incorrectly named a trapezium and said it was a rhombus, and he spelt this term incorrectly. He was also unable to explain the differences between the parallelogram and a rhombus. In the second lesson observation, Given presented the expanded notation incorrectly by not including the addition signs between the numbers, he showed the numbers separated, with no addition signs to show that the numbers are one. When asked how he encouraged higher-order thinking, he stated that *"It's difficult for the learners that I am currently working"* (Appendix C: line 43, p.2). This statement contradicts what he had said before that he did not experience challenges in teaching mathematics.

Musa indicated that it was sometimes difficult to teach mathematics and he did experience challenges in teaching mathematics, but whenever he experienced a challenge, he asked other mathematics teachers to help him. This is true as it was also observed during the lesson observations. In the first lesson observation, the teacher could not explain the differences between two-dimensional (2-D) shapes and three-dimensional (3-D) objects, and to group the names of 2-D shapes and 3-D objects separately so that the learners could understand their differences. Musa incorrectly explained the faces, edges and vertices. He described the edges as sharp corners, vertices as corners where two lines meet, and faces as the places where "this thing can sit". The teacher then incorrectly introduced the cube; he used a rectangular prism and said it looks like a cube. In the second observation, Musa explained what a 3-D object is correctly, but overall, most of his explanation was incorrect. He kept on confusing rectangular prisms and pyramids.

Thato did not mention that he experienced any challenges in teaching mathematics. This was confirmed during the lesson observations when he explained the concept correctly and demonstrated that he had good subject content knowledge.

The participants experienced challenges with regard to the teaching strategies that they applied. They had a challenge in encouraging higher-order thinking. It was observed that most of the questions that they were asking were lower-order questions. The teachers created classroom discussions only by asking learners questions to which the learners responded. They were not using the learners' responses to further elaborate on the concept or encourage critical thinking. These teachers further indicated their difficulty in encouraging higher-order thinking.

> Given: *"It's difficult for the learners that I am currently working with"* (Appendix C, line 43, p. 2).
>
> Musa: *"Eish…sometimes is very hard, looking at the kind of children that we are teaching."* (Appendix C: line 19, p. 11).

The quotes above show that these teachers were experiencing difficulty in teaching mathematics. But they mentioned that they loved and had a passion for teaching mathematics and this is what motivated them to teach mathematics regardless of the teaching difficulties they experienced. When the participants were asked if they had confidence in teaching mathematics, their responses were as follows:

> Given: *"I enjoy teaching mathematics, is one of the subjects I feel comfortable when teaching. I Love it basically"* (Appendix C: lines 14-15, p. 1).
>
> Thato: *"Mathematics, I love it. It starts from within. I Love maths because it is practical because since I…am having maths inside me"* (Appendix C: lines 42-44, p. 5).
>
> *Musa: "….is the subject that I like the most you know"* (Appendix C: line 103, p. 13).

Musa claimed that he was confident in teaching mathematics, but this was not evident during the lesson observations, perhaps this may have been due to my presence in the classroom. The fifth category that emerged from the data is knowledge application, which is discussed below.

4.6.2.3 Category 3.1.2: teaching knowledge

During the interviews, the participants indicated that one of their objectives was to help learners to be able to apply knowledge to real-life scenarios. This was not evident during the lesson observation and in their assessment tasks. The teachers did not use real-life examples to explain the concept or ask questions that required critical thinking or knowledge application. Even in their assessment tasks, they did not have problem-solving questions, except for Musa's assessment tasks because he used the assessment task from the district - he did not set his own assessment tasks. When they were asked about their objectives in teaching mathematics, their responses were:

> Given: *"My objectives are to see learners understanding what I am teaching them and getting good marks"* (Appendix C: lines 68-69, p. 3).
>
> Thato: *"… apply it every day"* (Appendix C: line 150, p. 8).
>
> Thato: *"I want for all of my learners, my wish is to see them passing with 100%, getting a 100% pass rate in my class. but I know that it is so difficult they cannot pass with 100% because it is not easy"* (Appendix C: lines 153-157, p. 8).
>
> Musa: *"That you know…chronologically thinking. You know they must start from somewhere. They must know that maths is like a building block, you cannot ... like I said before, you cannot reach the roof when you did not start with the foundation. You start with simple things then you get to more abstract things. That is why I said I instil this chronologically thinking"* (Appendix C: lines 120-126, p. 14).

The above responses contradict what was observed during the lesson observation; and the assessment tasks lacked questions that require knowledge application. Most of the questions required the recall of information and doing simple calculations. The participants also indicated that their goal when teaching mathematics was for the learners to develop an understanding of the subject and perform well in mathematics. This was not evident in the observations as the teachers used one method of teaching, the teacher-centred approach, not using manipulatives to explain the concept. They only asked lower-order questions, and they did not use the learners' responses to thoroughly explain the concept or correct any misconceptions or ask further questions.

In the interviews, the teachers indicated that there were contextual factors that hindered them from teaching effectively. It was observed that there were indeed contextual factors that influenced teaching and learning such as overcrowding, time limitation and a lack of representations when teaching. During the interview, Musa indicated these factors as challenges in executing his roles effectively. He said:

"Space is a problem. I teach learners that are sexist in class, learners who cannot participate very well and there are a lot of desks you know. Tables and those lot of things, it will be time-consuming because of overcrowding" (Appendix C: lines 75-78, p. 12).

4.7 CHAPTER SUMMARY

In this chapter, I presented the results of the study. Three themes were predetermined based on my conceptual framework and sub-research questions. The codes and categories emerged inductively from the study data. For Theme 1, I presented the results of multiple case studies on how non-specialist mathematics teachers execute their roles as teaching and learning specialists. I presented this theme by developing sub-themes with two categories, as indicated in Figure 4.2. The categories comprised the different teaching strategies that the participants indicated during the interviews, which could be triangulated with the lesson observations.

Theme 2: subject specialist was buttressed by two sub-themes, namely: lesson plans and assessment. The participants indicated that lesson plans were supplied by the district so they simply did alterations and planned their own formal and informal assessment. Theme 3: the characteristics of non-specialist mathematics teachers was supported by one sub-theme and two categories that emerged from the data. In the last chapter, I link the results of my study to the relevant literature and answer the research questions. The limitations and recommendations of the study are also discussed.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The purpose of this study was to investigate how the Professional Mathematics Teacher Identity (PMTI) of Grade 6 non-specialist primary school mathematics teachers was actualised in the classroom as a subject specialist and a teaching and learning specialist respectively. The findings from the semi-structured interviews, lesson observations, and document analysis that were conducted were presented in Chapter 4. In this chapter, I discuss the findings of the study based on the conceptual framework and compare it with the findings from the literature reviewed to address the research questions. The limitations of the study will also be discussed. The final section of this study will outline recommendations for future mathematics teachers' education, non-specialist mathematics teacher professional development, and research based on the study's findings.

5.2 ADDRESSING THE RESEARCH QUESTIONS

The main findings were summarised in Chapter 4. This chapter, therefore, synthesises the main findings to answer the secondary questions and the primary research question.

5.2.1 How does non-specialist mathematics teachers' PMTI manifest as a teaching and learning specialist?

Being a teaching and learning specialist involves the skills that the teacher employs to bring about effective learning. The teacher should be able to use both a learner- and teacher-centred approach for effective teaching and learning (Golafshani, 2013). The participants in this study applied more of a teacher-centred approach.

In their study, van Putten et al. (2014) found that the participants' perceptions and actualisation of their PMTI were not consistent. Their teaching practice did not correspond with their conception of their PMTI. This study corroborates their findings in that the teachers indicated knowledge of different teaching strategies, but these were not evident in the lesson observations. These non-specialist mathematics teachers showed an inadequate knowledge of teaching with regard to the presentation of subject matter: They almost exclusively used a teacher-centred approach. In support of this, Du Plessis (2018) found that such teachers find it difficult to implement the essential teaching strategies necessary for effective teaching.

Non-specialist mathematics teachers negatively influence the teaching and learning of mathematics (Du Plessis, 2016). It is important for a mathematics teacher to know "how the concept should be taught", which includes knowledge of different teaching strategies, the use of manipulatives and the application of real-life contexts when teaching, according to Van Zoest and Bohl (2005, p. 333). Nixon, Luft, and Ross (2017) have also found that out-of-field teaching negatively influences instruction. This corresponds with this study's findings that non-specialist mathematics teachers have a negative influence on the teaching and learning of mathematics as they are unable to determine how they should present the content effectively; they simply follow the textbook and the provided lesson plans. The participants taught mathematics as a fixed set of rules that need to be memorised. The learners learnt mathematics by rote learning and there was no flexibility. This relates to Donaldson (2012) findings (see Section 2.4.2.). Nixon et al. (2017) support the above statements by asserting that non-specialist teachers struggle to respond to the learners' questions and are more rigid in their interactions with learners.

Du Plessis (2018) also found that non-specialist teachers find group work difficult. This corresponds with the study's findings (see Section 4.4.2.3). No cooperative learning was observed and the participants also indicated that they found it difficult to employ cooperative learning in their classroom.

5.2.2 How does non-specialist mathematics teachers' PMTI manifest as a subject specialist?

Beijaard et al. (2000) state that a subject matter expert should be able to change programmes, develop effective tasks, explain things at a high-quality level, and diagnose students' understandings and misconceptions adequately. Reys and Fennell (2003) claim that mathematics specialist teachers have expert knowledge that enables them to create classroom discussions, learning opportunities, and to make use of manipulatives to explaining concepts thoroughly.

In this study, the participants showed a lack of subject knowledge in the way in which they presented their lessons and how they explained the concepts, often by asking lower-order questions (see Section 4.4.2.2). They did not use real-life examples and manipulatives to thoroughly explain the concept to learners. They did not encourage classroom discussion as they were asking recall-level questions, and to the learners' responses they either said yes or no, and they did not further elaborate on the concept or determine the learners' understanding, misconceptions and problem-solving skills (see Section 4.4.2.2).

Specialist mathematics teachers can change lesson plans and adapt them to meet their learners' needs (Donaldson, 2012). The non-specialist mathematics teachers in this study demonstrated a lack of knowledge of the subject matter with regard to lesson plan preparation as they used the lesson plans provided to them without adjusting them to suit their learners' needs and their teaching environment. Furthermore, in the observed lessons, the teachers relied heavily on the textbook and the supplied lesson plans. They could not use real-life examples, which confirms the findings of Maxwell (2001); by so doing, they infringe on the learners' opportunity to develop mathematical problem-solving skills as they learn mathematics as fixed rules and through passive or rote learning.

Botha (2012) and Reys and Fennell (2003) claim that mathematics teachers are expected to have knowledge above the grade level that they teach. In this study, I found that the non-specialist mathematics teachers had knowledge below the grade level that they taught and they explained some concepts incorrectly due to a lack of knowledge. This study's findings support those of Venkat and Spaull (2015), who found that 79% of Grade 6 mathematics teachers' subject content knowledge is below the grade level that they teach.

Reys and Fennell (2003) assert that mathematics teachers should be able to use the assessment to help learners learn. The participants indicated inadequate knowledge regarding the construction of questions in assessment tasks. They did not cover the four cognitive levels as required in the Intermediate Phase mathematics CAPS document. The learners' mathematical critical thinking skills were not accessed or developed as the teachers were unable to assess their problem-solving skills.

5.2.3 What are the characteristics of the PMTI of non-specialist mathematics teachers?

Swars et al. (2016) claim that mathematics specialist teachers enable learners to develop critical mathematical thinking skills and problem-solving skills, which was not found to be the case with these non-specialist mathematics teachers. Donaldson (2012) found that non-specialist teachers demonstrate a lack of confidence due to a lack of subject content knowledge and this was confirmed in this study in the lesson observations. Musa lacked confidence in teaching mathematics, as a result, he explained mathematical concepts incorrectly (see Section 4.6.2.2). Non-specialist teaching has an impact on the teacher's competency and confidence in presenting the concepts (Hobbs, 2013). Non-specialist mathematics teachers have a negative impact on the learners' mathematical understanding and achievement (Ríordáin & Hannigan, 2011). They struggle because of limited subject matter knowledge (Nixon et al., 2017). As a result, the learners' mathematical problem-solving skills will be influenced as what is done in the classroom depends on the teachers' subject content knowledge (Du Plessis, 2013).

Du Plessis (2018) has found that non-specialist teachers find it difficult to bring in the real world of science, mathematics and related fields. This study also found that the participants found it difficult to use real-life examples and manipulatives to explain a concept, and some concepts were difficult for them to explain. This has a negative influence on the learners' understanding of the content and the achievement of the learning goals. The participants were not able to teach learners problem-solving skills related to a real-life context, although, during the interviews, they said that their objective was for the learners to be able to apply knowledge in a real-life context (see Section 4.6.2.3), but that was not congruent with what was observed.

5.2.4 Primary research question

How can the Professional Mathematics Teachers' Identity (PMTI) of non-specialist mathematics primary school teachers be described?

In addressing the primary research question, it can be said that non-specialist mathematics primary school teachers have insufficient subject matter knowledge and teaching skills.

The findings showed that the non-specialist mathematics teachers had difficulty explaining some concepts and using different teaching strategies for effective teaching and learning. These three teachers used a teacher-centred strategy, dominating the classroom instruction and discussions instead of using various teaching strategies, including cooperative and discovery learning. The teachers were unable to use teaching strategies and assessment tasks to help the learners develop mathematical skills and could not use assessment strategies that helped the learners develop mathematical conceptual understanding and problem-solving skills.

5.3 LIMITATIONS

A case study, like any other research method, has its own limitations. In this study, the data were gathered from three participants who were observed in two lessons each, while two lesson plans and assessment tasks were analysed, and lastly, they were interviewed once. The findings of the study cannot be generalised because the study was conducted with only three male township non-specialist mathematics teachers. The sample size was small and only male teachers consented to participate in the study. The female teachers who were invited were not comfortable with being observed and videotaped and they declined to participate.

Despite my experience, knowledge and perceptions, I tried to guard against being biased and selective during data gathering and the analysis process to ensure the trustworthiness of the data. I have also used multiple data collection strategies to ensure the trustworthiness of the study.

5.4 RECOMMENDATIONS

The findings of the study have indicated that non-specialist teaching has an impact on the effective teaching and learning of mathematics. The findings from lesson observations indicated that the non-specialist mathematics teachers lacked subject matter knowledge and that they only used one teaching strategy, namely, the teacher-centred approach. Golafshani (2013) states that the teacher should use different teaching strategies for effective teaching and learning. Consequently, it is important that primary schools employ a mathematics specialist from the Intermediate Phase upward. This is likely to improve the level of mathematics participation in the Further Education and Training (FET) phase and the Matric mathematics pass rate. Du Plessis (2018) asserts that non-specialist teachers are struggling to deliver even the basics of mathematics. It is imperative that learners develop strong basic mathematics knowledge in the Intermediate Phase because in order to do well in mathematics at a later stage, they need to master the mathematics basics to be able to use these when solving mathematical problems.

Further study on the influence of non-specialist teaching on learners' mathematical interest, mathematics professions and South African economic growth should be conducted. There is a need for studies on the improvement of teaching and learning of mathematics in non-specialist mathematics teachers. This study was based on Grade 6 non-specialist mathematics teachers, the same study can also be conducted with Senior (Grade 7 to 9) and FET (Grade 10 to 12) phase teachers in order to determine the influence of non-specialist teaching.

Non-specialist teachers might be expected to upgrade their content knowledge by enrolling for mathematics short courses, which may influence their Professional Mathematics Teachers' Identity (PMTI) status. Also, the Department of Basic Education should consider mathematics in-service training and short courses for non-specialist mathematics teachers

5.5 CONCLUSION

"Teachers cannot teach what they do not know" (Spaull, 2013, p. 5). This study revealed that PMTI is important for the quality of mathematics education as it appeared from the lesson observations, interviews and the teachers' use of lesson plans that non-specialist mathematics teachers have inadequate subject knowledge and teaching skills. It was observed that the teachers had a difficulty in using learner-centred teaching strategies. This is consistent with Du Plessis (2018), who finds that non-specialist teachers find group work (cooperative learning) particularly difficult. Being teaching and learning specialists and subject specialists are two of the teachers' roles required by the Norms and Standards for teachers (DoE, 2000).

Du Plessis (2018) claims that non-specialist teachers struggle to deliver the basics - this was confirmed in the lesson observations carried out in this study.

The literature indicated that non-specialist mathematics teachers have inadequate subject content knowledge and teaching skills (Aina, 2016; Du Plessis, 2013; Hobbs, 2013; Kola & Sunday, 2015). The non-specialist teaching of mathematics in primary schools poses challenges for learners’ stream choices in the Further Education and Training (FET) phase and career choices at tertiary level. This may have an impact on national economic growth since we might have a greater number of learners who pursue careers in professions requiring mathematics, for example, engineers and doctors, amongst others.

The influence of non-specialist teaching in primary schools is often overlooked and it has a great impact on the learners' performance in the Further Education and Training (FET) Phase. I believe that a concrete mathematics foundation should be laid from primary level to increase the number of learners who do mathematics in the FET phase, and increase the mathematics pass rate at Grade 12 level. The strong mathematics foundation of mathematics can be laid by mathematics teachers with subject content knowledge and teaching skills. Newton (2007) indicates that learners who did not build a solid foundation in mathematics in primary school may experience mathematics problems in high school as a result of poor foundation skills.

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APPENDICES

APPENDIX A: LESSON PLANS AND OBSERVATION SCHEDULE

basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

MATHEMATICS LESSON PLAN
GRADE 6
TERM 1: January– March

PROVINCE:	GAUTENG
DISTRICT:	D 9
SCHOOL:	[redacted]
TEACHER'S NAME:	
DATE:	20 MARCH 2018.
DURATION:	1 Hour

1. TOPIC: PROPERTIES OF 2-D SHAPES: Range of shapes **(Lesson 7)**

2. CONCEPTS & SKILLS TO BE ACHIEVED:
By the end of the lesson learners should know and be able to recognise, visualise and name 2-D shapes focusing on parallelogram.

3. RESOURCES:	National workbook 1, DBE Text Book (LB and TG), textbooks,
4. PRIOR KNOWLEDGE:	• 2-D shapes • irregular and regular polygons • right angles, angles greater than right and angles smaller than right

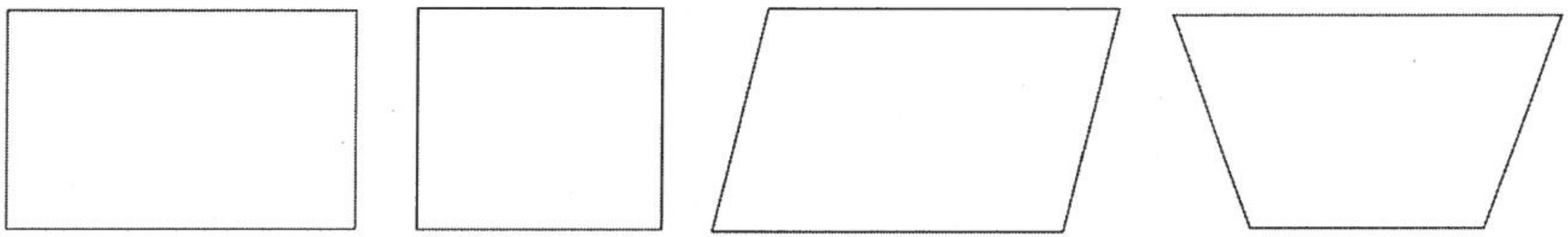
5. REVIEW AND CORRECTION OF HOMEWORK (suggested time: 10 minutes)

Homework provides an opportunity for teachers to track learners' progress in the mastery of mathematics concepts and to identify the problematic areas which require immediate attention. Therefore it is recommended that you place more focus on addressing errors from learner responses that may later become misconceptions.

6. INTRODUCTION (Suggested time: 10 Minutes)

Activity : Revise with learners the following:

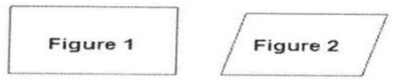
- Name the following quadrilaterals.
- Which of the quadrilaterals below is regular?
- Name the types of angles found in each
- What are the properties of a rectangle?
- What is the difference between a square and a rectangle?

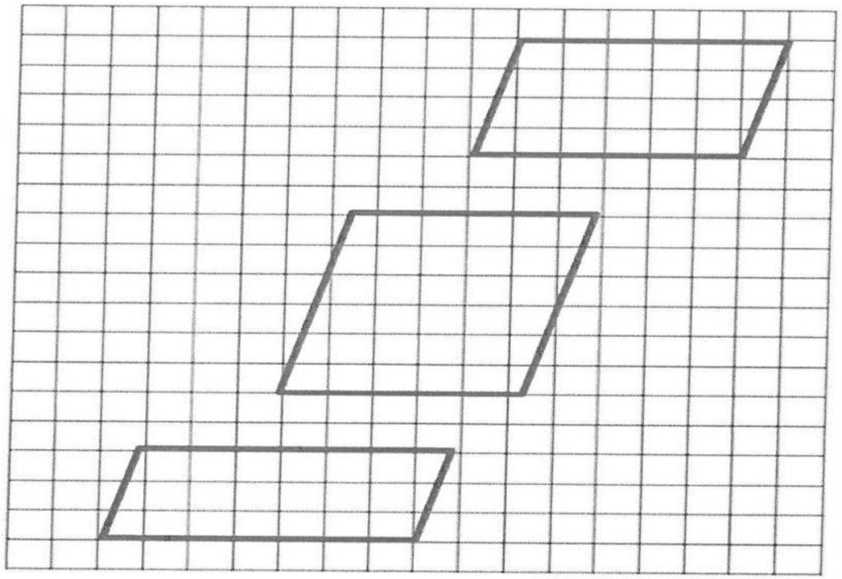


<table>
<tr><th colspan="2">7. LESSON PRESENTATION/DEVELOPMENT (Suggested time: 20 minutes)</th></tr>
<tr><th>Teaching activities</th><th>Learning activities
(Learners are expected to:)</th></tr>
<tr><td>

Activity 1 Group work)

- Ask learners to answer the following questions.
  - i) Name figure 1.
  - ii) Figure 2 is called a parallelogram, how does figure 1 differ from figure 2?





- iii) Use a ruler to measure the length of all the sides of each parallelogram.
- iv) Are there sides that are equal in a parallelogram?
- v) If your answer in (iv) above is yes, how many sides are equal?
- vi) Are the equal sides next to each other or opposite?
- vii) How many pairs of opposite sides are equal if two sides are called one pair?
- viii) What can you say about opposite sides of a parallelogram?
- ix) Complete: In a parallelogram, both pairs of opposite sides are _______.

NOTE: At this stage learners should be able to identify the properties of a parallelogram in terms of sides.

</td><td>be actively engaged during the lesson presentation by answering questions.</td></tr>
</table>

DATE: 18 [redacted] April 201[redacted] 18

LESSON PLAN 2

[redacted]: MATHEMATICS

GRADE : 6

CONTENT AREA : Numbers, operations and relationships

MULTIPLICATION

COMPONENTS	TIME	TASKS / ACTIVITIES	CAPS: Concepts and skills
WHOLE CLASS ACTIVITY	3 min	1. Count in 50-s starting from 23 470 forwards 2. Count in 50-s starting from 23 410 backwards	**Topic:1.1 (page 241)** **Number range for calculations** • Multiplication of at least whole 4-digit by 3-digit numbers • Multiple operations with or without brackets **Calculations techniques include** • Multiplying in columns • Building up and breaking down numbers
MENTAL MATHS	7 min	(see table below)	**KEYWORDS** Multiplication, building up method, breaking down method, columns, and place value.
HOMEWORK	10 min	• Reflection/remediation based on previous day's work.	**ASSESSMENT** **INFORMAL** o Oral o Self o Peer
READING / PRIOR KNOWLEDGE		In Grade 5 the learners learnt how to: • Multiply at least whole 3-digit by 2-digit numbers • Use a range of techniques to perform and check written and mental calculations of whole numbers including: -- estimation -- building up and breaking down numbers -- using a number line -- rounding off and compensating -- doubling and halving	

Mental maths:

		Answer			Answer
1.	60 x 4 =	240	6.	80 x 2 =	160
2.	90 x 3 =	270	7.	90 x 10 =	900
3.	50 x 1 =	50	8.	30 x 10=	300
4.	80 x 8 =	640	9.	600 x 10 =	6 000
5.	70 x 3 =	210	10.	400 x 10 =	4 000

D

LESSON CONTENT CONCEPT DEVELOPMENT	20 min	**This lesson deals with different multiplication calculation techniques.** • Ask learners to take out their cut-out 2 (place value cards) and use their place value cards to build three or four 4-digit numbers. Example: 7 353. Ask the learners how they would go about multiplying this number by 6..On the board write: 7353 x 6 = (7 000 x 6) + (300 x 6) + (50 x 6) + (3 x 6) = 42 000 + 1 800 + 300 + 18 = 44 118 Explain to the learners that we can also use place value columns to do the same calculation .Open **Headstart Mathematics Grade 6**: page 114. Go through the examples with the learners and discuss any questions they might have. VIVA MATHEMATICS pg 69 Activity 3 No 2 a–e	**RESOURCES** ○ DBE Workbooks ○ Headstart textbook ○ Learner books ○ Cut-out 2 ○ VIVA MATHEMATICS Other:_______________
		Use the first example (page 114, Method 1) to show learners the next method-vertical column method .Then does Activity 14, question 1a together. This method also involves place value and expanded notation. We call this method the breaking-down-numbers method. • On the next page in the textbook there are more examples using bigger numbers. Copy some of these examples and go through them as a class. Allow the learners to check their answers in pairs by using the breaking-down-numbers method. Exposing learners to different methods will help them to choose the method they find easiest and the one that is most appropriate for any given set of numbers.	
CLASSWORK ACTIVITY	20 min	**Headstart Mathematics Grade 6:** page 114, Activity 14, Questions 1b, c; 2a, b **DBE** Workbook Version 2014 CAPS aligned: Worksheet 31, Question 3 a (page 91).	
		ANA examples:	

DATE: [redacted] 23/04/2018

LESSON PLAN 27

[redacted]: MATHEMATICS

GRADE : 6

CONTENT AREA : NUMBERS , OPERATIONS AND RELATIONSHIPS

DIVISION

COMPONENTS	TIME	TASKS / ACTIVITIES	CAPS: skills and concepts
WHOLE CLASS ACTIVITY	3 min	• Count in multiples of 60 from 6 000 up to 66 000	**Number range for multiples and factors** • Multiples of 2-digits whole numbers to at least 100 • Factors of 2-digit whole numbers to at least 100 • Prime factors of numbers up to at least 100
MENTAL MATHS	7 min	(see table below)	**KEYWORDS** Factors, multiples and prime factors.
HOMEWORK	10 min	• Reflection/remediation based on previous day's work.	**ASSESSMENT** **INFORMAL** o Oral o Self o Peer

Mental maths:

		Answer			Answer
1.	180 ÷ 6 =	**30**		6 300 ÷ 70 =	**90**
2.	490 ÷ 7 =	**70**		6 300 ÷ 7 =	**900**
3.	240 ÷ 8 =	**30**		1 800 ÷ 30 =	**60**
4.	300 ÷ 6 =	**50**		1 800 ÷ 6 =	**300**
5.	150 ÷ 30 =	**5**		480 ÷ 80 =	**6**

READING – PRIOR KNOWLEDGE

In Grade 5 the learners learnt how to:

Number range for multiples and factors
• Multiples of 2-digits whole numbers to at least 100
• Factors of 2-digit whole numbers to at least 100

LESSON CONTENT CONCEPT DEVELOPMENT — 20 min

This lesson is about multiples, factors and prime factors.

- Revise with the learners that multiples are the result when two numbers are multiplied by each other.
  Example: 4 x 5 = 20. This means that 20 is a multiple of 4 and 5.
- Revise that factors are numbers that you can multiply to get another number.
  Example: (1; 2; 3; 5; 9; 10) are factors of 270 because 3 x 90 = 270. 1x 270 = 270, 9 x 30=270. 27x10= 270. Ask the learners do give you another product combination and extend list of factors
- A **prime number** has only two factors. The one factor is 1 and the other is the prime number. A **composite number** has more than two factors. The number 21 is a composite number. Ask the learners why.
- Give the learners a number board and ask them to circle all the multiples of 10. Let them read out their answers. Let them draw a triangle around all the multiples of 3 between 14 and 31. Colour all the multiples of 15 between 34 and 73.

RESOURCES

- o DBE Workbook
- o Learner books
- o 1 – 100 number board
- o VIVA Maths

Other:__________

CLASSWORK ACTIVITY	20 min	**DBE** Workbook Version 2014 CAPS aligned: worksheet 43 , Question 2(page 116)
ENRICHMENT/ SUPPORT ACTIVITIES	NB: Only done if learners complete class activity before the time is up / as support in extra classes	**ANA :** a. The third multiple of 12 is ______. b. The factors of 30 are ______. **Answers: a. 36 b. 1, 2, 3, 5, 6, 10, 15, 30**

REMEDIATION

Counting #	Division	Factor pair
1	12 ÷ 1 = 12	1 x 12
2	12 ÷ 2 = 6	2 x 6
3	12 ÷ 3 = 4	3 x 4
4	12 ÷ 4 = 3	4 x 3

Starting with 1, divide each counting number into the whole number.

If the numbers divide exactly (no remainder), then you have found a pair of factors.

List the counting number and the quotient of your division as a pair of factors.

Solution: The factors of 12 are 1, 2, 3, 4, 6 and 12.

List all factors separated by commas.

Keep dividing until a factor repeats.

HOMEWORK	**Headstart Mathematics Grade 6**: page 104 -105, Activity 3 and Activity 4
REFLECTION ON LESSON	**Success:** What went well in the lesson? **Challenge:** What did not go well? **Recommendation:** What changes are necessary to improve the lesson?

Topic : Describing 3-D Objects (Properties)

2. Concepts and Skills to be achieved.

(a) Naming the 3-D Objects
(b) Differentiating Faces, Vertex vertices, Edges
(c) Be able to count Faces, Vertices and edges.

3. Resources : DBE Books and Text books.

4. Prior knowledge : Angles and Shapes

5. Introduction :

What are the names of shapes you know. (3D objects)

6. Lesson Presentation

Showing learners what vertex, edges and faces. are.

7. Learner count them from different Shapes

8. Classwork 15 minutes or Homework

Name 3-D Objects you know and write number of Faces, Vertices and edges.

Given lesson observation number 1

Date of the observation	20 March 2018
School (pseudonym)	School A
Name of the teacher (pseudonym)	Given
Subject	Mathematics
Grade	6
Number of learners	52
Period number and time	Period number 2 (08:45-10:00)
Lesson topic	Properties of two-dimensional shapes (Angles)

Teaching and learning specialists	**Question guiding observation**	**Comments**
Teachers' subject content knowledge	Is the content presented correctly?	The content was based on properties of two-dimensional shapes. He started by doing corrections of previous homework on angles. The teacher said they will learn about the properties of a parallelogram, but he taught them about the properties of different quadrilaterals. He pronounced the word quadrilateral incorrectly.
	Is the content explained correctly?	He explained most of the angles correctly, just explained the obtuse angle incorrectly. On the two-dimensional shapes, he said they will look at parallelograms instead of saying quadrilaterals as he was teaching about shapes with

		four sides. He explained the two-dimensional shapes correctly, but he named a trapezium a rhombus and he did not know how to spell rhombus. He was unable to explain the differences between the parallelogram and rhombus.
	Is the teacher able to relate what he or she taught to real life examples?	The teacher could not relate the content he was teaching to real life examples, in order for the learners to understand the content easily.
	Is the teacher able to respond to learner's questions correctly?	The learners were not asking the teacher questions. The teacher was the one asking the learners' questions base on what he was teaching them.
	Is the teacher able to respond to learner's questions on a topic which was not prepared for the day?	The learners did not ask the teacher questions.
Teaching knowledge	Which teaching approach applied in the classroom?	Teacher centred approach.
	Does the teacher link content to learners' previous knowledge?	The teacher was teaching in a traditional method just imparting the knowledge to learners. The learners were not asked to name different quadrilaterals which they know. The teacher just started teaching about the quadrilaterals. The teacher did not link the learners' prior knowledge before starting with the lesson or teaching the concept.

	How does the teacher interact with the learners?	The teacher was asking learners questions and the learners respond. The teacher interacts less with learners when they respond to his questions does not further ask them why or ask them to explain to the class.
	Are the learners actively involved?	Only the learners were sitting in front were actively involved throughout the lesson, by responding to the teachers, questions.
	Does the teacher use mathematics teaching aids or visual examples to explain mathematics concepts?	The teacher uses verbal explanations alone for the classroom instruction. He did not use any teaching aids or visual examples to explain the concept.
	Does the teacher ask the learners questions to check their understanding of content?	The teacher was just asking lower order or recalling of information questions. Questions which require critical thinking were not asked.
	Does the teacher ask learners questions that cater to the different cognitive levels?	It was not evident in the lesson, as he asked questions like how many numbers of sides the shape has and are the sides of the shape straight or curved. The questions asked were not encouraging critical thinking, only recalling of information.
	How does the teacher use the learners' questions and responses to further elaborate on content being taught?	The teacher was just saying if the learners' response is correct or incorrect and also ask other learners the same question to hear their responses or ask if they agree or disagree with the response from their peers. The teacher

		was not using the learners' responses to further elaborate on the content being taught or rectify any misconception which the learners might have, for example, a learner named a revolution angle a full rotation.

Lesson observation schedule

Given lesson observation number 2

Date of the observation	17 April 2018
School (pseudonym)	School A
Name of the teacher (pseudonym)	Given
Subject	Mathematics
Grade	6
Number of learners	53
Period number and time	08:45 – 10:00
Lesson topic	Whole numbers: ordering, comparing and representing at least 9-digit numbers

Teaching and learning specialists	Question guiding observation	Comments
Teachers' subject content knowledge	Is the content presented correctly?	The content was based on whole numbers ordering, comparing and representation of numbers. He started by doing corrections of previous homework on writing 7-digits numbers from digits to words and from words to digits, writing numbers in correct place value and expanded notation. The teacher presented most of the content correctly, only the expanded notation which was presented incorrectly by not including the addition signs between the numbers, showing that the numbers are one it is just broken down.
	Is the content explained correctly?	The content was presented correctly but he did not teach the learners everything which was indicated on the topic of the lesson.
	Is the teacher able to relate what he or she taught to real life examples?	The teacher could not relate the content he was teaching to real life examples, in order for the learners to understand the content easily.
	Is the teacher able to respond to learner's questions correctly?	The learners' did not ask the teacher any question. The teacher was the one asking them questions and they respond to the questions.

	Is the teacher able to respond to learner's questions on a topic which was not prepared for the day?	The learners did not ask any question.
Teaching knowledge	Which teaching approach applied in the classroom?	Teacher-centred approach.
	Does the teacher link content to learners' previous knowledge?	The teacher was not linking the learners' previous knowledge with the content being taught.
	How does the teacher interact with the learners?	The teacher was asking the learners questions and they learners just respond to the questions.
	Are the learners actively involved?	The learners who were seated in front were the ones actively involved. The teacher asks questions and the learners respond.
	Does the teacher use mathematics teaching aids or visual examples to explain mathematics concepts?	The teacher did not use any teaching aids or visual example. He used the traditional method of teaching, talking and writing on the chalkboard.
	Does the teacher ask the learners questions to check their understanding of content?	The teacher asked questions based on what he was teaching, and the questions were most knowledge recalling questions. He did not ask questions which require learners to think critically or knowledge application questions.

	Does the teacher ask learners questions that cater to the different cognitive levels?	The questions which were asked were mostly from the lower cognitive levels, for an example, what is the value of the underlined digit, what is this number, not asking the learners to write down the number so he can determine if the learners can write the number in words.
	How does the teacher use the learners' questions and responses to further elaborate on content being taught?	The teacher did not use the learners' responses to further explain the concept. He just asks the all the learners to say the answer as a class.

Lesson observation schedule

Thato lesson observation number 1

O

Date of the observation	18 April 2018
School (pseudonym)	School B
Name of the teacher (pseudonym)	Thato
Subject	Mathematics
Grade	6
Number of learners	50
Period number and time	1 to 3: 07h45-09h15
Lesson topic	Multiplication of 3-digits by 2-digit numbers

Teaching and learning specialists	**Question guiding observation**	**Comments**
Teachers' subject content knowledge	Is the content presented correctly?	The teacher presented the content correctly. He introduced the lesson by asking learners to count forward in the 50s, they were doing addition and number patterns. The learners were also asked to complete a mental on the multiplication of multiples of 10, it was explained to them that they should multiply digits first and then add the zeros when they got their answer. For example 60× 40 = 2400, they should start by saying 6 × 4 = 24 then add the two zeros.
	Is the content explained correctly?	The teacher explained to the learners how to do the rounding off to the nearest 10 and then multiply the numbers. Also explained the multiplication of 3-digit

		numbers by 2-digit numbers using the breaking down method. He incorporated the addition using the column method.
	Is the teacher able to relate what he or she taught to real life examples?	The teacher did not use real-life examples to explain the multiplication concept, in order to make the learners relate multiplication to their everyday activities.
	Is the teacher able to respond to learner's questions correctly?	The learners did not ask the teacher any question. The teacher was the one asking the learners' questions base on what he was teaching them.
	Is the teacher able to respond to learner's questions on a topic which was not prepared for the day?	The learners did not ask the teacher any questions.
Teaching knowledge	Which teaching approach applied in the classroom?	It was more teacher-centred approach.
	Does the teacher link content to learners' previous knowledge?	Yes, the teacher linked the learners' previous knowledge of times table or multiples and using a number line to do rounding off to the nearest 10, and also counting in 10 to do rounding off to the nearest 10.
	How does the teacher interact with the learners?	The teacher frequently interacts with learners by asking them questions throughout the learners. He encourages the learners to calculate by themselves, ask learners questions in order to determine their understanding.

	Are the learners actively involved?	All the learners were actively involved throughout the lesson. The teacher encourages the learners to calculate using their scribblers.
	Does the teacher use mathematics teaching aids or visual examples to explain mathematics concepts?	The teacher did not use any teaching aids, but he used a visual example of a number line to explain the concept of rounding off.
	Does the teacher ask the learners questions to check their understanding of content?	The teacher was frequently asking learners question throughout the lesson and then explain the concept.
	Does the teacher ask learners questions that cater to the different cognitive levels?	It not evident in the lesson as the teacher was asking questions like what is 80 × 6 =. The questions asked were not encouraging critical thinking.
	How does the teacher use the learners' questions and responses to further elaborate on content being taught?	The teacher repeated his question if the learner gave a wrong answer or just say you are not listening. He also asks other learners the same question to hear their response or ask if they agree or disagree with their peers' answer. The teacher did not use the learners' responses to further elaborate on the content being taught or rectify any misconception which the learners might have, for example when they are doing multiples of 10 and the learner say 115, he will point another to give a correct answer.

Lesson observation schedule

Thato lesson observation number 2

Date of the observation	23 April 2018
School (pseudonym)	School B
Name of the teacher (pseudonym)	Thato
Subject	Mathematics
Grade	6
Number of learners	50
Period number and time	2: 08h15-09h45
Lesson topic	Introduction of division

Teaching and learning specialists	**Question guiding observation**	**Comments**
Teachers' subject content knowledge	Is the content presented correctly?	The teacher presented his lesson based on factors and multiples.
	Is the content explained correctly?	He correctly explained to the learners what a factor is. The teacher did not explain what division is, He just explained to the learners how to divide the numbers with zero. He said they should close the zero and when they get their answer and then write the zeros which they have closed. He also

		explained that for example 12 ÷ 2 =, the learner should count in multiples of 2 until he/she reach 12, they can use their fingers then the number of fingers they counted will be their answer.
	Is the teacher able to relate what he or she taught to real life examples?	The teacher did not use real-life examples to explain the concept and for the learners' to understand the concept being taught.
	Is the teacher able to respond to learner's questions correctly?	The learners' did not ask the teacher questions. The teacher is the one who asks learners questions.
	Is the teacher able to respond to learner's questions on a topic which was not prepared for the day?	The learners' did not ask the teacher questions.
Teaching knowledge	Which teaching approach applied in the classroom?	Teacher-centred approach.
	Does the teacher link content to learners' previous knowledge?	The teacher linked the factors with the learners' previous knowledge of multiples.
	How does the teacher interact with the learners?	The teacher interacts with all the learners in the classroom. The teacher asks the learners questions and the learners respond.
	Are the learners actively involved?	All the learners were actively involved throughout the lesson. When the teacher asks a question, he points to any learner who raised his hand.

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	Does the teacher use mathematics teaching aids or visual examples to explain mathematics concepts?	The teacher did not use mathematics teaching aids or visual examples to explain the concept of factors.
	Does the teacher ask the learners questions to check their understanding of content?	The teacher asks the learners questions throughout the lesson.
	Does the teacher ask learners questions that cater for the different cognitive levels?	The teacher was asking the learners recalling information questions like, what are the factors of eight. He also asked how many factors does six have and what is the third multiple of 12.
	How does the teacher use the learners' questions and responses to further elaborate on content being taught?	The teacher was repeating his question if the learners respond is incorrectly or rephrase his question. If the learners' response is correct he says yes or he just nodded.

Lesson observation schedule

Musa lesson observation number 1

Date of the observation	19 April 2018
School (pseudonym)	School C
Name of the teacher (pseudonym)	Musa
Subject	Mathematics
Grade	6
Number of learners	64
Period number and time	6: 11h10 – 11h40
Lesson topic	Three-dimensional shapes and their properties

Teaching and learning specialists	**Question guiding observation**	**Comments**
Teachers' subject content knowledge	Is the content presented correctly?	The content was based on 3-D shapes. The teacher explained the 3–D shapes correctly. The teacher only used two examples of 3-D shapes to explain the concepts he didn't look at the different 3-D shapes and prisms. The teacher incorrectly presented the cube. He uses a rectangular prism (box) and said it looks like a cube.

	Is the content explained correctly?	The teacher explained what 3-dimensional objects is in an abstract manner. He did not further explain what is the difference between the 2-dimensional shape and the 3-dimensional shapes. He asked the learners to give the examples of shapes that they know and the learners gave him both the names of 2-dimensional shapes and 3-dimensional shapes, for example, the leaners responded by saying square, cylinder and triangle and he said correctly. A cylinder spelling was incorrectly and it is not a 2-dimensional shape. The teacher could not group the names of 2-d shapes and 3-D shapes separately so that the learners can understand their differences. The teacher also incorrectly explained what are the faces, edges and vertices. He described the edges as the sharp corners, vertices are corners where two lines meet and faces are the places where this thing can sit.
	Is the teacher able to relate what he or she taught to real life examples?	The teacher did not use real-life examples to explain the concept of 3-D shapes or to give

		examples of the 3-D objects which they use every day.
	Is the teacher able to respond to learner's questions correctly?	The learners did not ask the teacher questions. They were just responding to the teachers' questions.
	Is the teacher able to respond to learner's questions on a topic which was not prepared for the day?	It was not evident in this lesson as the learners did not ask the teacher any questions.
Teaching knowledge	Which teaching approach applied in the classroom?	The traditional method of teaching, teacher-centred approach.
	Does the teacher link content to learners' previous knowledge?	The teacher could not link the learners' previous knowledge of shapes to the new concept of 3-D shapes. He just asks them to name any shapes which they know and the learners responded, but he did want to know more what they know about those shapes.
	How does the teacher interact with the learners?	The teacher interacts with the learners'. He was explaining to them more. The teacher just asked few questions and the learners' responded.
	Are the learners actively involved?	Only learners who were seated in front were actively involved throughout the lesson, by responding to the teacher's questions.

	Does the teacher use mathematics teaching aids or visual examples to explain mathematics concepts?	The teacher did not use the teaching aids to explain the concept or visual examples for the learners to understand the concept of 3-D easily. He only used one example of a rectangular prism a box to explain its properties namely; faces, vertices and edges.
	Does the teacher ask the learners questions to check their understanding of content?	The teacher asked learners questions of the names of shapes which they know.
	Does the teacher ask learners questions that cater for the different cognitive levels?	The teacher asked lower order thinking questions, for example, name different shapes which you know, how many faces, edges and vertices?
	How does the teacher use the learners' questions and responses to further elaborate on content being taught?	The learners did not ask the teacher questions. The teacher was asking the learners questions and when they respond, he asked the whole class to count together the number of faces, edges and vertices to verify the response from one of the learners.

Lesson observation schedule

Musa lesson observation number 2

Date of the observation	25 April 2018
School (pseudonym)	School C
Name of the teacher (pseudonym)	Musa
Subject	Mathematics
Grade	6
Number of learners	64
Period number and time	5: 10h10 – 11h10
Lesson topic	Describing 3-dimensonal objects (properties)

Teaching and learning specialists	**Question guiding observation**	**Comments**
Teachers' subject content knowledge	Is the content presented correctly?	The teacher presented the lesson based on 3-dimensional objects and their properties. He presented the objects into three groups curved objects, prisms and pyramids. In this lesson the teacher only focused on the 3-dimensional objects name and number of faces, the vertices and edges were not discussed. The teacher also did not discuss the shapes of faces and their surfaces.
	Is the content explained correctly?	The teacher explained some of the content correctly and mostly incorrectly, he kept on confusing the prism and

		pyramids. The teacher asked the learners to name prisms which they know and the learner named a triangular prism and the teacher said a triangular prism fall under pyramids. He stated incorrect composition of a rectangular prism, he said a rectangular prism is made up of two rectangles and two triangles. He confuses the shapes of the faces of the 3-dimensional objects. The teacher confuses the objects number of faces with the 2-dimensional shapes sides. For example the hexagonal prism number of faces, the child responded as six and the teacher said is correct, which is incorrect as a hexagon has got 6 sides and a hexagonal prism has got eight faces. Incorrectly explained a pentagonal prism, he said it has it has got 8 sides. The teacher also incorrectly described the faces of a cylinder and cone, he said they are flat and curved, and a sphere has a curved face. This objects faces are not flat and curved but their surfaces are flat and curved and the sphere has a curved surface only.
	Is the teacher able to relate what he or she taught to real life examples?	The teacher used one real-life example a cupboard to explain what is a length, breadth and height.
	Is the teacher able to respond to learner's questions correctly?	The learners' did not ask the teacher any question.

	Is the teacher able to respond to learner's questions on a topic which was not prepared for the day?	The learners' did not ask the teacher any question.
Teaching knowledge	Which teaching approach applied in the classroom?	Teacher-centred approach
	Does the teacher link content to learners' previous knowledge?	The teacher did not link the learners' previous knowledge of shapes. He just introduced a new topic of three-dimensional objects without linking it to two-dimensional shapes.
	How does the teacher interact with the learners?	The teacher was asking the learners questions and the learners' responds.
	Are the learners actively involved?	Only the learners' who were raising hands and responding to the teachers' questions were actively involved.
	Does the teacher use mathematics teaching aids or visual examples to explain mathematics concepts?	The teacher did not use teaching aids to explain the concepts, but he drew on the board the 3-dimensional objects and explain to them while they visualise the objects.
	Does the teacher ask the learners questions to check their understanding of content?	The teacher asked the learners to name curved objects, prisms and pyramids which they know.

	Does the teacher ask learners questions that cater for the different cognitive levels?	The teacher asked lower order questions, like the names of 3-dimensional objects and the number of faces.
	How does the teacher use the learners' questions and responses to further elaborate on content being taught?	The teachers were saying Yes to the correct response. If the learner gave an incorrect respond he asks it again until he got a correct response.

APPENDIX B: INTERVIEW SCHEDULE

Interview template **Date:___________________**

Topic: The Professional Mathematics Teacher Identity of non-specialist primary school mathematics teachers.

Interviewee:_____________________________________

Interviewer:_____________________________________

1. Please provide some background to your teaching career.
2. Explain your experience of teaching mathematics.
3. What are your guiding principles when teaching mathematics?
4. Which teaching method do you apply when teaching mathematics?
5. Why do you teach mathematics in such manner?
6. Do you have alternative methods for teaching mathematics?
7. How do you create the learning opportunities?
8. How do you encourage higher-order thinking in learning mathematics?
9. How do you accommodate the diverse learning needs in your classroom?
10. Do you have confidence in teaching mathematics?
11. What are your objectives when teaching mathematics?
12. How do you assess the learners' understanding of the content being taught?
13. How do you prepare the assessment tasks?
14. How do you plan your lessons?

APPENDIX C: TRANSCRIPTION OF INTERVIEW SCRIPTS

Teaching-and-learnimg specialist: How does the non-specialist mathematics teachers' PMTI manifest as teaching and learning specialist?

Subject specialist: How does the non-specialist mathematics teachers' PMTI manifest as a subject specialist?

Characteristics of non-specialist maths teacher: What are the characteristics of PMTI of the non-specialist mathematics teachers?

Interview with Given (Johannesburg East district, Participant 1).

Zanele: Thank you very much for allowing me to interview you. Before we start, do you have any questions you would like to ask before we proceed?

Given: No, I do not have any question.

Zanele: Please provide some background to your teaching career.

Given: I started teaching in 2013. I was teaching commerce subjects in high school. I was teaching business studies, EMS and economics. I came to primary school due to redeployment, and I started to teach mathematics Grade 4, 5, 6 and 7. I have two years of experience teaching mathematics. I started teaching Grade 6 this year.

Zanele: Explain your experience of teaching mathematics.

Given: I enjoy teaching mathematics, is one of the subjects I feel comfortable when teaching. I Love it basically. I do not have challenges when teaching mathematics since it’s a primary level one.

Zanele: What are your guiding principles when teaching mathematics?

Given: The love of the subject that what motivates me to go to class on daily basis. To see learners achieving and understanding what I have taught them. It gives me motivation and that it is a good sign.

Zanele: Which teaching method do you apply when teaching mathematics?

Given: Textbook teaching method that basically the method I am using.

Zanele: Why do you teach mathematics in such manner?

Given: It works for the learners of this school because of they are lazy to do extra-activities, and for them to work you have to be there. Make them work, give them activities from the textbooks. Some activities are from the internet and the DBE workbooks.

Zanele: Do you have alternative methods for teaching mathematics?

Given: No, I am only using the textbook method only.

Zanele: How do you create the learning opportunities?

Given: by engaging learners in group discussion and helping them or monitoring them when they are discussing something.

Zanele: How do you encourage higher-order thinking in learning mathematics?

Given: It's difficult for the learners that I am currently working with. Ya…with 2 or 3 learners in a class you can do that, by giving them extra higher order questions like problem-solving questions, but with others, it's just the waste of time. I tried and tried… I don't know how to do it, but 2 or 3 at least they can go beyond with problem-solving questions. If the work is challenging they will relax and they won't attempt to answer the questions and they won't ask me how they can solve the problems. I will come back and work on the solutions for them so that they can just copy.

Zanele: How do you accommodate the diverse learning needs in your classroom?

Given: Yes….I give fast learners extra-work to do and give slow learners extra time to do their work and complete it. Within a period I make sure I sit with the slow learners to teach them at least 5 minutes, I show them how to do the work step by step. Sometimes after school, we remain and redo them

60. work we were doing during the lesson. The clever ones I
61. normally when I give them classwork, I will give them more work to do.
62. that they can be busy with something when I am busy with
63. the slower ones.
64. Zanele: Do you have confidence in teaching mathematics?
65. Given: Yes of course I do.
66. Zanele: What are your objectives when teaching
67. mathematics?
68. Given: My objectives is to see learners understanding what I
69. am teaching them and getting good marks. If the learners fail
70. an assessment, I will reset the test and give them another
71. one.
72. Zanele: How do you assess the learners' understanding of
73. the content being taught?
74. Given: By asking questions while teaching, and giving them
75. classwork and homework to find out if they understood the
76. content or not. Actually informal assessment.
77. Zanele: How do you prepare the assessment tasks?
78. Given: I look at different provinces previous question papers
79. and check for questions align with the understanding of the
80. learners, and from the textbook, classwork and homework as
81. well. I do look at the ANA previous question papers. Most of
82. the questions are from ANA. We write common test in June
83. and end of the year.
84. Zanele: How do you plan your lessons?
85. Given: The lessons are planned by the department, I do some
86. alteration. I just download them from the internet from the
87. department of education website and do some changes on
88. the lesson plan to suit the needs of my learners and my needs
89. as well but aligned with CAPS.
90. Zanele: We came to the end of the interview. thank you so much for your time.

Interview with Thato (Johannesburg East district, Participant 2)

1. Zanele: Thank you very much for allowing me to interview
2. you. Before we can start do you have any questions you
3. would like to ask?
4. Thato: No I don’t have any questions we can start.
5. Zanele: Please provide some background to your teaching
6. career.
7. Thato: Ok… normally I am a mathematician myself as I am
8. saying, Although my qualifications are for high school. I did
9. commercial subjects, economics, accounting and business
10. economics, and now is called business studies. I started
11. working at a primary school. I did not go to teach at a high
12. school. I don’t know whether I was placed by God or what,
13. but as times go on it will be revealed. (Yes sir). I taught
14. mathematics though I never have qualifications by then, all
15. those years from 1994 until 1997, then I moved to the public
16. primary school. I started at a Catholic primary school which
17. was a private school. Then in, I went to public primary 18.
school. I did not have mathematics qualification, now I have
19. obtained ACE in maths. But I managed to teach mathematics
20. as I had a maths background. I did maths from Grade 1 to
21. Grade 12, I…did pure mathematics at a high school and I was
22. lucky to teach it in a primary school. Though I did not have an
23. opportunity to teach at a high school. (“so when you started
24. teaching at Catholic primary school what were you teaching
25. mathematics”, I inquired).
26. Thato: I taught mathematics, a home language which was
27. SeSotho, natural science, I taught all subjects including
28. afrikaans. History, geography, and I also taught health
29. education, except IsiZulu because the only have two African
30. languages which are IsiZulu and SeSotho.
31. Thato: when I went to public school that when I found that
32. SeSotho was not there. I taught maths and economics and
33. management science (EMS), religious education. I think they
34. looked at my personality. They said I look like a pastor and
35. they gave me a religious education and I taught it.

Zanele: so currently what are you teaching here at your school?

Thato: I am…luckily, I am teaching EMS three classes in Grade 7 and then two classes in Grade 6 mathematics. I am teaching EMS and maths.

Zanele: Explain your experience of teaching mathematics.

Thato: Mathematics I love it. It starts from within. I Love maths because it is practical because since I…am having maths inside me. I am able to draw the attention of learners. I am not textbook bound. I can provide my own examples besides the one I will find in the textbook. (“practical examples, using real-life objects, I enquired”).

Thato: Ya…and also…particularly when I teach fractions I can start by using their families. How many are you in the family and they say we are four and who is there in your family? if they say my father is not there and then ask if the family is complete if your father is not there? The family is not complete, for you to have a complete family. For your family to be complete you must bring your mother, your father and brothers or sisters. That we call it a family which is a whole. That is a practical example of fractions. (“Oh…That's’ interesting”, I supported).

Zanele: What are your guiding principles when teaching mathematics?

Thato: My guiding principles I think….the ATP and the textbooks I think are the guiding ones, and also the legislatures, the assessment legislatures. I cannot go and teach mathematics without looking both policies. The policies are my guidelines.

Zanele: Which teaching methods do you apply when teaching mathematics?

Thato: question and the answer, I will say I prefer that, because when you teach you to start providing the background, baseline questions we normally call that. That is where I involve them in question and answer. after that now when I introduce my…my concept if not the topic, that's when I will start involving my narrative method to explain. The narrative method that is when now explanation takes place. After that…After narrative method, I will go back to question and answer then from there peer grouping. They start doing the questions in groups.

Zanele: Why do you teach in that manner?

Thato: I think the interaction is so nice because of the personal interaction as the principles of teaching, you are a parent, a pastor, you are a mentor, supervisor, it involves almost everything under the seven principles of a teacher that allows me to do that, I cant just dictate. I need to interact with them and then bring that kind of an atmosphere, the learning atmosphere. ("Yes, in order to see if they are listening or not, and determine their understanding of the content, I affirmed").

Zanele: Do you have alternative methods of teaching mathematics?

Thato: I think we…I alternatively use different methods, question and answer, and then grouping peer educating, because I Love them to teach, I involve them, they come on the chalkboard to write questions or maybe answers. Or the other ones answer. By so doing they will be competing and by mere competing will gain more knowledge and they will never forget what they have been taught.

Zanele: How do you create the learning opportunities?

Thato: learning opportunities I will say after I have rendered my…my lesson, then I am going to find out that some of the learners they are not on par with us or they have just missed it. Then for those who missed it, I will then reteach the subject or the concept slowly with their level and for those who have mastered it. I will give them extra work so that they can do something and also assist those who are lacking behind.

("do you use DBE workbooks, I enquired").

Thato: Yes we do, they have extra activities. My DBE when I use it, I look at whatever concept I am teaching. Then I will go to the activity that is aligned with the concept I am

107. teaching that particular time. It will not be random activity
108. giving.
109. Zanele: How do you encourage higher-order thinking in
110. learning mathematics?
111. Thato: Ehh… higher order thinking. I think particularly for
112. those who master the content quickly, Ehh…I will allow them
113. to give me answers because of all the answers are with
114. them. And you might think they cannot think in a higher order
115. but by merely providing me with their own solutions. I think
116. that will be an opportunity for higher order thinking.
117. Zanele: How do you accommodate the diverse learning
118. needs in your classroom?
119. Thato: Eh… since we have five African languages in our
120. school. Ehh…I think I will allow them by providing them with
121. an opportunity for explaining in their languages. And then
122. from there re-explain for those who did not understand. (“Do
123. you also try to speak the five languages, I inquired”).
124. Thato: Yes, I also try but there are two who are so difficult
125. for, particularly Tsonga and Venda…(he laughs).
126. (“so do you ask the learners who understand the concept
127. being taught to explain to their peers in Tsonga and Venda,
I 128. asked”).
129. Thato: Ya…I explain in English and I also put it in Zulu and
130. then let them explain to those who do not understand,
131. particularly the Venda and Tsonga. (“But the learners are
132. very clever they know other languages and mostly they
133. understand isiZulu, I corroborated”).
134. Thato: Yes, they are very clever.
135. Zanele: Do you have confidence in teaching mathematics?
136. Thato: Ya…Ya…I love maths (laughing). I feel like I can
137. teach maths (“only, I asked”).
138. Thato: I can teach 24/7 only maths in the school. (“is that the
139. the reason you went to ACE in mathematics to become a
140. specialist, I asked”).
141. Thato: I did Ace in mathematics and EMS, I was doing then
142. concurrently. I completed my maths first, and then I was left

143. with one module in the ACE in EMS, and I just dropped out
144. I just said I am enough with mathematics (he laughs).
145. Zanele: What are your objectives when teaching
146. mathematics?
147. Thato: Ehh…since maths is lifelong, you know…activity if
148. not a subject because you do it every day. every second it
149. is maths, whenever, even if you are angry its maths so it is
150. an ongoing subject because you apply it every day. Even if
151. you say you do not like maths but unaware you are doing
152. maths I will encourage my learners to do pure maths
153. throughout their lives. That is what I…I want for all of my
154. learners, my wish is to see them passing with 100%, getting
155.100% pass rate in my class. but I know that it is so difficult
156. they cannot pass with100% because it is not easy. (“it is not
157. easy I know, I affirmed”).
158. Zanele: how do you assess the learners’ understanding of
159. the content being taught?
160.Thato: The…classwork I think, the homework and towards
161. the end then it will be the controlled assessment task that is
162. going to be marked and then also the test. We have a task
163. and a test. The task is a little bit formal but recorded because
164. is going to form part of the year mark, or maybe the term
165. mark. (“alright, the tasks are the projects and assignments,
I 166. inquired”).
167. Thato: Ya…projects and assignments that they normally do
168. in class.
169. Zanele: How do you prepare the assessment tasks?
170. Thato: Ehh… I am using the ATP, (“yes, I said”), and
171. also, the textbooks are assisting us, or for a proper recording
172. of assessment, I think we have a policy that is a CAPS
173. document will assist, N4PR assessment policy assists us so
174. that we must not do assess randomly but follow the policy.
175. (“do you sometimes use previous question papers like ANA
176. to set a test, I asked”).
177. Thato: Ya…Ya…definitely we normally do that because
178. when we set the test, we actually pick the questions

179. according to Blooms' taxonomy and then pick the questions.
180. because we want to allow every learner in class, and all
181. the levels must be covered. because if you only take one
182. level you are going to have a problem, so Blooms' taxonomy
183. is actually assisting us, that is why we collect all the previous
184. question papers so that we can see the standard of
185. questioning.
186. Zanele: How do you plan your lessons?
187: Thato: Ehm…I think we…we since I am not alone in school,
188. so we assemble or gather as maths department and then
189. we share ideas and look at the questions and look at
190. Blooms' taxonomy as I said earlier, it covers all the
191. knowledge levels, those who are not able to answer the
192. higher-order questions they are accommodated at the
193. beginning of the test. There will be lower, middle and higher-
194. order questions. ("With lesson planning do you follow the
195. CAPS document or you look at term 1 work and you meet
196. together as maths department and plan together, I asked").
197. Thato: I think CAPS document covers everything we cannot
198. work or plan the lesson and also do the assessment task
199. without looking at the CAPS document because you will be
200. out of order, you will not be able to cover the work. because
201. it also allows us whatever you have covered. it also actually
202. goes with the plans of CAPS. ("Ok, so in the school, you do
203. not download lesson plans from the GDE website, I
204. inquired").
205. Thato: We normally do, but it depends, if you go to the
206. internet and you find that the lesson plan has been set is of
207. poor quality, we look at what is best from the lesson plans
208. from the internet.

Interview with Musa (Johannesburg East district, Participant 3)

1. Zanele: Thank you very much for allowing me to interview
2. you. Before we can start do you have any questions you
3. would like to ask?

Musa: No mam we can start.

Zanele: Please provide some background to your teaching career.

Musa: I can say that now I have been teaching mathematics in different schools. I started teaching in 1995 in Borhkrom area and I…I thereafter went to Lembone district of Lesheshane, er…and ahh…I am now in Gauteng. I can say maths is fascinating, I feel happy when teaching mathematics because maths provide me you know a…lot of things that are enjoyable. You see mathematics is a subject that you cannot just standup and say I am going to teach without preparing. So in fact I enjoy preparing, counting is something I like. ("it is interesting, I affirmed").

Zanele: Explain your experience of teaching of teaching mathematics.

Musa: Eish…sometimes is very hard, looking at the kind of children that we are teaching. You will find that there is a lot of learners who cannot understand my language clearly, so I using English most of the time, so sometimes those are the things that give me challenge most of the time. but wherever I meet a problem I just go out and find a teacher who can explain some of the things more clear to the learners. But all in all teaching maths it is challenging. ("for how many years you have been teaching Grade 6 mathematics, I enquired"). Ever since I have started teaching in 1995 until now. I have 21 years teaching mathematics in Grade 6.

Zanele: What are your guiding principles when teaching mathematics?

Mmm…again an interesting question. Ehh…my guiding principles are…ehh…starting from what we call the lower level to the higher level when dealing with aspects of mathematics. Sometimes we say a house cannot be built…you know in one day. It needs a foundation, the wall and also the roofing. So I start with what you call simple things until I get to the abstract things ("Which simply means that you give learners practical examples. something which they see every day when you explain maths, I enquired").

Musa: Yes

Zanele: Which teaching method do you apply when teaching mathematics?

Ehh…I use discovery method and sometimes I will give them homework and base on that I will be able to explain certain things the coming day. The first have to discover what they have been given, so that I can be able to see tomorrow if they will be able to understand or not. But immediately I get to the lesson I make things more clearer. ("so when you teach you use textbook Or what, I asked").

Musa: Ah…no when I teach I use different books and the textbooks and whatever available information that is necessary. ("so after the learners, they went to do the research do they come back and report as a discussion in the classroom or you just ask them questions and explain from there, I asked").

Musa: I just ask questions because since we have limited time of teaching, I just make sure I asked them questions generally so that I can be able to know what the difficult part of what they were doing is.

Zanele: Why do you teach mathematics in such a manner?

Musa: You know, I sometimes use to hear people saying that learners are blank, they must be things written on them. But amm..really against that I think learners they can know certain things that I do not know, I give them that opportunity to excel on their own, before I can get to the real lesson.

Do you have alternative methods of teaching mathematics?

Musa: Ya…It's a question and answer method.

Zanele: How do you create the learning opportunities?

Musa: Mmm…although its difficult mam, ehh.I am just trying sometimes. I put them in groups and sometimes I just make sure that they just sit as they are arranged. So it differs

73. according to you know from day to day. (“So what makes it to
74. be difficult for you to keep them in groups, I asked”).
75. Musa: space is a problem. I teach learners that are
76. sexist in class, learners who cannot participate very well
77. and there are a lot of desks you know. tables and those lot of
78. things, it will be time-consuming because of overcrowding.
79. Zanele: How do you encourage higher-order thinking in
80. learning mathematics?
81. Musa: Ehh…like I said. I like the discovering method. Ehh you
82. know …sometimes I give learners challenging things so that
83. I can really know …detect from what I have given them that
84:they can reach up to the higher level. But firstly I cannot give
85. them the abstract things, without Ehh…trying to explain to
86. them how they have to do it and all those things. I explain
87. a little and then after they come up with their own, what we
88. call…their conclusion.
89. Zanele: How do you accommodate the diverse learning
90. needs in your classroom?
91. Musa: Mmm…that one I accommodate, most of the time I use
92. English because of the…the…Ahh…I teach learners
93. sometimes mixed in one class, from different cultures and all
94. those things. In fact, I encourage them to interact with one
95. another so you know, I hate those groups, you know…where
96. you find the Zulu learners being there and pedi learners being
97. there. Even when Ah…I pass through the plots and see
98. learners grouped in a tribal way. I do not feel happy, I want
99. them to share. In fact, in a class, you may find that I have put
100. a Zulu learner and Pedi learner on the table so that the can
101. be able to interact (“work together as groups, I collaborated”).
102. Zanele: Do you have confidence in teaching mathematics?
103. Musa: Hheyi…eish…the confidence it's so high, is the
104. a subject that I like the most you know. Eish, in fact, I can
105. say the confidence even started when I was very young at
106. home they use to sell some tomatoes and all those things.
107. This the thing of grouping and all those things I started

knowing them there. so that is why I say mathematics is like Ehh… you know what you call Ehh…Ehh…a continued addition that is multiplication, the repetition of an addition. Is like sometimes when I teach this method of a…long division, I make sure that the number that they must divide with it added with many times. When they reach the particular number they are dividing they stop there and then they count the numbers so they can say Ohh…I added four many times now this 4 are 6 which means is 24. (“which means you incorporate division with multiplication as well, I enquired”).

Zanele: What are your objectives when teaching mathematics?

Musa: That you know…chronologically thinking. you know they must start from somewhere. They must know that maths is like a building block, you cannot. Like I said before you cannot reach the roof when you did not start with the foundation. You start from simple things then you get to more abstract things. that’s why I said I instill this chronologically thinking.

Zanele: How do you assess the learners’ understanding of the content being taught?.

Musa: Mmm…can you repeat the question mam (“how do you assess the learners’ understanding of the content being taught, I asked”).

Musa: I give them classwork, sometimes I write problems on the chalkboard, and divide the chalkboard ad I call them in groups of eight, they work on the problem given and all those things and that’s when I am going to understand if they got it clearly.

Zanele: How do you prepare the assessment tasks?

Musa: Mmm…I use different previous papers you know. I come up with my own thing and then after compare ehh…the particular task with other previous question papers. that helping me to know, showing Mmm…that ehh…the paper is according to the standard and all those things. But mostly I get information from the CAPS. (from mathematics CAPS document, I collaborated).

Musa: Yes. (“what you need to cover in the test, I enquired”)

Musa: Yes.

Zanele: How do you plan your lessons?

Musa: Mmm…the lessons, that is the other part I enjoy a lot. We are provided with the lesson plans that are prepared by the department of education, but I don’t use that lesson as it is, there is where I add my own things in order for the learners to be able to understand what I am teaching them.

Zanele: Can I please take you back on your background to your teaching career, were you qualified to teach mathematics or you were fortunate enough that when you start working you taught mathematics because you had mathematics background up to matric level.

Musa: Actually I qualified for teaching English and Afrikaans, but my background as I told you, I grew up in a family where they were selling tomatoes, so my experience started there that’s why when they said they wanted a maths teacher, I jumped and said I am available, I can teach mathematics (“You have interest in teaching mathematics, I affirmed”).

APPENDIX D: ALL IDENTIFIED CODES AND TALLIES

Interviews codes (61)

Anchor codes:

***Teaching-and-learning specialist* –** how does the non-specialist mathematics teachers' PMTI manifest as a teaching and learning specialist?

***Subject specialist*–** how does the non-specialist mathematics teachers' PMTI manifest as a subject specialist?

***Characteristics of non-specialist maths teachers* -** what are the characteristics of PMTI of the non-specialist mathematics teachers?

1. **Characteristics of non-specialist maths teachers**: Qualified FET EMS teacher
2. **Characteristics of non-specialist maths teachers**: qualified language teacher
3. **Characteristics of non-specialist maths teachers**: overcrowding,
4. **Characteristics of non-specialist maths teachers**: Difficulty in teaching
5. **Characteristics of non-specialist maths teachers:** difficulty in teaching other content
6. Page: 45
   Characteristics of non-specialist maths teachers: enjoy teaching maths, Love of maths
7. **Characteristics of non-specialist maths teachers**: have confidence
8. **Characteristics of non-specialist maths teachers**: knowledge application
9. **Characteristics of non-specialist maths teachers**: Learners understanding and achievement
10. **Characteristics of non-specialist maths teachers**: learners' achievement
11. **Characteristics of non-specialist maths teachers**: Love of mathematics
12. **Characteristics of non-specialist maths teachers**: love of mathematics
13. **Characteristics of non-specialist maths teachers**: Love of maths
14. **Characteristics of non-specialist maths teachers**: Passion for maths and love of maths

15. Page: 46

    Characteristics of non-specialist maths teachers: Redeployment

16. **Characteristics of non-specialist maths teachers:** started working in a primary school

17. **Characteristics of non-specialist maths teachers**: Teaching difficulty

18. **Characteristics of non-specialist maths teachers**: Teaching without maths qualification

19. **Characteristics of non-specialist maths teachers**: teaching without a maths qualification

20. Page: 46

    Characteristics of non-specialist maths teachers: Learners' understanding and achievement

21. **Characteristics of non-specialist maths teachers**: learners' understanding

22. Page: 46

    Characteristics of non-specialist maths teachers: teaching difficulty

23. **Characteristics of non-specialist maths teachers**: Knowledge application

24. **Subject specialist**: different levels of questions

25. **Subject specialist**: download lesson plans from GDE website

26. **Subject specialist**: informal and formal assessment

27. **Subject specialist**: Informal assessment

28. **Subject specialist**: Lesson plan supplied by DBE. Do alterations on the lesson plans.

29. **Subject specialist**: Lesson plans are supplied

30. **Subject specialist**: lessons plans aligned with CAPS document

31. **Subject specialist**: maths needs preparation

32. **Subject specialist**: pre-knowledge to abstract knowledge

33. **Subject specialist**: Previous question papers and textbook

34. **Subject specialist**: question and answer, and informal assessment.

35. **Subject specialist**: start with pre-knowledge to abstract knowledge

36. **Subject specialist**: Subject policy documents

37. **Subject specialist**: subject policy documnets

38. **Teaching-and-learning specialist**: classroom discussion

39. **Teaching-and-learning specialist**: classroom discussion

40. **Teaching-and-learning specialist**: code switching

41. **Teaching-and-learning specialist**: code switching.

42. **Teaching-and-learning specialist**: cooperative learning

43. **Teaching-and-learning specialist**: extra activities for the intelligent learners, help the slow ones.

44. **Teaching-and-learning specialist**: Extra activities to intelligent learners, help the slow learners, slow learners given extra-time

45. **Page: 47**
    Teaching-and-learning specialist: group discussions

46. **Teaching-and-learning specialist**: peer learning

47. **Teaching-and-learning specialist**: real-life examples

48. **Teaching-and-learning specialist**: Teacher centred approach

49. **Teaching-and-learning specialist**: teacher centred approach.

50. **Teaching-and-learning specialist**: teacher centred approach.

51. **Teaching-and-learning specialist**: teacher-centred approach. Question and answer

52. **Teaching-and-learning specialist**: Teacher-centred and group discussion

53. **Teaching-and-learning specialist**: teacher-centred and learner-centred approach

54. **Page: 47**
    Teaching-and-learning specialist: a teacher-centred approach

55. **Page: 47**
    Teaching-and-learning specialist: a teacher-centred approach

56. **Teaching-and-learning specialist**: a teacher-centred approach

57. **Teaching-and-learning specialist**: a teacher-centred approach

58. **Page: 48**

    Teaching-and-learning specialist: Teacher-centred approach Textbook bound

59. **Teaching-and-learning specialist**: textbook bound.

60. **Teaching-and-learning specialist**: a teacher-centred approach

61. **Teaching and-learning specialist**: learners unwillingness to participate

61 codes and their respective frequencies in alphabetical order

Non-specialist mathematics teacher: qualified in Bcom accounting, PGCE FET and senior phase EMS (3)

Non-specialist maths teacher: qualified language teacher (1)

Non-specialist maths teacher: have confidence (1)

Non-specialist maths teacher: learners achievement (3)

Non-specialist maths teacher: learners understanding (3)

Non-specialist maths teacher: love of mathematics (5)

Page: 48
Non-specialist mathematics teacher: Redeployment (1)

Non-specialist mathematics teacher: teaching difficulty and understanding of other concepts (4)

Non-specialist mathematics teacher: knowledge application (3)

Non-specialist mathematics teacher: no manipulatives (2)

Non-specialist mathematics teacher: overcrowding (2)

Subject specialist: lesson plan supplied by DBE (2)

Subject specialist: download lesson plans from GDE website (1)

Subject specialist: informal and formal assessment (3)

Subject specialist: maths needs preparation (1)

Subject specialist: previous question papers and textbook (1)

Subject specialist: subject policy documents (2)

Subject specialist: different levels of questions (1)

Teaching-and-learning specialist: classroom discussion (2)

Teaching-and-learning specialist: code-switching (2)

Teaching-and-learning specialist: extra activities for the intelligent learners (3)

Teaching-and-learning specialist: cooperative learning (1)

Page: 49

Teaching-and-learning specialist: group discussions (2)

Teaching-and-learning specialist: grouping learners according to a different level of understanding (1)

Teaching-and-learning specialist: peer learning (1)

Teaching-and-learning specialist: real-life examples (1)

Teaching-and-learning specialist: teacher-centred approach. (Question and answer) (12)

Teaching-and-learning specialist: textbook bound (2).

Teaching-and-learning specialist: learner-centred approach (1)

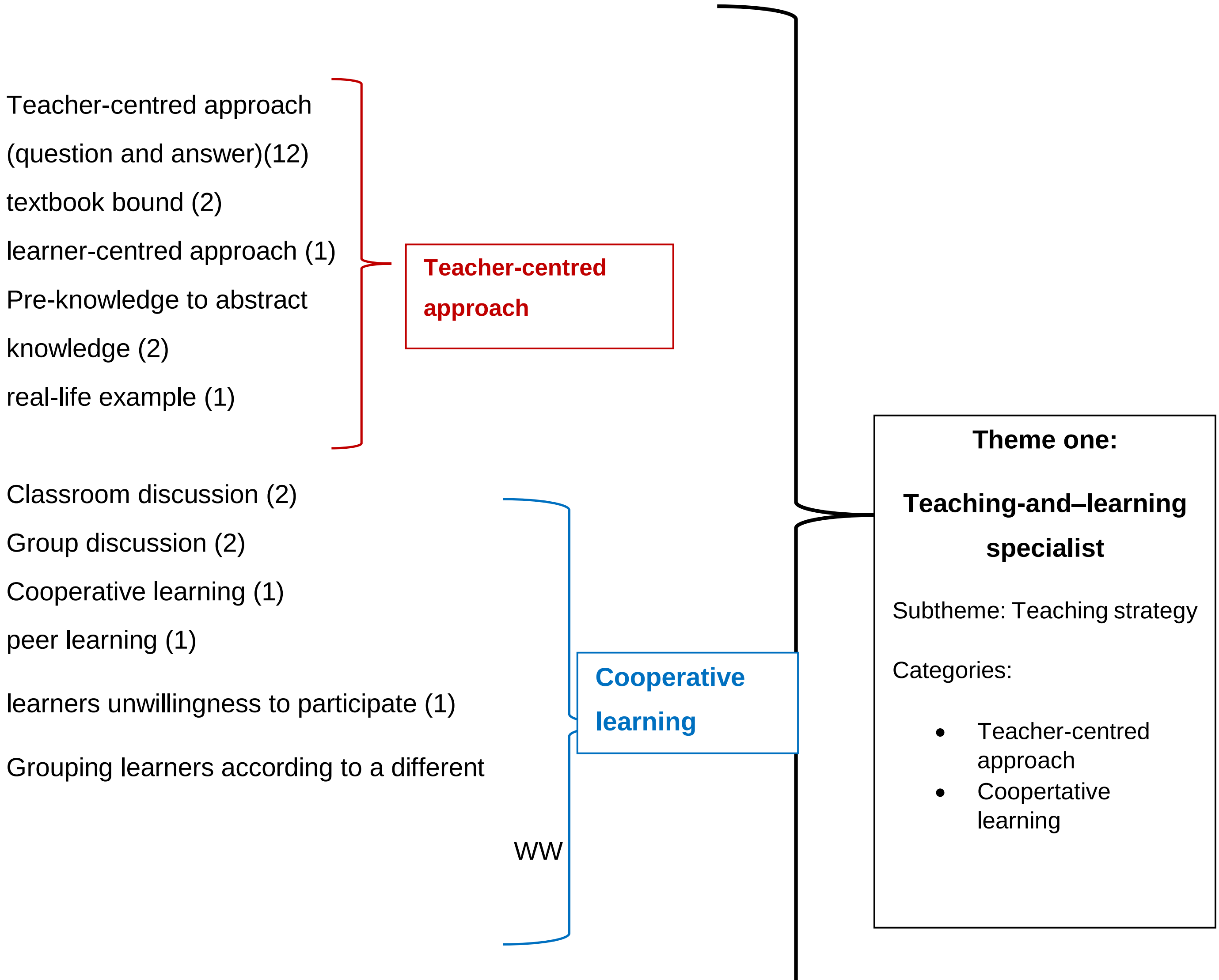
Teaching-and-learning specialist: start with pre-knowledge to abstract knowledge (2)

Teaching-and-learning specialist: learners unwillingness to participate (1)

Appendix E: Codes, categories, subthemes and themes based on research question

Codes, categories, subthemes and themes

How does the non-specialist mathematics teachers' PMTI manifest as teaching and learning specialist?



level of understanding (2)

Extra activities for intelligent learners and help

slow learners are given their own activities (3)

How does the non-specialist mathematics teachers' PMTI manifest as a subject specialist?

Lesson Plans are supplied (2)

maths needs preparation (1)

Download from GDE website (1)

Planning

Informal and formal assessment (3)

Previous question papers and textbook (1)

different levels of questions (1)

Subject policy document (2)

Informal and formal assessment

Theme two:

Subject specialist

Subthemes: lesson plans and assessment tasks

Categories:

- Planning
- Informal and formal assessment

What are the characteristics of PMTI of the non-specialist mathematics teachers?

unqualified maths teacher (3)

Redeployment (1)

Difficulty in teaching and understanding other concepts (4)

Love of mathematics (5)

confidence (1)

Learners understanding (3)

application of knowledge (2)

Subject matter knowedge

No manipulatives (2)

Overcrowding (2)

Teaching knowledge

Theme three

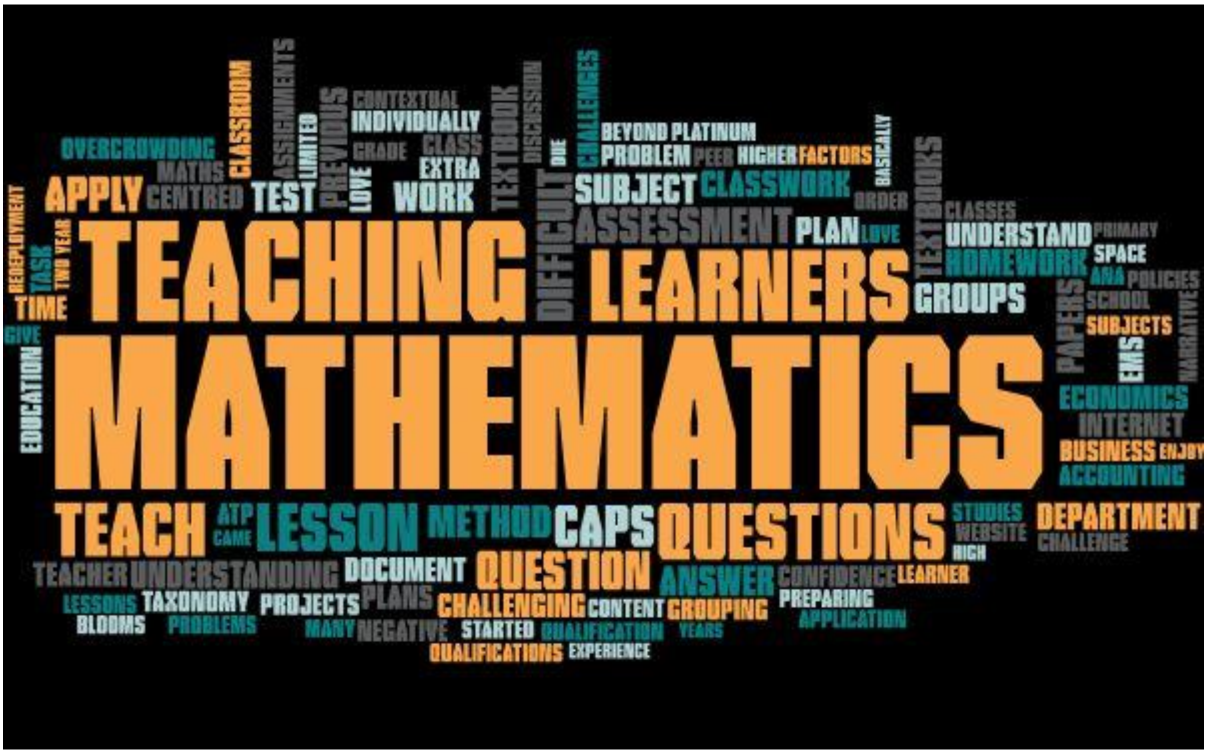
Characteristics of non-specialist mathematics teachers

Subtheme: Characteristics

Categories:

- Subject matter knowledge
- Teaching knowledge

APPENDIX F: WORD CLOUD VISUALISATION OF CODES, CATEGORIES AND THEMES



APPENDIX H: GDE RESEARCH APPROVAL LETTER

GAUTE PROVI CE

Department: Education

REPUBLIC OF SOUTH AFRICA

GAUTENG PROVINCE

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**09 March 2018**
Validity of Research Approval:	**05 February 2018 – 28 September 2018** **2017/377**
Name of Researcher:	**Dibane Z.**
Address of Researcher:	**67 Xubeni Section**
	Tembisa
	1632
Telephone Number:	**072 8900 248**
Email address:	**zdibane@gmail.com**
Research Topic:	**The professional mathematics teacher identity of non-specialist primary school mathematics teachers.**
Type of Degree: **Number and type of schools:**	**Masters** **Four Primary Schools**
District/s/HO	**Johannesburg East**
Re: A roval in Res	***ect of Re uest to Conduct Research***

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

13/03/2018

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

Making education a societal priority

Office of the Director: Education Research and Knowledge Management

7th Floor, 17 Simmonds Street, Johannesburg, 2001

Tel: (011) 355 0488

Email: Faith.Tshabalala@gauteng.gov.za

Website: www.education.gpg.gov.za

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Ms Faith Tshabalala
CES: Education Research and Knowledge Management

DATE: 13/03/2018

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

APPENDIX I: INFORMED CONSENT

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education

FACULTY OF EDUCATION
DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION
Groenkloof Campus
Pretoria 0002
http://www.up.ac.za
23 February 2018

LETTER OF PERMISSION: PRINCIPAL

Dear Sir / Madam

I am an MEd student studying through the University of Pretoria and I would like to collect data at your school for a research project titled *The Professional Mathematics Teacher Identity of non-specialist primary school mathematics teachers.*

The purpose of this study is to investigate how the Professional Mathematics Teacher Identity (PMTI) of non-specialist Grade 6 mathematics teachers manifest as subject specialist and teaching and learning specialists. Although much research has been done on PMTI, very little is known about the PMTI of non-specialist mathematics teachers. The non-specialist Grade 6 mathematics teachers will be chosen in consultation with the Gauteng Department of Education (GDE) mathematics subject advisor in Johannesburg East District.

The Grade 6 mathematics teachers will be invited to complete an interview, which will not last more than 40 minutes, in order to determine how the teachers view their professional identity as mathematics teachers. The interviews will be completed during Term 2 and 3 in the teachers' normal mathematics classroom. I will also ask the teachers to make copies of their lesson plans and assessment activities in order to determine how teachers actualise their identity as mathematics teachers.

Based on this information, I may ask teachers to further participate in this study by allowing me to video record and observe two of their mathematics lessons. The video recording will take place during Term 2 or 3, in their normal Grade 6 mathematics classes and will not last more than 60 minutes each. These video recordings are necessary for accurate analysis. I will sit quietly in the back of teachers' classes and take notes. Only the actions of the teachers will be recorded. The video will also record any interaction that the teachers have with their learners, but the learners will not be included in the video recordings.

For the recordings, the teachers will be asked to teach their normal mathematics classes. As the research is focused on studying the identity of Grade 6 mathematics teachers, it will not in any way comment on the teachers' or learners' mathematical competence. This study will not attempt to evaluate the quality of teaching, but aims to identify mathematics teachers' professional identity as a Grade 6 mathematics teachers.

The data collected for this study will be handled in strict confidentiality, and neither the schools nor the participants will be identifiable in any report. The teachers who are participants may withdraw anytime without any penalty. The teachers, parents and learners will be provided with letters that will elicit their informed consent and the researcher will only commence with data gathering once all these have been granted. The video recording, document analysis transcripts and interview transcripts will only be used for research purposes and the content will remain confidential.

The results of this study may be presented at conferences or published in scientific journals. On completion of the study an electronic copy of the dissertation will be available at the University of Pretoria's library. If it is required, I will be available to provide short presentations on the purpose, findings and recommendations of my research to both GDE officials and the schools concerned.

Participation is subject to the Ethics Committee of the Faculty of Education at the University of Pretoria's regulations, and the following will apply:

1. The names of the school and identities of the participants will be treated confidentially, and will not be disclosed.
2. The video recording, document analysis transcripts and interview transcripts will be treated confidentially. Only the researcher (Ms Zanele Dibane) and the supervisor (Dr Sonja van Putten) will have access to the video recordings and the transcribed data.
3. Only the researcher (Ms Zanele Dibane) will know the identity of the teachers who agreed to participate in the study.
4. Pseudonyms for schools and teachers will be used in all spoken and written reports.
5. The information provided by the teacher and learners will be used for academic purposes only.
6. Participation in this project is entirely voluntary. Participants have the right to withdraw at any time without any penalty.
7. The teachers and learners will not be exposed to acts of deception at any point in the research study.
8. The teachers and learners will not be placed at risk of any kind.
9. No incentives will be offered to any of the research participants.

For any further queries, you are more than welcome to contact the researcher or her supervisor.

Your support in this matter will be appreciated.

Ms Zanele Dibane
072 890 0248
zdibane@gmail.com

Dr. Sonja van Putten (supervisor)
(012) 420 5657
Sonja.vanPutten@up.ac.za

Should you be willing to grant me permission to conduct the study at your school, please fill in the details on the next page:

I, ____ (your name only), give permission for the research project titled, *The Professional Mathematics Teacher Identity of non-specialist primary school mathematics teachers* to be conducted at my school.

……………………………… ……………………………..
Signature Date

UNIVERSITEIT VAN PRETORIA
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Faculty of Education

FACULTY OF EDUCATION
DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION
Groenkloof Campus
Pretoria 0002
http://www.up.ac.za
23 February 2018

LETTER OF INFORMED CONSENT: TEACHER

Dear Teacher,

I am an MEd student studying through the University of Pretoria and would like to collect data at your school for a research project titled *The Professional Mathematics Teacher Identity of non-specialist primary school mathematics teachers.*

As a Grade 6 mathematics teacher, you will be invited to complete an interview, which will not last more than 40 minutes, in order to determine how you view your identity as a mathematics teacher. These interviews will be completed during Term 2 and 3 in your mathematics classroom. I will also ask you to make some copies of your lesson plans and assessment activities in order to determine how you actualise your identity as a mathematics teacher.

Based on this information, I may ask you to further participate in this study by allowing me to video record and observe two mathematics lessons and will not last more than 60 minutes each. The video recording will take place during Term 2 or 3, during your normal Grade 6 mathematics classes. This video recording is necessary to allow me to do detailed analysis. I will sit quietly in the back of your class and take notes. I will have a video camera that will only record your actions as a teacher. The video will also record any interaction that you have with your learners, but the learners will not be included in the video recordings.

For the recordings, you will be asked to teach your normal mathematics classes. You should not teach mathematics any differently than you are used to. As the research is focused on studying the identity of Grade 6 mathematics teachers, it will not in any way comment on your competencies as a teacher. This study will not attempt to evaluate the quality of your teaching, but aims to identify your identity as a Grade 6 mathematics teacher.

The results of this study may be presented at conferences or published in scientific journals. On completion of the study an electronic copy of the dissertation will be available at the University of Pretoria's library. If it is required, I will be available to provide short presentations on the purpose, findings and recommendations of my research to both GDE officials and the schools concerned.

Participation is subject to the Ethics Committee of the Faculty of Education at the University of Pretoria's regulations, and the following will apply:

10. The names of the school and identities of the participants will be treated confidentially, and will not be disclosed.
11. The video recording, document analysis, transcripts and interview transcripts will be treated confidentially. Only the researcher (Ms Zanele Dibane) and the supervisor (Dr Sonja van Putten) will have access to the video recordings, audio recordings, lesson plans and the transcribed data.
12. Only the researcher (Ms Zanele Dibane) will know the identity of the teachers who agreed to participate in the study.
13. Pseudonyms for schools and teachers will be used in all spoken and written reports.
14. The information provided by the teacher and learners will be used for academic purposes only.
15. Participation in this project is entirely voluntary. Participants have the right to withdraw at any time without any penalty.
16. The teachers and learners will not be exposed to acts of deception at any point in the research study.
17. The teachers and learners will not be placed at risk of any kind.
18. No incentives will be offered to any of the research participants.

For any further queries, you are more than welcome to contact the researcher or her supervisor.

Your participation will be appreciated.

Ms Zanele Dibane	Dr. Sonja van Putten (supervisor)
072 890 0248	(012) 420 5657
zdibane@gmail.com	Sonja.vanPutten@up.ac.za

Should you agree to participate in the study under the above stated terms, please fill in the following details:

I, ________________________________ (your name only), agree to take part in the research project titled, *The Professional Mathematics Teacher Identity of non-specialist primary school mathematics teachers.*

……………………………… ……………………………..

Signature Date

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education

FACULTY OF EDUCATION
DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION
Groenkloof Campus
Pretoria 0002
http://www.up.ac.za
23 February 2018

LETTER OF INFORMED ASSENT: LEARNERS

Dear Learner

Why am I here?

Sometimes when we want to find out something, we ask people to join something called a project. What you are taught in your class and how your teacher teaches it is often based on research. To continue to improve on what you are taught and how you are taught, there are research projects that look at what happens in a mathematics classroom. This is such a research project. In this project, I will be looking at how your teacher is teaching you mathematics. This project will give me a chance to look at different ways that teachers teach mathematics.

What will happen to me?

I will be video recording your teacher during two of your lessons. You should work and behave just as you always do in class. The camera that I will use to record your teacher will not record your face. The recording will only be used for me to check what you and your teacher have said, so there is no need to worry about what others may think about you or how you might look or act in the class. These recordings will not be shown to anyone (except your teacher, the camera person and my lecturers). If you do not want to say anything you do not need to.

Will the project help me?

This project is a bit like cleaning up a river, building houses in poor areas, or protecting rhinos; it will not necessarily help you immediately, but it may help to improve how mathematics is taught in future.

What if I have any questions?

You can ask your teacher or me any questions you have about this research. If you have questions later you can phone Ms Zanele Dibane at 072 890 0248, or you can ask her next time you see her at school.

Do my parents/guardians know about this project?

This project was explained to your parents/guardians in a letter, and they agreed that your mathematics lessons can be video recorded. You can talk this over with them before you decide if you want to be in this project or not.

Do I have to be in the project?

You do not have to be in this project if you do not want to. No one will be upset if you do not want to participate. You will not lose any marks for mathematics if you do not participate. If you do not want to be in the video recordings, you just have to tell us, and we won't use any of your words. You can say yes or no and if you change your mind later, you do not have to be part of the project anymore. It is up to you.

Writing your name on this page means that you agree to be in the project and that you know what will happen when we do the project. If you decide to quit the project at any time, all you have to do is tell me or your teacher.

……………………………… ……………………………………………

Signature of the learner **Date**

……………………………… ……………………………………………

Signature of the researcher **Date**

23/02/2018

……………………………….. ……………………………………………

Signature of the supervisor **Date**