EXPLORING THE PEDAGOGICAL CONTENT KNOWLEDGE OF INTERMEDIATE PHASE TEACHERS IN THE TEACHING OF DECIMAL FRACTIONS IN GRADE 6 AT RAKWADU CIRCUIT IN LIMPOPO PROVINCE

by

NTSAKO SHEREEN MOREMI

DISSERTATION

Submitted in fulfilment of the requirements for the degree of

MASTER OF EDUCATION

in

CURRICULUM STUDIES

in the

FACULTY OF HUMANITIES

(School of Education)

at the

UNIVERSITY OF LIMPOPO

SUPERVISOR: MS K.M THEMANE

CO- SUPERVISOR: MS B.K. MAPHUTHA

2020

DEDICATION

I dedicate this dissertation to my grandmother, Ennie Maimela, and my uncle, Joseph Maimela, who inculcated in me both the love for education and endurance in everything I do.

DECLARATION

I declare that the dissertation titled **"EXPLORING THE PEDAGOGICAL CONTENT KNOWLEDGE OF INTERMEDIATE PHASE TEACHERS IN THE TEACHING OF DECIMAL FRACTIONS IN GRADE 6 AT RAKWADU CIRCUIT IN LIMPOPO PROVINCE"** hereby submitted to the University of Limpopo, for the degree of Master of Education in Curriculum Studies has not previously been submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.

..…… ……..

Moremi N.S (Ms) DATE

ACKNOWLEDGEMENTS

I would like to express my sincere thanks and appreciation to the Almighty God who continuously showered me with His blessings every time I continued studying. I strongly hope that He will continue to lead me and make all things possible.

I further wish to express my gratitude to the following persons for their particular contributions towards the success of this dissertation:

- My supervisor, Ms K.M. Themane, as well as my co-supervisor, Ms B.K. Maphutha, for their tolerance, untiring support and the professional supervision they maintained throughout until the completion of this study;
- My husband, Albanus, for his absolute love, perseverance and encouragement;
- My three children, Lerato, Lesego and Palesa, for being considerate and supportive;
- All teachers who participated in the interviews and shared their honest experiences;
- My cousin, Andrew, for his undying support, tolerance and believing in me when I doubted myself;
- The Department of Basic Education, Mopani District, for permitting me to conduct the research at schools in the Rakwadu Circuit; and
- All principals of the sampled schools who allowed me entrance into their school premises without hesitation.

ABSTRACT

The purpose of this study was to explore the Pedagogical Content Knowledge (PCK) of Intermediate Phase teachers in the teaching of decimal fractions to Grade 6 learners. The study followed a qualitative research approach whereby a case study design was adopted. Three Grade 6 teachers were selected using a purposive sampling strategy to form part of the study. Shulman's (1986) Theory of Teacher Knowledge was used to guide the entire study. Data were collected through lesson observations, semi-structured interviews and document analysis. Data were analysed and interpreted using the Argyris, Putman and Smith's Ladder of Inference.

The study established that Grade 6 teachers lacked PCK in the teaching of decimal fractions. Teachers lacked confidence in the teaching of decimals. The analysis of data also revealed that teachers' knowledge of decimal fractions was poor, and that teachers experienced challenges in teaching decimal fractions. Generally, decimal fractions were found to be difficult for teachers to teach. This led to the conclusion that teachers lack Pedagogical Content Knowledge in the teaching of decimal fractions.

These findings, though not generalizable to a wider population, provide useful information for further research and insights of what Grade 6 mathematics teachers may be experiencing in their classrooms. The findings may help teachers improve their teaching. They also have implications for teacher-education institutions as they may restructure their teaching programmes, both for pre-service and in-service teachers.

Key words: Fractions, decimal fractions, Pedagogical Content Knowledge, conceptual knowledge

ABBREVIATIONS/ACRONYMS

ACE	Advanced Certificate in Education
ANA	Annual National Assessment
CCK	Common Content Knowledge
CK	Content Knowledge
DBE	Department of Basic Education
GPK	General Pedagogical Knowledge
KCS	Knowledge of Content and Students
KCT	Knowledge of Content and Teaching
MKT	Mathematical Knowledge for Teaching
NSES	National Science and Education Standard
OECD	Organization for Economic Cooperation and Development
PCK	Pedagogical Content Knowledge
PISA	Programme for International Student Assessment
SACMEQ	Southern Africa Consortium for Monitoring Educational Quality
SBT	School Based Team
SCK	Specialized Content Knowledge
SMK	Subject Matter Knowledge
SPTD	Senior Primary Teachers Diploma
TIMMS	Trends in International Mathematics and Science Study

TABLE OF CONTENTS

LIST 0F FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION AND ORIENTATION TO THE STUDY

1.1. CONTEXTUAL BACKGROUND

Rational numbers in general are deemed the utmost challenging topic to teach and teachers are expected to have a proper knowledge base in order to appropriately deal with learners' problems. Most teachers, however, lack this important knowledge base (Depaepe, Torbeyns, Vermeersch, Jannsens, Janssen, Kelchtermans, Verschaffel & Van Dooren, 2015). Studies in developed countries such as Japan (Lortie-Forgues, Tian & Siegler, 2015) and Hong Kong (Lai & Murray, 2015) point out that teachers experience difficulties in the teaching of mathematics, in particular, decimals. This is because fractions and rational numbers are reflected as multifaceted mathematical areas in basic school mathematics (Isiksal & Cakiroglu, 2011).

This problem is even worse in developing countries like South Africa (Spaull & Kotze, 2015). Spaull and Kotze (2015) further maintained that this dire situation was supported amongst others by local and international evaluations of mathematical achievement. Le Roux (2015) pointed out that challenges may be due to factors such as changes in curriculum, under qualified teachers, ineffective teaching methods, and barriers to learning existing in the classroom. Agrawal and Morin (2016) supported this idea when maintaining that teaching and learning decimal fractions is a 'hot spot' (curriculum concepts with which students and teachers struggle consistently). Isiksal and Cakiroglu (2011) maintained that unless teachers understand decimal fractions conceptually, they cannot assist learners with concepts and topics that they struggle with.

The interest in studying decimal fractions was motivated, amongst others, by the following: South Africa is 8th for mathematics of the 14 education systems; it is behind poorer countries such as Tanzania, Swaziland and Kenya (Spaull, 2013) and that, decimals were valued in mathematics curriculum owing to increased usage of calculators and their importance on metric measurement system (Ubuz & Yayan, 2010). Moreover, the study was motivated by the fact that some study areas need usage of

decimals, for example, economics courses for calculating interests and gains (Ubuz & Yayan, 2010).

The current research focused on three key forms of knowledge (Cotton, 2016) in order to understand the Pedagogical Content Knowledge of teachers in the teaching of decimal fractions to Grade 6 learners in the Rakwadu Circuit in Limpopo Province.

(i) Do teachers have knowledge of mathematics and are they confident in teaching mathematics as a subject in schools?
(ii) Do teachers understand the topic they are supposed to teach? Do they clearly understand mathematical ideas and concepts that are suitable to the level of learners they teach?
(iii) Do teachers know suitable pedagogical approaches and activities required to engage learners in learning decimal fractions?

Although research existed regarding Pedagogical Content Knowledge and challenges that teachers faced, the researcher is not aware of any study that focused on the Pedagogical Content Knowledge (PCK) of teachers teaching decimal fractions in primary schools at the Rakwadu Circuit. This study helped to bridge the gap.

1.2. THE PROBLEM STATEMENT OF THE STUDY

Intermediate Phase teachers in South Africa lack Pedagogical Content Knowledge in the teaching of fractions, including decimal fractions. Other studies have been conducted on this issue. Whitacre and Nickerson (2016) investigated the improvement of prospective elementary teachers' number sense in reasoning about fraction. The study found that fractions are a thought-provoking area for teachers in basic mathematics. Du Toit (2013); Ubuz and Yayan (2010) researched on teaching and learning of fractions in primary schools and noted that teachers face challenges in teaching fractions because they rely on practising rules and procedures when teaching fractions to make learners understand. Ubuz and Yayan (2010) further maintained that

today's teachers use the same simple rules that they were traditionally taught by their teachers because they do not want to challenge their subject matter knowledge

It appears that these teachers struggle to teach decimal fractions for understanding which confirmed their PCK deficiency. The teachers' posing of tasks was poor which also questions their PCK. This is revealed in the tasks that were given to learners during lesson observations. A number of factors have been attributed to this problem. For example, lack of resources, poorly qualified teachers, et cetera. In spite of this, how teachers teach decimal fractions in Grade 6 has received little attention in South Africa (Spaull, 2013), Teachers need enrichment workshops during school holidays at the end of each term to be trained on learner-centred pedagogical strategies and on how to teach fractions, including decimal fractions for conceptual understanding. It is through this background that the present study sought to explore the PCK of Grade 6 teachers in the teaching of decimal fractions. Though this phenomenon has been researched, the researcher was not aware of any study that sought to explore the PCK of teachers in Rakwadu Circuit, Limpopo Province. This study makes a start on this problem and might be strategic in provoking other researchers' interest into this area.

1.3. LITERATURE REVIEW

1.3.1 Introduction

The literature reviewed indicated that the teaching of decimal fractions is a global problem. For example, studies conducted in many Western countries reveal teachers' difficulty in teaching mathematics, in particular, decimals (Beswick, Callingham & Watson, 2012). Lai and Murray (2015) reported that teachers in Hong Kong also experienced challenges in teaching decimal fractions because they did not have a well-integrated knowledge of decimal numeration and have a risk of transferring their own misconception to learners.

A study conducted in Turkey by Ubuz and Yayan (2010) found that primary teachers face problems that learners face. For example, only 6% achieved a perfect score out of

the 18 decimal concepts test that was administered among 63 teachers in Turkey. This shows that even teachers who had taught decimals, they also experience similar problems. Teachers in Lesotho (Du Toit, 2013) as well as South Africa (Spaull, 2013) were not an exception.

Literature review followed the structure: clarification of concepts, teaching primary mathematics, the understanding of decimal fractions, difficulties of teaching decimal fractions and strategies to improve teaching of decimal fractions.

1.3.2 Clarification of concepts

1.3.2.1 Decimal fractions

According to Zhang, Wang, Lin, Ding and Zhou (2013), decimal fractions are a non-symbolic form of fractions, which employ a decimal point and it is without a denominator. Lortie-Forgues et al., (2015) defined decimal fractions as rational numbers expressed in base-ten notations. Decimal fractions have tenths, hundredths; thousandths, **ten** thousandths etc. for example, 0.8 (see Section 2.2.2) The present study adopted the latter as in this study decimals referred to fractions with a base-ten notation and a decimal point which teachers struggle to teach.

1.3.3 Teaching primary mathematics

In a study conducted among US teachers by Lortie-Forgues et al. (2015), it was found that teachers placed emphasis on memorisation of rules and procedures as they lacked knowledge needed to transfer to learners. Bartell, Webel, Bowen and Dyson (2013) posit that teachers required a specific kind of knowledge in order to teach mathematics for conceptual understanding, because teaching mathematics is complex. It shows that to be able to teach decimal fractions effectively, teachers need conceptual mathematical knowledge.

1.3.4 The Understanding of decimal fractions

Mathematics is categorised as a collection of concepts in hierarchy, which must be comprehended and intertwined together (Sarwadi & Shahrill, 2014). For teachers to teach decimal fractions effectively, they should have a clear understanding of decimal fractions themselves. This idea was strengthened by Whitacre and Nickerson (2016) who posited that teachers lack understanding of basic mathematics needed in teaching. This was a valid point because, if teachers do not understand decimals, the danger of transferring their misconceptions to learners would be rather high. This implied that poor understanding of fractions and decimals would have severe long-term consequences on academic and occupational success (Jordan, Hansen, Fuchs, Siegler, Gersten & Micklos, 2013; & Lortie-Forgues et al., 2015).

1.3.5 Difficulties of teaching decimal fractions

Teaching decimal fractions in schools is focused on how to get accurate responses using rules or procedures rather than why procedures work (Sarwadi & Shahrill, 2014). This is because poor comprehension of fraction and decimal arithmetic is problematic. In a study conducted by Muzheve and Capraro (2012), it was found that primary teachers experience flaws in comprehending concepts on place value, working with fractions, and multiplication of decimal fractions, percentages, and measurement. Instead, teachers as well as textbook authors, rely on procedures that could quickly generate correct answers (Beswick et al, 2012).

1.3.6 Strategies to improve the teaching of decimal fractions

Strategies to improve the teaching of decimal fractions should be tailored around introducing procedural skills in using basic concepts because learners should develop procedural skills in order to understand any mathematical conceptions (Sarwadi & Shahrill, 2014). Therefore, teachers should not emphasise rules, procedures and formulas used to reach exact answers, but they should enhance the teaching of basic concepts to students (Sarwadi & Shahrill, 2014). In support of this idea, Durkin and

Rittle-Johnson (2015) stated that students could master decimals to improve their learning in more advanced mathematics only if teachers could develop strategies that could assist them.

1.4. ROLE OF THEORY IN THE STUDY

This study was guided by Shulman's Theory of Knowledge (1987/1986) because it deals with complexities of teacher understanding and transmission of content knowledge (Shulman, 1986). Shulman's theory proposed the integration of Subject Matter Knowledge and pedagogical knowledge and terms it PCK. This theory is more comprehensive because it focused on content knowledge in teaching, namely: Subject Matter Knowledge (SMK), PCK, and General Pedagogical Knowledge (GPK) (Jankvist, Mosvold, Fauskanger & Jakobsen, 2012; Zhou, Peverly & Xin, 2006). PCK is concerned with the representation and the formulation of concepts in the subject pedagogical techniques and knowledge of students, theories of teaching and learning (Fennema, Carpenter, Jacobs, Franke & Levi, 1998).

Since the study was about the teaching of decimals, this theory was relevant because it deals with teachers and their content knowledge. SMK for example, helped teachers to understand rules and procedures in attempting decimal tasks, and why those rules and procedures were used and on what grounds. PCK would help teachers to understand why particular topics were easy or challenging to learn, for example, decimals, as well as understanding of preconceptions and misconceptions that students have (Shulman, 1986).

The theory claims that those preconceptions were often misconceptions, for example, if 70>7, then 0.70>0.7. This theory further claims that teachers must have information on the strategies that could be used in restructuring understanding of learners. "General pedagogic knowledge includes knowledge of theories and principles of teaching and learning, knowledge of learners, knowledge of principles and techniques of classroom behaviour and management" (Zhou et al., 2006: 439). This theory guided the whole study.

1.5. PURPOSE OF THE STUDY AND THE RESEARCH QUESTIONS

The purpose of this study was to explore the PCK of Grade 6 teachers in the teaching of decimal fractions in Primary schools in the Rakwadu Circuit.

Research Questions

a) What are the Pedagogical Content Knowledge experiences of Grade 6 teachers in the teaching of decimal fractions at primary schools?
b) What is the knowledge of Grade 6 teachers concerning decimal fractions?
c) What are their teaching strategies in the teaching of decimal fractions?

1.6. RESEARCH METHODOLOGY

1.6.1 Research design

This research was located within the interpretivist paradigm to guide the researcher to gain deeper information from the participants in their sites. The methodology used to locate the study in the empirical world was qualitative in nature (Flick, 2015; Lewis, 2015). A case study design was used to get an in-depth understanding of teachers' PCK in the teaching of decimals in Grade 6. Selected teachers were visited and interacted with to get in-depth information.

1.6.2 Sampling

Purposeful sampling was used to select information rich cases linked to the current study (Palinkas, Horwitz, Green, Wisdom, Duan & Hoagwood, 2015). Three primary schools in the Rakwadu Circuit and one Grade 6 mathematics teacher from each of those schools formed part of the sample.

1.6.3 Data collection

The researcher observed Grade 6 classes where learners were taught decimals. The researcher remained a detached observer (see Section 3.6.1.1) in the lesson (Nieuwenhuis, 2012b). Self-planned observation sheet was used (Appendix C). At the end of the observation period, semi-structured interviews with teachers were conducted

(Nieuwenhuis, 2012b). Participants were guided and encouraged to share their experiences and views regarding the teaching of decimal fractions in Grade 6. Interviews were conducted after school and participants were interviewed, audiotaped and brief notes were taken. There were follow-up discussions for accuracy checks. After interviews were conducted, the researcher analysed documents such as teachers' lesson plans and learners' activity books.

1.6.4 Data analysis

The collected data consisted of textual data, mainly transcripts from the interviews with the participants. Tape-recorded interviews were transcribed according to standardised rules (Maimela, Geertruyden, Alberts, Modjadji, Meulemans, Fraeyman & Bastiaens, 2015), and translated into English where necessary. Data were read several times, classified according to categories and saved (Nieuwenhuis, 2012c). Segments of data were coded with descriptive words using inductive coding and categories or themes were established. A diagram was developed to illustrate themes or categories. In other words, inductive thematic analysis was applied (Maimela et al., 2015). Thereafter, bounded conclusions depending on the themes were drawn (Nieuwenhuis, 2012c). In this study, data analysis followed Argyris, Putman and Smith's model (1985, cited in Luneta, 2011).

1.6.5 Quality criteria

Different criteria are used to determine the rigour of qualitative research (Houghton, Casey, Shaw & Murphy, 2013). Amongst others, Lincoln and Guba (1985, cited in Anney, 2014)) identified the following criteria which are mostly used in qualitative research: dependability, confirmability, credibility and transferability (Section 3.8).

To ensure dependability, the participants evaluate the findings, interpretations and recommendations of the study to ensure that they are solely supported by the data collected from participants (Anney, 2014). In addition, the researcher identified the themes with participants to ensure that they are authentic (Maree, 2012:305).

Anney, (2014); Korstjens, & Moser (2018) assert that confirmability concerns the extent to which the findings of the study are confirmed by other researchers. In the current

study, the researcher ensured that the findings were derived from the data collected from the participants in their settings and but not own imagination.

Confirmability was ensured by looking for any data and literature for evidence that disconfirms the findings (Neuman, 2011). The final report of the research process was audited by an auditor (Section 3.8).

Korstjens, & Moser, (2018) maintained that there are strategies which are used to ensure credibility in qualitative research. These are: prolonged engagement, persistent observation, triangulation and member-check. Korstjens, & Moser, (2018) further advised that not all preceding strategies may be suitable in a study. So it is the responsibility of the researcher to determine strategies that will be suitable in a particular study (Section 3.8). Credibility was achieved by spending sufficient time at the research site with Grade 6 teachers to gain their full understanding of the challenges they face in teaching decimal fractions. In addition, an expert was used to support credibility of the findings and participants were allowed to read the transcription of their interviews (Houghton et al., 2013). To ensure transferability, the researcher ensured that the results of this study could be transferred to other contexts using different participants.

1.7. SIGNIFICANCE OF THE STUDY

The study might improve existing and future research in the teaching of decimal fractions in Grade 6 at the Rakwadu Circuit. This study proposed, through its findings, interventions to improve teachers' ability to teach decimal fractions without any difficulties. Teachers might reflect on the findings while teaching. The findings might be able to add to the existing literature pertaining to teachers and could be useful to other stake holders as regards further research. Policy makers would also benefit from the findings of this study.

1.8. ETHICAL CONSIDERATIONS

As this study focused on selection of people and sites and gaining access to people and sites, it involved a wide range of ethical considerations. To begin with, the proposal was

submitted to the University of Limpopo Research Ethics Committee for ethical considerations. Consent to conduct research in primary schools was requested from the Provincial Department of Education. The local circuit office was notified of the approval and of the intention to visit schools. Participants were not exposed to unnecessary physical or psychological harm nor subjected to unusual stress. Informed Consent forms were given to the participants to sign before commencement of the study. Participants were told about discontinuance, that is, they were told that they were free to withdraw from participating in the study any time they felt like doing so without being victimized. Participants' non-betrayal and deception, privacy and anonymity were guaranteed by using pseudonyms and by ensuring them that data collected were confidential to protect their identities and to shield participants from harm (Hammersley & Traianou, 2012). Learners were made aware through their teachers that their classwork and homework books were going to be checked after the observation period.

1.9. CONCLUSION

Chapter one, which is the introduction and background to the study, described the background and motivation of the problem concerning the PCK of teachers in the teaching of decimal fractions. The research problem, the purpose of the study together with the research questions which enlightened the study were also highlighted. A brief discussion of the literature which served as a base to clarify the research questions was also included. In addition, key concepts were clarified (see Section 2.2). Shulman's theory (1987/1986) served as a lens to guide the study.

The next chapters are sequenced as follows; Chapter two describes literature that was reviewed in answering the research questions of this study. Chapter three, which is about methodology, describes the research methodology which was followed to conduct the study. Chapter four, which is discussions, presentation or interpretation of the findings, discusses the findings from data that were collected from participants. Lastly, Chapter five, which is summary, recommendations and conclusions, summarises the findings of the research conducted in the study.

CHAPTER TWO: LITERATURE REVIEW

2.1. INTRODUCTION

Chapter one presented the background and motivation to the study, the research problem, a brief synopsis of the literature review, role of theory in the study, purpose of study and the research questions, research methodology, significance of the study and ethical considerations. Chapter Two presents review of literature which helped to clarify the research questions and to put the problem in its correct perspective. Firstly, concepts used in the study are clarified. Secondly, teacher knowledge in the teaching of decimal fractions is highlighted. Thirdly, difficulties that teachers experience in the teaching of mathematics and misconceptions that were formed in learning decimals are given. Fourthly, strategies that were used in the teaching of decimals are explained. Fifthly, the theoretical framework that guided the study is provided.

Various studies have been conducted concerning teachers' difficulties in the teaching of mathematics, particularly decimal fractions, in primary schools, for example, Beswick et al., (2012); Ubuz and Yayan (2010). Some of the studies found that the problem lied within the teachers themselves (Beswick et al., 2012; Lai & Murrray, 2015; Girit & Akyuz, 2016). The teachers' difficulties in the teaching of mathematics have led to South African schools performing below par in mathematics as compared to poorer neighbouring countries such as Swaziland (Spaull, 2013). As a result, various reasons why learners fail mathematics have been raised.

Among the reasons that cause this high failure rate, PCK of teachers seems to be at the centre of the argument. For example, Depaepe et al., (2015); Lee, Brown and Orrill (2011) postulate that teachers should have knowledge base in mathematics in order to teach rational numbers, particularly decimal fractions. They further propose that teachers should have applicable content knowledge (CK) that is, conceptual knowledge and procedural knowledge concerning the rational numbers as well as PCK (Shulman, 1986). The researcher agrees with the authors because teachers' mathematical knowledge is at the core of effective mathematics teaching.

Some teachers have weak mathematical knowledge and are not comfortable with their own mathematical mistakes (Huillet, Adler & Berger, 2011). Venkat and Adler (2012); and Maher and Muir (2011) concur with Huillet et al. (2011) when they maintain that mathematics teachers in South Africa have insufficient mathematics skills to teach confidently and consequently rely on their procedural knowledge when teaching. Whether this is the case with the teachers in this target group, has not been established. However, other researchers such as Depaepe et al. (2015); Turnuklu and Yesildere (2007); Ball, Thames and Phelps (2008) have a different opinion. They argue that the teachers' procedural knowledge might not be the solution. They believe that teachers' CK and PCK on rational numbers, in particular, decimal fractions, could be the remedy.

In a study conducted by Depaepe et al. (2015), along the lines of Baumert, Kunter, Blum, Brunner, Voss, Jordan et al. (2010), it was found that prospective teachers should have adequate CK in order for their PCK to develop. Teachers' limited CK in their study was validated by the fact that teachers failed to apply algorithms properly when working with decimal fractions. Moreover teachers' limited PCK was clear because they could not foresee learners' misconceptions and that their projected approaches to overcome learners' problems were very procedural (Depaepe et al., 2015). Therefore, the purpose of this chapter is to locate the problem within the existing literature in order to investigate this dilemma.

2.2. CLARIFICATION OF CONCEPTS

This section strives to clarify the key words in the study namely, decimal fractions, conceptual knowledge and PCK. However, the researcher deemed it important to clarify what a fraction is, as well as the types of fractions before clarifying decimal fractions and PCK.

2.2.1 Fractions

According Yssel and Dill (1983, cited in Themane, 2015), a fraction is a representation of a number of equal parts of a whole. Haylock and Cockburn (2008) explain fractions

differently as numbers, positions on the number line or ruler and as the ratio between a part and a whole. Du Toit (2013) view fractions as the set of rational numbers which could be defined as an integer divided by an integer which is not equal to zero. Mamede, Nunes and Bryand (2005) explain fractions in part-whole and quotient situations. The latter claim that in a part-whole situation, the denominator represents the number of parts into which a whole was divided, whereas the numerator represents the number of parts that has been taken. This implies that $\frac{3}{6}$ for example, in a part whole situation mean that a whole such as a pizza was divided into six equal parts and three parts have been taken. Mamede et al., (2005) further assert that, in a quotient situation, the denominator indicates the number of receivers, while the numerator indicates the number of items being shared. As an example, in $\frac{3}{6}$, it suggests that 3 parts of a whole (for instance, 3 pieces of pizza) were shared among six people.

Fractions could be written in different ways, for example, half of an object can be written as: a common fraction ($\frac{1}{2}$), a decimal (0.5) or a percentage (50%) (Lortie-Forgues et al., 2015). Fractions consist of three parts, which are, namely: a numerator, which shows the number of parts in a whole; a vinculum, which is a separating line; and a denominator, which indicates the number of equal parts in a whole (Lortie-Forgues et al., 2015). This composition makes fraction notation awkward to understand. However, the knowledge of the key concepts of fractions can assist in understanding other important topics such as algebraic operations and other kinds of numbers, including decimals in this case (Hoon, Yaakob & Singh, 2016).

2.2.1.1 Types of fractions

There are different types of fractions in mathematics. For instance: proper fractions whereby the numerator is less than the denominator, for example, $\frac{1}{2}$, $\frac{12}{27}$ or $\frac{10}{100}$; improper fractions where the numerator is greater than the denominator, for example, $\frac{9}{5}$ or $\frac{29}{11}$ and mixed fractions, which consist of a whole number plus a fraction, for example, $3\frac{1}{2}$ or $4\frac{4}{8}$ (Themane, 2015).

2.2.2 Decimal fractions

According to Zhang et al. (2013), a decimal fraction is a non-symbolic form of fractions which is noticeably written with a decimal point (decimal comma as renowned in Indonesia) (Widjaja, Stacey & Steinle, 2011) and it is without a denominator. For example, 9.0 and 0.13 are decimals whilst 9 and $\frac{13}{100}$ are not decimals. This implies that decimal fractions are a representation of a fraction. For example, 0.5 (decimal fraction) has the same value as $\frac{1}{2}$ (fraction).

Additionally, Lortie-Forgues et al. (2015); and Mohamed (2015) define decimal fractions as rational numbers expressed in base-ten notation. In simpler words, they are fractions whose denominator is a power of 10 and its numerator is indicated by digits to the right of a dot (decimal point). It means that a decimal fraction is a form of a number using a decimal point. This suggests that a decimal with a single digit behind a point is a fraction with a denominator of 10, for example, $\frac{5}{10}$ written as 0.5 whereas a decimal fraction containing two digits behind a point is a fraction with a denominator of 100, for example, $\frac{32}{100}$ written as 0.32 (Lortie-Forgues et al., 2015). The study adopted the latter as it is easier to work with fractions with a decimal point, especially when working with operations such as addition and multiplication. For example, it is easy to calculate 0.5 + 0.7 than adding $\frac{1}{2} + \frac{7}{10}$ which entails consideration of Lowest Common Multiple (LCM).

2.2.3 Conceptual knowledge

Isiksal and Cakiroglu (2011) maintain that conceptual knowledge is knowledge that enables teachers to respond to learners' questions concerning the meaning behind symbolic manipulations to address concepts relationships and to clarify why particular procedures operate whilst others do not. This is a kind of knowledge that is rich in relationships, which is a prerequisite for effective teaching and learning in the classrooms. This knowledge enables meaningful learning to prevail in the classrooms (Hiebert & Lefrere, 1986, in Themane, 2015). Teachers are therefore supposed to

understand the aim of teaching a specific mathematical content and how it should be developed (Proctor, 2019).

2.2.4 Pedagogical content knowledge

According to Park and Oliver (2008), PCK is the transformation of Subject Matter Knowledge used mainly for the purpose of teaching. They further maintain that PCK signifies teachers' understanding and their way of helping a group of learners understand particular subject matter using various strategies, representations, and assessments. Shulman (1986), on the other hand, defined PCK as the knowledge which teachers require to teach a particular content to learners. Gess-Newsome, Taylor, Carlson, Gardner, Wilson, and Stuhlsatz, (2019) further explain PCK as the knowledge base that locate the teacher knowledge within the teaching of a particular subject. Furthermore, Rollnick, Davidowitz & Portgieter (2017), explain PCK as the knowledge special to teachers which is supported by content knowledge.

Having highlighted on what conceptual knowledge and pedagogical knowledge mean, the next section discusses these kind of knowledge needed by teachers to teach decimal fractions effectively. It is important to understand this kind of knowledge to locate the study within its appropriate perspective.

2.3 TEACHER KNOWLEDGE IN THE TEACHING OF MATHEMATICS

Teaching focuses on helping others to grow academically. Teachers are therefore expected to know a handful of things to enhance effective teaching: concerning teaching, learners, the cultural, and political as well as the social context in which they work (Isiksal & Cakiroglu, 2011). Mosvold and Fauskanger (2014), further posit that teachers should be familiar with the mathematics knowledge to ensure that learners are taught the correct mathematical concepts. Research has revealed that mathematics teachers in South Africa have inadequate content knowledge needed to teach mathematics, particularly in Grade 6, and learners' performance is affected (Bansilal, 2012; Venkat & Spaull, 2015). Bartell et al. (2013); Mosvold & Hoover. (2017) posit that

teachers require a specific kind of knowledge to teach mathematics for conceptual understanding, because teaching mathematics is complex. Pitjeng-Mosabala, & Rollnick, (2018) assert that South African teachers are challenged with regard to content knowledge. Therefore Pitjeng-Mosabala, & Rollnick, (2018) advised that teachers need to know the subject matter they are assigned to teach

Ball et al. (2008); Cole (2012); Jakobsen and Mosvold ([Sa]:115); Kazima, Pillay and Adler (2008); Lee et al. (2011), also support that teachers need a kind of knowledge which is special for mathematics teachers to teach effectively. Nisbet (2015), drawing on Shulman (1986), proposed that teachers are required to know why particular topics are important to a subject and why others are considered insignificant.

It has been shown in various studies that teachers' inadequate knowledge affects them drastically. For example, the reality of teachers' unproductive efforts is revealed in tests offered by Trends in International Mathematics and Science Study (TIMMS) (Reddy, Prinsloo, Arends, Visser, Winnaar, Feza & Ngema, 2012); Southern Africa Consortium for Monitoring Educational Quality (SACMEQ) (Chetty & Moloi, 2011); Spaull, 2011, Venkat & Spaull, 2015); National Science and Education Standard (NSES) (Taylor, 2011; and Taylor, Van der Berg & Mabogoane, 2013); and the Department of Basic Education, (2014, 2013, 2012). For example, of the 401 South African primary mathematics teachers who participated in SACMEQ lll of 2007, 79% of them displayed content knowledge below Grades 6/7 band. Some of Grade 6 learners outperformed a number of teachers who also participated in SACMEQ III (Spaull, 2013). This study revealed that quite a number of Grade 6 mathematics teachers based in poor and rural communities that are from quintiles 1, 2 and 3 schools had lower fundamental level of CK and PCK alike.

Teachers' conceptual knowledge might be associated with their basic understanding of mathematics. To support this, Bethany and Wagner (1999, cited in Themane, 2015), maintained that it is the conceptual knowledge that offers a platform for understanding of basic principles in solving problems. Isiksal and Cakiroglu (2011) further postulate that teachers with good conceptual knowledge are less challenged in responding to

learners' questions concerning the meaning behind symbolic manipulations, in addressing conceptual' relationships and in clarifying why particular procedures operate whilst others do not.

Kleickmann, Richter, Kunter, Elsner, Besser, Krauss and Baumert (2013) also maintain that the extent of the teacher's conceptual understanding of the particular content will give room for the development of PCK. This appears to be a useful idea because teachers will be able to assist learners in understanding for instance that properties of whole numbers are not always applicable to decimal fractions. This shows that for teachers to teach decimal fractions effectively, they should have a clear understanding of decimal fractions.

In addition, Fazio and Siegler (2011) maintained that teachers' profound understanding of fraction concepts was required in order to be able to use visual representations such as diagrams, number lines etc., excellently in the classrooms. This would assist teachers to develop conceptual knowledge to understand decimal fractions and to be aware of difficulties resulting in using such visual representations. If teachers lack conceptual knowledge, it might be a challenge for them to teach fractions, which offers a basis in problem solving as they continue studying mathematics (Shulman, 1986). In addition, the danger of transferring their misconceptions to learners will be very high (Whitacre & Nickerson (2016). This implies that poor understanding of fractions, including decimals, will have severe long-term consequences on academic and occupational success (Jordan et al., 2013; Lortie-Forgues et al., 2015).

Some of mathematics teachers in South Africa lack basic understanding of mathematics (Venkat & Spaull, 2015). In this regard, such teachers struggle to understand the content that is to be conveyed to learners. Their confidence and the quantity of work in class are drastically affected. This authenticates that most of mathematics teachers in South Africa have inadequate fundamental levels of content knowledge and lack understanding of basic mathematics needed for teaching (Whitacre & Nickerson, 2016).

The problem appears to be explicit among Grade 6 mathematics teachers, especially

when teaching decimal fractions. Poor knowledge of teachers in mathematics is also revealed in the way they teach. In support of this, Sapire and Sorto (2012) attest that South African teachers rarely engaged learners in hands-on activities and slightly emphasised engaging discussions. This implies that their lessons merely focused on transferring information but with no intentions of assisting learners in learning specific items (Sapire & Sorto, 2012). For example, teachers place emphasis on memorisation of rules and procedures because they lack knowledge that is to be transferred to learners and because teachers did not want to be exposed to questions about concepts that they will fail to answer (Lortie-Forgues et al., 2015). It seems that teachers are challenged in imparting what they are not familiar with which reveals lack of knowledge. It seems that teachers are challenged in imparting what they are not familiar with, which reveals lack of knowledge.

2.3.1 Teachers' pedagogical content knowledge

The concept of PCK has been theorized as the knowledge used by teachers in the teaching of learners. This knowledge has been investigated in various field of study, notably mathematics (Chick, & Beswick, 2018). It is significant to explore the PCK of Grade 6 mathematics teachers because they play the most important role in developing complete understanding of learners with regard to decimal fractions. The term PCK was first used in the Shulman's Presidential address (1986) and in the related Harvard Education Review article (Shulman, 1987). Shulman identified three different kinds of knowledge, namely: content knowledge (CK), PCK and curricular knowledge. According to Shulman (1987/ 1986), CK refers to knowledge of a particular subject matter that the teacher is supposed to have in order to teach effectively. That is, the teacher's deep understanding of the subject matter that is to be taught (Kleickmann et al., 2013). For example, knowledge of History. Lemonidis, Tsakiridou, & Meliopoulou, (2018) posit that teachers' CK in rational numbers including decimals, influence the PCK of working with the rational numbers.

According to Shulman (1987/ 1986) PCK is the knowledge of how a teacher teaches a particular content, whilst curricular knowledge, is the knowledge that enables a teacher

to understand curriculum that is to be taught. This includes knowledge of various instructional materials related to a particular curriculum (Shulman, 1986). Amongst the three kind of knowledge, Shulman (1987/1986) view PCK as the most fundamental knowledge for effective teaching. PCK has since been used by various researchers, for example, in various professions as well as in a range of subjects such as science, mathematics, English and many more (Ball et al., 2008).

Other scholars also consider PCK to be important and different from knowledge possessed by others not teaching mathematics (Baumert et.al. 2010; Fauskanger, Jakobsen, Mosvold & Bjuland, 2012; Lee, 2010). Kleickmann et al., (2013); Delaney, Ball, Hill, Schilling and Zopf (2008), in line with Shulman, (1987/1986) attest that PCK is a kind of knowledge that teachers need in order make the subject matter accessible to learners. More specifically, PCK entails the knowledge that is utilised by teachers in interpreting specific subject matter to learners while considering their conceptions or misconceptions (Depaepe, Kelchtermans & Verschaffel, 2013; Shulman, 1986).

In addition, it is this knowledge that enables teachers, for example, to teach mathematics (Lee, 2010) and to apply in teaching (Depaepe et al., 2013) decimal fractions to Grade 6 learners; to develop and choose appropriate tasks relevant for their learners; examine learners' understanding and to analyse learners' mistakes and difficulties (Baumert et al., 2010; Du Toit, 2013). Furthermore, PCK enables teachers to change and reorganise the content knowledge in such a way that it becomes easily comprehended by learners (Bertram, 2011; Isiksal & Cakiroglu, 2011).

This suggests that if Grade 6 teachers could teach, for example, addition or ordering of decimal fractions effectively and in an understandable way to their learners that will constitute the optimization of teacher's PCK in relation to teaching mathematical concepts of addition and ordering of decimal fractions in Grade 6 (Lee, 2010). Lack of such knowledge has an impact on learners' performance in mathematics. Baumert, et al (2010) support this idea, drawing from the data collected on database from a longitudinal extension to the 2003 cycle of the Organization for Economic Cooperation

and Development's (OECD) Programme for International Student Assessment (PISA) in Germany. They maintain that PCK affects teachers in teaching mathematics (Baumert et al., 2010).

Shulman (1987) further highlighted that teachers need to have a diverse understanding of concepts to be communicated to learners, for example, pictorial representation of concepts, and how such concepts correlate with other concepts within and outside the subject (Du Toit, 2013). Molebale (2005) further advises that teachers should use multiple representations of fractions, and strongly discourage the use of only examples that depict the part region interpretation of the fraction concept whereby only pictorial representation of fractions is used. This has a negative impact on learners' future mathematics knowledge in general and understanding of fraction concepts in particular. Learners' ability at problem solving, especially in decimal fractions become very limited. This habitual practice by most teachers, display their poor PCK in the teaching of decimal fractions. This study therefore sought to explore the PCK of Grade 6 teachers to enrich learners' conceptual understanding of decimal fractions beyond pictorial representations.

An example of the most commonly used pictorial representation of fractions, particularly in decimal fractions, is depicted in the use of $\frac{1}{2}$ for fraction which is equivalent to 0.5 (which is made of five pieces of 0.1 each) for decimal fraction. This means that $\frac{1}{2}$ is equivalent to 0.5. Whether this is the case with the target group it is not clear, hence the need for this study. For teachers to enhance their PCK, they also require to go through pedagogical reasoning and actions (Shulman, 1987:14), for example:

- Comprehension of the subject matter whereby teachers are expected to understand what is to be imparted to learners in different manners. The current study sought to understand how Grade 6 teachers comprehend and teach decimal fractions (see, Section 1.5).
- Transformation of comprehended ideas, which involves critical interpretation and preparation of a particular text according to teacher's own understanding. The

study tried to find out if target teachers in Grade 6 could represent the ideas in the form of analogies, examples, illustrations, et cetera, by choosing from a diversity of teaching methods and models. Learners are from diverse backgrounds, so are their needs. Mathematics teachers may adapt the representations to learners' diverse characteristics such as learners' abilities, gender, prior knowledge and so forth.

- Instruction, which encompasses most aspects of pedagogy, namely: arranging and managing the classroom; allocating and examining work; and associating with learners through questioning and probing coupled with praise and criticism. This embraces management, explanations, discussions and all features of effective teaching.
- Evaluation which entails checking for understanding and misunderstanding that teachers use while teaching interactively. For example, through formal testing and evaluation that teachers do to provide feedback and to check learners understanding. This calls for use of PCK.
- Reflection which includes looking back at what transpired during effective teaching whereby teachers' own performance and of learners is critically analysed. This also entails usage of a particular kind of knowledge.

On these bases, it is important to examine teachers' knowledge as regard to teaching mathematics, particularly decimal fractions, and to check if their knowledge affects their teaching. Shulman's (1986) work on PCK generated countless studies in knowledge for teaching in various content areas (Gess-Newsome, Taylor, Carlson, Gardner., Wilson, & Stuhlsatz, 2019; Olanoff, Lo & Tobias, 2014), a handful of which aimed on teacher's knowledge of mathematics. For example, Ball et al. (2008) in a similar line of research at the University of Michigan initiated a body of knowledge, which was based on Shulman's categories of knowledge. They named this, Mathematical Knowledge for Teaching (MKT) which is an extension of PCK (Du Toit, 2013). Such knowledge was exclusively suitable for mathematics teachers and looked at the work done by teachers.

Ball et al. (2008) aver that Shulman's (1987/1986) Subject Matter Knowledge base consists of three domains. First, Common Content Knowledge (CCK), which refers to mathematical knowledge that should be familiar to all teachers. Second, Specialised

Content Knowledge (SCK) referring to the knowledge of mathematics content specific to mathematics teachers. In support of this idea, Lee et al. (2011) postulate that teachers with resilient specialised knowledge would be able to interpret learners' work and assist where necessary. Third, horizon content knowledge, one category of MKT (Mosvold & Fauskanger, 2014), entails the understanding of how diverse mathematical topics, including decimal, are associated (Olanoff et al., 2014). Besides Specialised Content Knowledge, Ball et al.(2008) attest that there is also Common Content Knowledge that could be used by anyone in solving a specific mathematical problem (Baumert et al., 2010; Delaney et al., 2008; Jakobsen & Mosvold, [Sa]: 116)[1].

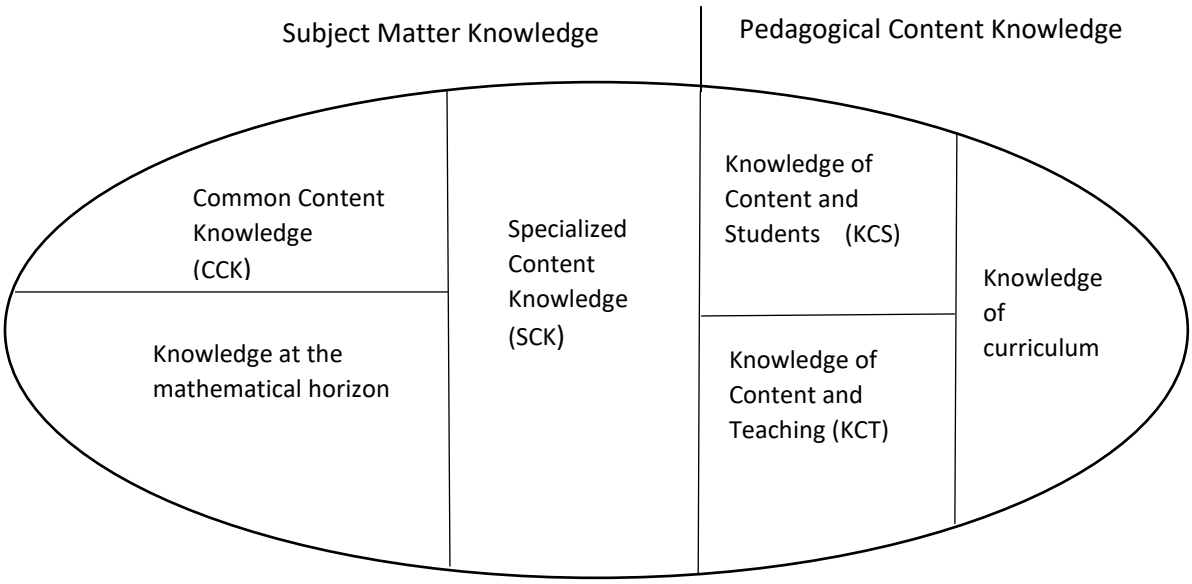
Likewise, PCK is also broken into three categories, namely, Knowledge of Content and Student (KCS), which is about understanding how learners are associated with various topics; Knowledge of Content and Teaching (KCT), which entails the ordering of topics and the use of representations; and knowledge of the curriculum at large (Drake, Land & Tyminski, 2014; Ng, 2012). This PCK is knowledge of how to assist learners to comprehend mathematical concepts, that is, in this study, it entails knowledge of how mathematics teachers interpret and transfer decimals to learners in a comprehensible way (Lee, 2010). Ball et al. (2008) equally view the two subdomains of PCK, which are, namely: Knowledge of Content and Students (KCS) and Knowledge of Content and Teaching (KCT) as well as the Specialised Content Knowledge needed by mathematics teachers as very crucial.

PCK along with MKT assist teachers in recognising and becoming aware of why particular topics, in this, study decimal fractions, are easy or difficult to learn. Furthermore, PCK will aid teachers to spot the conceptions, preconceptions as well as perceiving the misconceptions that are coupled with them (Nisbet, 2015), thus representing and expressing them in such a way that they are easily conceptualised by the learners (Izsák, 2008). This implies that teachers need to possess a variety of strategies derived from both investigations and knowledge to supply learners with clarifications (Nisbet, 2015). Ball et al. (2008) further attested that the Specialised

[1] [Sa] is the abbreviation for "Sine anno" which means that the year of publication is not known

Content Knowledge is an area of MKT that is distinctive for teaching mathematics and is not needed in other occupations that use mathematics. Proctor (2019), asserts that MKT is related to learners achievement.

Furthermore, Ball et al. (2008) contributed a lot in mathematics teaching because they developed measures to assess teachers' MKT, which are widely used to date in various countries (Jakobsen & Mosvold, [Sa]:116). These MKT measures had since been adapted and used in various countries (Fauskanger et al., 2012; Mosvold, Fauskanger, Jakobsen & Melhus, 2009). For example, in Norway (Fauskanger et al., 2012; Fauskanger & Mosvold 2010; Mosvold et al., 2009), in Indonesia (Ng, 2012); in Ghana (Cole, 2012); in South Korea (Kwon, Thames & Pang, 2012) and in Ireland (Delaney et al., 2008). Jakobsen and Mosvold,([Sa]: 116) claimed that MKT measures were modified and endorsed in the countries that are listed in order to detect Mathematical Knowledge for Teaching among educators.



Source: Adopted from Ball, Thames and Phelps (2008: 403)

Figure 2.1: Domains of MKT Measures

Figure 2.1 indicates the Ball et al.'s (2008) MKT measures that were modified and used in various countries for effective teaching. These additional domains are also important as they contribute to effective teaching of fractions.

In South Africa, the introduction of Annual National Assessment (ANA) was thought to be of help in reducing learning gaps and in developing potential of all children from diverse background (Van der Berg, 2015). Even though the Department of Basic Education in South Africa introduced (ANA) as a measure for monitoring progress in reading and mathematics in Grade 1 to 6 and Grade 9, Grade 6 learners still perform below par as compared to other African countries (Department of Basic Education, 2014). Less progress was pronounced in destitute circuits such as Rakwadu in the Limpopo Province. This was revealed in Grade 6 mathematics ANA results where learners in Limpopo performed poorly in mathematics when compared to other provinces (Department of Basic Education, 2014). The planned 2015 ANA tests initially planned for 15/16 September 2015 to further assess Grade 1 to 6 and Grade 9 learners' performance in mathematics and English were not administered after negotiations with various teacher's organizations in South Africa (www.news 24.com./southafrica).
This dire situation indicated that South African Grade 6 rural mathematics teachers have inadequate CK and PCK alike when compared to rural Grade 6 mathematics teachers in Swaziland, Tanzania, Uganda and Kenya (Spaull, 2013). It shows that in order to advance learners' progress in impoverished and rural areas, mathematics teachers' CK and subsequently their PCK should be developed first (Spaull,2013).

Table 2.1 highlights ANA results from 2012 to 2014 as the last ANA tests in South Africa were administered in 2014. The percentage of learners attaining acceptable achievement levels in Universal ANA varied across provinces from 21.3% for Limpopo to 51.7% for Gauteng (Department of Basic Education, 2014). These results could be associated with teachers' lack of PCK which affects learners' performance drastically. It shows that much attention is not yet given to the teaching of mathematics by Grade 6 teachers.

Table 2.1: Achievement in Grade 6 Mathematics in the Nine Provinces of South Africa from 2012 to 2014

PROVINCE	ACCEPTABLE ACHIEVEMENT ≥ 50%			
			2014	
	2012	2013	Universal	Verification
Eastern Cape	8.1	16.2	23.3	22.0
Free State	11.7	26.5	44.0	41.0
Gauteng	16.4	38.4	51.7	53.1
Kwazulu Natal	11.8	30.4	36.4	31.4
Limpopo	**4.6**	**15.3**	**21.3**	**15.9**
Mpumalanga	5.7	16.1	27.0	27.1
Northern Cape	7.6	20.5	28.2	24.4
North West	7.1	20.8	26.6	20.0
Western Cape	19.9	37.7	50.9	44.9
National	10.6	26.5	35.4	32.4

Source: Adopted from the Department of Basic Education, (2014).

Disparities in performance with regard to mathematics in Grade 6 was also evident among Districts in Limpopo in ANA 2014, Mopani District, 48.3% and Vhembe, 52.4% (Department of Basic Education, 2014). The results could be further associated with Phurutse's (2005) finding that teachers in Limpopo Province demonstrate poor content and conceptual knowledge as regards to mathematics and English. This questions the teachers' knowledge in teaching mathematics, which calls for examination of their PCK. It shows that, to be able to teach mathematics effectively, and decimal fractions in particular, teachers need conceptual mathematics knowledge.

2.3.2 Sources for the development of PCK

Kind, & Chan, (2019), maintained that teachers acquire PCK from a range of sources. This involves, their past experiences as learners, copying from experienced teachers and engaging in discussions with colleagues. Friedrichsen, Abell, Pareja, Brown, Lankford and Volkmann (2009) drawing from the work of Grossman (1990), further posit that teachers acquire their knowledge of subject matter from sources such as: (i) teachers' own learning experiences, (ii) teacher education and professional development programmes, and (iii) teaching experiences.

2.3.2.1 Teacher's own learning experience

Teachers can acquire CK and PCK informally during their schooling years by observing their own teachers before entering the teaching profession, that is, informal learning by experience (Kleickmann et al., 2013; Patrick, 2010). The study therefore sought to investigate if what teachers have learnt during their school years could contribute in assisting them in teaching decimal fractions to Grade 6 learners.

2.3.2.2 Teacher education and development programmes

Furthermore, teachers can acquire their PCK by purposefully attending formal institutions such as colleges of education with the intention of getting qualifications (Patrick, 2010) or by attending seminars and workshops. However, teachers' participation in such workshops does not automatically imply that they had acquired new knowledge or improved their teaching (Bertram, 2011). Therefore, the implication for this study on this is that teachers should be continuously taught how to gain deep conceptual knowledge during their professional development programs.

2.3.2.3 Teaching experience

PCK can be acquired through one's teaching years within peer groups of teachers by engaging in talks and through working together with colleagues. For example, in cluster meetings. (Kleickmann et al., 2013; Patrick, 2010). However, teaching experience could not be perceived as a factor in improving decimal knowledge because some teachers with many years teaching experience might still be challenged in teaching decimals (Girit & Akyuz, 2016).

The sources from which teachers can acquire their PCK have been examined. Lack of PCK in the teaching of decimals often leads to difficulties in teaching them (decimals), which often leads to formation of errors and misconception among learners. The next section therefore sought to highlight difficulties that teachers experience in teaching mathematics, in particular, decimal fractions. Besides, misconceptions and errors (mistakes) relating to decimals will also be highlighted.

2.4 DIFFICULTIES IN THE TEACHING OF DECIMAL FRACTIONS

Teaching fractions, including decimals or even finding the correct and proper representations, can be very challenging for mathematics teachers. These are among the reasons that habitually make teachers resort to choosing and giving learners tasks with procedural applications as they personally have inadequate understanding of decimal fractions. This idea is supported by previous studies which claim that teachers would only select or execute tasks that match up their subject matter, curriculum and pedagogical knowledge of the topic (Charalambous & Pitta-Pitanzi, 2005)

Teaching and learning fractions, in particular, decimal fractions, in primary schools is problematic Barmby, 2009; Leung, 2009). Bailey, Zhou, Zhang, Cui, Fuchs, Jordan, Gersten, Siegler (2015); Torbeyns, Schneider, Xin & Siegler (2015) also support that difficulties in mathematics start earlier in primary school mathematics. The difficulty habitually stems from teachers themselves (Coetzee & Mammen, 2017). The source of these problems appeared to be weak understanding of place value units and link between units (Kastberg & Morton, 2014); reading scale, ordering numbers, finding the nearest decimal and doing operations like adding and subtracting (Girit & Akyuz, 2016). Problems that primary teachers experience regarding decimals are similar to those faced by learners and pre-service teachers (Muir & Livy, 2012; Ubuz & Yayan, 2010). Torbeyns, et al. (2015) maintained that difficulties with fractions are also popular among teachers in other countries. Consequently, the need for this problem to be treated urgently to avoid this problem to be carried to the upcoming generation. Hence this study.

Ubuz and Yayan (2010) further attest that teachers' difficulties in teaching decimals might be revealed in various ways, for example; failure to understand the place value of decimals or in ordering decimals with diverse number of digits as compared to ordering decimals with the same number of digits. Numerous causes are ascribed to this. For instance, teacher quality, societal attitudes towards mathematics, language of learning and teaching etc. (Joubert, [Sa]).

It is for these reasons that teaching is focused on how to get accurate responses using rules, procedures or formulas rather than why procedures work (Isiksal & Cakiroglu, 2011; Sarwadi & Shahrill, 2014) and they firmly rely on their lesson designs (Isiksal & Cakiroglu, 2011). This study therefore sought to understand if the same sources would be applicable to the teachers in this case.

In addition, Sarwadi and Shahrill (2014) further attested that teachers concentrated a lot on emphasising rules through drills and exercises, rather than first teaching learners' fundamental mathematical concepts. Beswick et al. (2012) corroborated with them and postulated that teachers as well as textbook authors relied on procedures that could quickly generate correct answers. If teachers embarked on teaching procedural skills before teaching mathematical contents, learners' learning would be ruined and they would lack mathematical skills for future use (Sarwadi & Shahrill, 2014).

A teacher who banks on such teaching will be displaying poor comprehension of fraction and decimal arithmetic. Muzheve and Capraro (2012) attested that primary teachers experienced flaws in comprehending concepts on place value, working with fractions, multiplication of decimal fractions, percentages, and measurement. These problems were correlated to how fractions were represented as numbers and the manner in which they were denoted as diagrams or pictures (Barmby, 2009). To lessen this problem, Barmby (2009) proposed that learners should be introduced to the number concepts earlier than fractions since fractions, including decimal fractions, were originally not considered as numbers. Difficulty in the teaching of decimals could be attributed to the misconceptions attached to decimal fractions. The next section discusses misconceptions in both learners and teachers with regard to decimal fractions.

2.4.1 Misconceptions in teaching and learning of decimal fractions

Bush and Karp (2013) view misconceptions as familiar mistakes made associated with decimals. Swan (2001, cited in Luneta, 2015) maintained that misconceptions occur because they are viewed as a natural stage of conceptual development. Isiksal and

Cakiroglu (2011) state that misconceptions signify the misinterpretation and misapprehension of terms, concepts as well as procedures whilst solving problems. Aksu & Kul (2016); Rollnick, Davidowitz and Potgieter (2017) researched on mathematics teachers' PCK and found that teachers lacked PCK in correcting the errors and misconceptions in learners. Misconceptions could arise when learners try to understand what is being taught. For example, learners erroneously apply rules to solve problems. At times, misconceptions are formed if fractions, particularly decimals, are not recognised as numbers.

Swan (2002, cited in Themane, 2015), argues that misconceptions need to be made explicit, discussed and corrected, instead of being ignored. Taken this way, misconceptions will assist learners to develop positive self-concept and to see their mistakes as a valued way of effective learning. This will improve learners understanding and make them feel valuable to their peers and teachers. For effective teaching and meaningful learning to take place, teachers and learners are advised to expose their misconceptions and mistakes. Failure to do so, misconceptions will be prolonged whereas learners' thinking might be challenged or they (learners) might even be discouraged to ask questions (Luneta & Makonye, 2010).

Teachers are therefore advised to allow learners to share their problems and mistakes with their peers and to explore why misconceptions and mistakes were made (Luneta & Makonye, 2010). Themane (2015) advised that teachers should refrain from giving learners complicated activities or ready-made activities that challenge their (learners') understanding. This suggests that, to reduce formation of misconceptions and mistakes made by learners, teachers should avoid giving learners activities that they (teachers) are not sure of. Teachers should be skilful in this regard. This suggests that teachers are expected to realise and identify learners' misconceptions earlier and to be able to assist them (Ball et al., 2008; Mdaka, 2011). The subsequent paragraphs highlight an exposition of various examples of common misconceptions and mistakes as shown by different authorities in the teaching and learning of decimal fractions.

Misconceptions can manifest themselves among learners and teachers in various forms. For example, Vamvakoussi and Vosniadou (2010) underscored that learners develop misconceptions when trying to incorporate current knowledge with recent information, before experiencing deep conceptual change. In support of this, DeWolf and Vosniadou (2015) maintain that learners have common and continued misconceptions concerning decimal magnitudes. For example, overgeneralising their experiences in whole numbers to decimal fractions because concepts are not modified or accommodated to decimals (Ubuz & Yayan, 2010; Durkin & Rittle-Johnson, 2015; Isiksal & Cakiroglu, 2011).

Misconceptions also arise when learners think that adding zero at the far end of decimal fraction would change it to be large, 0.6<0.600 (Huber, Klein, Willmes, Nuerk & Moeller, 2014). Ubuz and Yayan (2010) further attest that misconceptions could be formed when learners attempt to handle the unusual numbers (decimals) the way decimals look like as they are uncertain of their meaning. Misconceptions of decimal fractions could lead to problems in learning decimals which are associated with the meaning and place value of decimals (Ubuz & Yayan, 2010). According to Ubuz and Yayan (2010), such problems are displayed in:

One; ordering decimals, for example, incorrectly ordering 0.02, 0.38 and 0.1 increasingly as 0.1, 0.02 and 0.38. Ordering decimals seemed to be challenging than merely comparing two decimals (Kastberg & Morton, 2014). Two; scale reading, for instance, failing to write a decimal for the given location between numbers on the number line (Widjaja, Stacey & Steinle, 2011). Three; getting the nearest decimals, for example, choosing 30 instead of 0.3 from a given set of decimals: 0.2, 0.3, 0.02 and 30 as the nearest decimal to 0.29 because of ignoring the zero. Four; addition and subtraction of decimals, for example, adding or subtracting from the very last digit after the comma irrespective of the place value, for instance, writing the difference between 25.875 and 0.3 as 25.872 instead of 25.572 or adding 25.875 and 0.3 as 25.878 instead of 26.175.

Furthermore, Ubuz and Yayan (2010) argued that problems related to ordering decimals and getting the nearest decimals could be clarified using three implied and inaccurate rules. One, “select as smaller the number whose decimal part is the smaller whole number”, for example, 0.10>0.5 (because 10 is bigger than 5). This is the most habitually used rule and denotes inaccurate knowledge of decimals (Ubuz & Yayan, 2010) and inappropriate insight about fundamental meaning of decimal numbers, specifically in comparing amongst decimals (Mohamed, 2015); two, ‘select as smaller the number that contains more numbers in its decimal section’ that is regarding longer decimals to be smaller as they have smaller parts (e.g., Durkin & Rittle-Johnson, 2015; Widjaja, et al., 2011), for example,0.895 should be less than 0.6 since thousandths are smaller than tenths.

This is inconsistent with the findings of the study by Van de Walle, Karp and Bay-Williams (2010), which posit that the longer decimals had longer value, e.g., 0.562 is larger than 0.58. Three, ‘select as smaller the decimal that contains a zero directly after the decimal point’. This is inconsistent with the study by Durkin and Rittle-Johnson (2015); Desmet, Gregoire, and Mussolin (2010) that highlighted that ‘zero’ at the tenths place of a given decimal fraction does not make any changes in value when compared to a decimal fraction with no zero in its tenth decimal place (e.g., 0.099 is the same as 0.99).

Primary mathematics teachers equally experience similar problems to those faced by learners and pre-service teachers (Girit & Akyuz, 2016; Ubuz & Yayan, 2010). On that note, researchers had been interested in recognising misconceptions by teachers as the basis of learners’ flawed reasoning (Kastberg & Morton, 2014). Teachers’ misconceptions and disintegrated knowledge limit them to respond to learners’ conceptions or to establish cognitively stimulating learning environment (Lange, Kleickmann & Moller, 2010). According to the study conducted by Ubuz and Yayan (2010), such problems were similarly displayed in the following:

Firstly, in scale reading, whereby a substantial number of primary mathematics teachers experienced problems in comprehending the nature of decimal fractions. Problems related to reading scale were displayed in various ways, for example, one; failure to write down a decimal for a specified position on a number line. Two; failure to conceptualise the complexity of decimals. Three; failure to differentiate the properties and nature of decimals from those of whole numbers. For example, the fact that when 'zero' is added to the right end of a whole number changes its value (8≠80), will also apply to decimals (0.8≠0.80) (Lortie-Forgues et al., 2015).

This suggested that teachers experienced problems with equivalent representations since they failed to understand that 0.8 is similar to 0.80 or to 0.800 (Bush & Karp, 2013; Kastberg & Morton, 2014) or to see decimals as composites of units. Four; tendency to ignore the digits behind the decimal point. Five; challenges in reading scale when subunits were based differently other than on base 10. The cited complexities revealed that several teachers had a shallow understanding of the meaning of decimals when reading scales.

Secondly, teachers' misconceptions were also revealed in addition and subtraction with decimals. This indicated that teachers were challenged when working with subtraction of decimals that required borrowings (for example, failing to give the difference between 0.728 and 0.599 as 0.129 or with addition of decimals that required carryings for example failing to give the sum of 0.728 and 0.599 as 1.327). In addition, teachers ignored or construed the decimal point as being a separator whilst adding or subtracting decimals (Ubuz & Yayan, 2010).

Thirdly, misconceptions in teachers were additionally displayed in ordering of decimals. Primary mathematics teachers appeared to be practising the second rule by regarding the number that has more digits in its decimal part to be smaller (Ubuz & Yayan, 2010). One; unsuitably linking the value of decimal with the length of the decimal when ordering decimals with diverse number of decimal places (for example, selecting 0.3 as bigger than 0.45 and 0.09). Two; considering the decimal fraction with short decimal

places to have larger value (for example, Bush & Karp, 2013; Ubuz & Yayan, 2010) that is, “the shorter is larger” misconceptions (Widjaja et al., 2011). For example, ordering 0.394, 0.2, 0.95, 0.63 from smallest to biggest as 0.394, 0.95, 0.63, 0.2. or taking 0.8 (the decimal referred to as a ‘shorter number’ to be larger than 0.888, the ‘longer number’) for various reasons:

First, using the ‘denominator centred thinking’ for example, a decimal number like ‘0.666’ could be regarded as 666 thousandths whilst 0.6 as 6 tenths. Widjaja et al., (2011) further attested that over generalising that 1 tenth is bigger than 1 thousandth, might result in absolute generalisations such as considering all decimal numbers with 3 decimal places, that is, thousandths (e.g., 0.666) to be smaller than all decimal numbers with one decimal place, that is, tenths (e.g., 0.6).

Second, using the reciprocal thinking allied with various incorrect connections amongst decimal and fractions. For example, considering 0.6 to be the same as 6. That is, a whole (a loaf of bread) divided into 6 equal slices whereas 0.666 imply cutting the whole (bread) into several small pieces. On this base, some teachers thought that a number such as 0.666 was too small as compared to 0.6 (Widjaja et al., 2011). Teachers undoubtedly ignored the decimal point. For example, ordering 3.8, 0.19, 0.15 and 0.55 (from smallest to biggest) as 15, 19, 38 and 55. This implied that ordering decimal numbers that had dissimilar number of digits (Desmet et al., 2010) as compared to ordering decimals with equal number of digits behind the decimal place is a problem.

Finally, misconceptions among teachers were revealed in finding the closest number of the given decimal. Teachers struggled to get the closest decimal once the chosen decimal was between 0 and 1. This indicated that Grade 6 teachers had problems in conceptualising decimal places (for example, they regarded 0.51 instead of 0.5 to be nearer to 0.46). Consequently, teachers’ understanding for the decimals could be enhanced if they could be made cognisant of learners’ misconceptions concerning decimals (Ubuz & Yayan, 2010).

In addition, teachers should assist learners not to develop misconceptions or help in clearing misconceptions that might be existing (Du Toit, 2013) so that effective teaching and learning could take place. The study sought to examine if the sample teachers experience similar problems. Having discussed the difficulty in the teaching of decimal fractions and the related misconceptions, it is important to look at the strategies that could help in the teaching and understanding of decimal fractions.

2.5. STRATEGIES (APPROACHES) TO IMPROVE THE TEACHING OF DECIMAL FRACTIONS

Around the world, researchers have struggled to find relevant strategies that could be employed to improve the teaching and the understanding of decimal fractions. For example, Durkin and Rittle-Johnson (2015) support this idea when they maintain that learners could master decimals to improve their learning in more advanced mathematics only if teachers could develop strategies that could assist them. Despite this, Hilker, (2011) maintained that in countries such as Rwanda, teaching methods are largely teacher- centred with little attention given to open debate and to the teaching of critical thinking skills.

This led to countless strategies (approaches) to be employed in the teaching of decimal fractions. For example, Dietiker, (2015) asserted that mathematics may be taught through the use of mathematical stories to make it exciting. Dietiker, (2015) called this mathematical story framework. Stories may therefore be used in tasks to arouse curiosity which eventually compel teachers and learners to be engaged. Dietiker, (2015) further claimed that learners might be engaged in debates. For example, being interested in knowing how 0.999…= 1. Erlinda, & Surya, (2017) advised that teachers should use the relevant teaching and learning resources in order to make mathematics fun to learn. The right learning and teaching resources will make the lesson interesting for learners to learn e.g. using decimal grids. This will provide optimal results for learners' understanding of the content being used (Erlinda, & Surya, (2017:18). This implies that teachers ' PCK in decimal fractions will enable them to use hands on ways in teaching decimal fractions which assist learners understand them deeply. Even

though researchers such as Ubuz and Yayan (2010) and Isiksal and Cakiroglu (2011) had proposed strategies listed below to overcome the misconceptions or difficulties in the teaching of decimal fractions, this study intends to reveal as to whether similar strategies will be employed by target teachers or not. Consequently, the need of this study.

Ubuz and Yayan (2010) proposed strategies (approaches) that could be employed by mathematics teachers for eradication of their misconceptions and hindrances associated with decimals. Such strategies could also enhance learners' and teachers' understanding of decimal fractions. For example, conflict teaching approach, integration of everyday context as well as position–driven group discussion.

2.5.1. Conflicting teaching approach

In this approach, both teachers and learners are involved in discussion of and reflection on their misconceptions related to decimals (Ubuz & Yayan, 2010). By applying this approach, both teachers and learners would recognise inadequacy of their own conceptions and the need for modification (Ubuz & Yayan, 2010). This implies that their misconceptions and mistakes that were formed concerning decimals would decrease and uncertainty overpowered.

2.5.2 Integration of everyday context approach

Learners should be presented with suitable decimal fraction problems that are related to their everyday situation. Ubuz and Yayan (2010) maintain that learners who worked on contextualised decimal problems would have an improved scientific decimal knowledge as well as an amplified retention of decimal knowledge. For example, working on daily examples incorporated with mathematical problem posing, such as price lists of pizza shops (Ubuz & Yayan, 2010). This suggests that mathematics teachers should provide learners with increased opportunities to create their own knowledge and thoughts. In addition, teachers should be acquainted with learners' prior knowledge since experience is the best teacher.

2.5.3 Position–driven group discussion approach

In this approach, a group of learners are directed in discussing one or more focal questions using a reasonably restrained number of possible responses (Ubuz & Yayan, 2010). Though the preceding strategies might be employed in the teaching of decimals, there might be limitations attached to them. For example, the fact that teachers should present learners with suitable decimal fraction problems might be challenging to teachers with misconceptions and disintegrated knowledge (Lange et al., 2010).

However, Isiksal and Cakiroglu (2011) have a different opinion. They proposed the following strategies that could be employed in the teaching of fractions, namely, strategies based on teaching methods, strategies based on formal knowledge of fractions and strategies on psychological constructs. The researcher agrees with these strategies because they are much related to the teachers' PCK in teaching decimal fractions. More importantly, the strategies listed are useful because if teachers could use various strategies, misconceptions related to decimals will be overpowered.

2.5.4. Strategies based on teaching methods

This strategy requires teachers to employ the following strategies in order to teach concepts in an effective manner. One, various methods of teaching. Two, multiple representations such as figures, verbal expressions, visual materials as well as day-to-day life examples. Three, emphasising practise whereby learners are given more exercises, for example, on decimal fractions to practise. Four, motivating learners to indicate and explain the methods they used while solving problems (Isiksal & Cakiroglu, 2011).

2.5.5 Strategies based on formal knowledge of fractions

Isiksal and Cakiroglu (2011) underscored that teachers should start by explaining the meaning of a particular concept before teaching learners. For example, by explaining to learners what decimal fractions are, and by giving quite a number of examples to clarify the meaning. Afterwards, teachers should clearly state the relationship amongst the

operations when working with fractions, in particular, decimal fractions, before working out the problems.

2.5.6 Strategies based on psychological constructs

Most learners have misconceptions and difficulties concerning decimal fractions not because of their poor cognitive skills, but because of mathematical anxiety caused by ignorance of their emotional needs. This implies that teachers should not only concentrate on learners' cognitive needs, but also on their motivational needs as well (Isiksal & Cakiroglu, 2011), in order to assist them to develop positive attitude concerning mathematics.

2.6 THEORETICAL FRAMEWORK

A theoretical framework is important in researching the mathematical knowledge of teachers for several reasons: basically, it offers a lens through which the data are interpreted or analysed. It is like a torch that enlightens even at night. That is why Agherdien, Henning and van der Westhuzen (2007, in Themane, 2015), highlighted that a theoretical framework is like a torch that gives light to enlighten in the dark. It further assists the researchers to see all the constructs related to the problem (Govender, 2009). Since the current study is concerned about the teaching of decimals, theoretical framework is vital because it assisted in connecting the researcher with existing body of knowledge concerning teaching.

Themane (2015) further maintains that a theoretical framework is essential because it embraces concepts, definitions, propositions and theories that guide the study. In the case of the current study, it assisted the researcher to understand why Grade 6 mathematics teachers find it difficult to teach decimals effectively. Furthermore, theoretical frameworks enable researchers to make sense of the data that were collected since a theoretical framework serves as a tool from which data can be collected and interpreted.

2.6.1 Shulman's theory of teacher knowledge

Since the current study focused on the PCK of teachers in the teaching of decimal fractions, the researcher opted for Shulman's (1987/1986) Theory of Teacher Knowledge as the lens to guide the study. Shulman (1986: 9) explained Pedagogical Content Knowledge (PCK) as knowledge that includes:

> The most useful forms of representation of those ideas, the most powerful analogies, illustrations examples, explanations, and demonstrations- in a word, the most useful ways of representing and formulating the subject that make it comprehensible to others…Pedagogical Content Knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and misconceptions that students of different ages and backgrounds bring with them to the learning of those most frequent taught topics and lessons.

Shulman (1987: 8) identified seven categories of teacher knowledge that lied behind teachers' understanding required in teaching: "content knowledge (CK), General Pedagogical Knowledge (GPK), curriculum knowledge (CK), Pedagogical Content Knowledge (PCK), knowledge of learners and their characteristics, knowledge of educational contexts and knowledge of educational ends, purposes and values". Among the seven categories, PCK has since been considered important as regards to knowledge required for teaching.

2.6.1.1 Components of PCK

According to Shulman (1986); Lee, (2010), PCK comprises of teacher knowledge of the subject (Subject Matter Knowledge) and pedagogy (pedagogical knowledge). Viewed in this way, Shulman (1986) theory proposed the integration of the two components of PCK because Shulman (1986) found it wrong to separate the two. Shulman (1986) emphasised that teachers should know the content that is to be taught to learners and how to teach it. According to Kleickmann et al. (2013); Olanoff et al. (2014), PCK comprises of two vital elements, namely: knowledge of instructional strategies and representations as well as knowledge of students' misconceptions. This suggests that

teachers should be able to apply a variety of strategies to enable learners to understand the topic that is being taught, in this case, decimal fractions and to minimise misconceptions. PCK should also assist teachers to understand learners' background and the type of resources required to facilitate effective learning and teaching.

2.6.1.2 The importance of PCK

Shulman's (1987 /1986) Theory of Teacher Knowledge is important to the researcher because it enabled the researcher to understand the complexities of teachers' understanding and transmission of content knowledge. It afforded the researcher with the opportunity to engage with how teachers teach decimal fractions to Grade 6 learners. This theory is more comprehensive because it focused on content knowledge in teaching, namely, Subject Matter Knowledge (SMK), Pedagogical Content Knowledge (PCK), and General Pedagogical Knowledge (GPK) (Jankvist ,Mosvold, Fauskanger,& Jakobsen., 2012; Zhou, et al. 2006).

PCK is vital since it is concerned with the representation and the formulation of concepts in the subject pedagogical techniques and knowledge of learners, theories of teaching and learning (Fennema et al., 1998). Since the study was about teachers' PCK in the teaching of decimals, this theory was relevant because it enabled the researcher to explore the PCK of teachers in this regard. This theory was of great help since it assisted the researcher to understand rules and procedures used by teachers in attempting decimal tasks, and why those rules and procedures were used and on what grounds (for example, see Section 2.4.1).

PCK enables the researcher to understand why particular topics were easy or challenging to learn. It further assists in understanding of preconceptions which often lead to misconceptions (Shulman, 1986), for example, if 70>7, then 0.70>0.7. Furthermore, PCK also assists the researcher to understand the context in which teaching takes place. For example, learners' background as well as teaching and learning resources needed for effective teaching and learning. This theory further claims

that teachers must have information on the strategies that could be used in restructuring understanding of learners.

2.7 CONCLUSION

This chapter provided a discussion of literature that was reviewed in response to the research questions of this study. Additionally, key concepts used throughout the study were also clarified. Shulman's (1986) PCK theory was used as the theoretical frame work to guide the study. The next chapter discusses the research methodology followed in answering the research questions which included amongst others the following; the research design that was used, sampling methods, data collection strategies as well as analysis of data collected.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

The purpose of this study is to explore the PCK of Grade 6 mathematics teachers in the teaching of decimal fractions (Section 1.5). In Chapter two, related literature was reviewed. This chapter on research methodology elucidates how empirical data that assisted in fulfilling the purpose of this study were attended to. The chapter addresses the following topics (issues) as follows: research methodology, research design, selection of participants, data collection, data analysis, quality criteria, significance of the study and, finally, the ethical issues that the researcher considered in conducting the study are also presented. The next section discusses and explicates the methodology that was adopted for this study.

3.2 THE RESEARCH METHODOLOGY FOR THE STUDY

There are three main paradigms that inform educational research, namely: positivist, interpretivist and critical theory. This research methodology is located within the interpretivist paradigm to guide the researcher to gain the best information from the participants in their sites (Nieuwenhuis, 2012a). In paradigms, there are approaches to use. The methodology that was used to locate the study in an empirical world is qualitative in nature (Flick, 2015; Lewis, 2015). Qualitative research is relevant to the current study because the researcher visited schools, interacted with teachers, observed the lessons on decimal fractions and interviewed them. This implies that the researcher gathered data directly from the source (McMillan & Schumacher, 2010).

Furthermore, the researcher entered the classrooms without predetermined information, but interpreted the teachers' actions as they happened. In addition, Creswell, Ivankova and Clark (2012) support the choice of qualitative research for this kind of study when they state the following characteristics of qualitative research:

- The goal of qualitative research is to explore and understand a central phenomenon, which, in this study, is to explore the PCK of mathematics teachers;
- The research questions are broad and general; and
- The selected sample is small and purposeful.

3.3 RESEARCH DESIGN

Teaching decimal fractions in Grade 6 formed the background against which the study was conducted. The identification of a suitable case began with getting Grade 6 mathematics teachers who were willing to participate in the research study. Another essential point was to negotiate with the teachers for the observation of the lessons over a period of one week and to seek their consent to be interviewed at the end of their lessons. Denzin and Lincoln (2008, cited in Themane, 2015) maintained that a research design depicts a variable set of guidelines that connects theoretical paradigms to strategies and methods for collecting empirical data. Consequently, the choice of a case study design to be employed was considered suitable for this study.

Research of this type is normally conducted using a case study design because it enables the researcher to get an in-depth understanding of teachers' experiences in the teaching of decimals in Grade 6 and to reach saturation (Nieuwenhuis, 2012b; Palinkas et al., 2015;). However, this design is criticised for being unable to provide a generalising conclusion as its findings are based on few cases, which is not the aim of case study design (Nieuwenhuis, 2012b). In addition, Gall, Borg and Gall (2007) point out that a case study design focuses on a phenomenon, a case, unit of analysis as well as focus of the study. In this study, the phenomenon of focus is how teachers teach decimal fractions and primary schools in the Rakwadu Circuit in Limpopo Province formed the context of the cases. However, the unit of analysis is made of Grade 6 mathematics teachers and their PCK. Besides that, the focus of this study is the PCK of Grade 6 mathematics teacher in the teaching of decimals fractions.

Case study design was chosen for this study because it examines contemporary phenomenon in a real life context using multiple methods in the data collection to establish trustworthiness of the information (Creswell, et al., 2012). For example interviews, documents review and observations (Nieuwenhuis, 2012b) of teachers' lessons. Equally important, case study design allowed the researcher to understand Grade 6 mathematics teachers by visiting and interacting with them to get in-depth information.

3.4 SELECTION OF THE PARTICIPANTS

3.4.1 The population of the study

The study was conducted in three primary schools in the of Rakwadu circuit in the Limpopo Province in South Africa. The researcher was informed by the Rakwadu circuit office that there are 30 Primary schools in the circuit. At the time of conducting this study, the researcher found that amongst the 30 schools, 7 of them were big schools with two Grade 6 classrooms in each school. In these schools, different mathematics teachers were responsible for each Grade 6 class. This shows that there were 14 Grade 6 mathematics teachers in the 7 schools. Furthermore, the researcher learnt that the other 13 schools also have two Grade 6 classrooms but with one mathematics teacher being responsible for both Grade 6 classes. It means that there were 13 Grade 6 mathematics teachers in these 13 schools. The remaining 10 schools of the 30 schools in the circuit were very small schools with only one Grade 6 classroom. In these 10 schools, Grade 6 mathematics teachers were also responsible for other subjects. A total of 37 Grade 6 mathematics teachers in the 30 primary schools at the Rakwadu Circuit, in the remote rural area in Modjadji in the Limpopo Province formed the population of this study. Learners were also involved in the study because they were part of the lessons that were observed by the researcher and most importantly, their educational materials were examined and studied (see Section 3.6.1.3 & Section 3.10.1). Permission to study their educational materials was obtained from their teacher.

Primary schools in the Rakwadu Circuit are a number of kilometres apart from each other with only a few of them being 2km apart. It was not possible to study the entire population, that is, all the 37 Grade 6 mathematics teachers because this is not in line with the nature of the study. The researcher was not interested in using a large number of teachers, but only a few teachers in order to yield in-depth information. For that reason, the researcher selected a small section of the population, particularly because the study is qualitative in nature. In addition, the purpose of this study is not to generalise the findings, but to get an in-depth understanding (Nieuwenhuis, 2012b) of the PCK of teachers in relation to the teaching of decimals in Grade 6. The next section describes the sampling technique employed in this study, namely, purposeful sampling.

3.4.2 Purposeful sampling and the study sample

The purpose of selecting Grade 6 mathematics teachers was not to evaluate them because this is not in line with qualitative research procedure, but to learn from them the mathematical demands of teaching decimal fractions. Relevant to this study, purposeful sampling was used to find and choose information rich cases linked to the current study (Palinkas et al., 2015). Of the 37 Grade 6 mathematics teachers in the 30 primary schools at the Rakwadu Circuit, only three Grade 6 mathematics teachers participated in the study. The sampled teachers were from three different primary schools in the remote rural area of Modjadji in the Rakwadu circuit. Grade 6 learners in the sampled teachers' classrooms were also involved in the study (see Section 3.6.1.3 & Section 3.10.1). Sampling is important because it reduces the length of time used in the study and saves money that the researcher would have used in conducting the study (Dezin & Lincoln, 2008, cited in Themane, 2015).

Purposeful sampling was used in the study because it focuses on specific characteristics of the population that were of interest to researcher. In this study, the features of interests were grounded on four criteria: one, the teachers were to be two males and three females. Two, the teachers were to be teaching mathematics in Grade 6 during the period of this study. Three, the teachers had at least two years or more of teaching experience. Four, that teachers should have one of the following qualifications:

an Advanced Certificate in Education (ACE), honours degree or a Master's degree. The four criteria assisted the researcher to find participants who would assist in answering the research questions. For example, in School Y there were two Grade 6 classes and two teachers who were teaching mathematics. Both teachers were females. The researcher was looking for a female teacher who is more qualified and with more than two years of teaching experience in mathematics. The listed criteria assisted the researcher to select the teacher in School Y that eventually participated in the study. Of the two teachers in School Y, only one teacher met the set criteria and was sampled to participate in the study. The sampled teacher had a master degree and had been teaching mathematics in Grade 6 for fifteen years.

In all primary schools in the circuit, the researcher was challenged in securing male participants because most of them were not interested. Male teachers, who showed interest in the study, did not meet the set criteria. With that said, only two male teachers were sampled to participate in the study. Though initially the researcher had a sample of about five teachers which comprised of two males and three females to ensure that a minimum of four teachers complete the study, only a total of three teachers participated. The other two teachers refused to participate and had different excuses for not participating. That is, one male teacher and one female teacher in the sample decided to excuse themselves from the study. The participating teachers comprised of two females and one male teacher and they were of diverse backgrounds. This implies that three primary schools were sampled as sites for the study and three Grade 6 mathematics teachers who met the desired criteria participated in the study.

The main reason for selecting the teachers was that, according to the curriculum, decimals are also taught in Grade 6, of which they are responsible for. The three teachers who consented to partake in the study were informed about the purpose of the study and their questions were clarified. Besides, teachers were told about the interview and they were also informed that the researcher would observe some of their lessons. In addition, they were also informed that at the end of the observation periods, the researcher would have a look at their lesson plans, as well as learners' mathematics activity books (see Section 3.6.1.3). Learners were made aware through their teachers

that their classwork books were to be studied in this study. Table 3.1 indicates the number of teachers in the study. In Table 3.1, Teacher A is abbreviated as TA; Teacher B, as TB; Teacher C as TC.

Table 3.1: Total Number of Participants

Schools	Teachers	Gender
School X	Teacher A (TA)	Male
School Y	Teacher B (TB)	Female
School Z	Teacher C (TC)	Female

After teachers were purposefully selected, the researcher decided to conduct a pilot study before the actual study to check if the instruments will yield the required data. The next section describes the pilot study conducted.

3.5. PILOT STUDY

Lancaster (2015) views pilot studies as a mini version of a full scale study as well as the specific pretesting of instruments used in research like questionnaires or interview schedule. A pilot study was conducted in this study because the researcher wanted to check if the instruments were prepared accordingly or not.

A pilot study was conducted two weeks before the actual study in a school not identified to participate in the research study. Similar instruments that were to be used in the main study were used during the pilot study. For example, the researcher used similar interview schedule, observation sheet and document analysis template during the pilot study. In addition, the researcher piloted the initial interview, observations and document analysis with two teachers from a school identified for piloting. Both teachers were responsible for teaching mathematics in Grade 6 but they were not part of the sample. The researcher wanted to check if both teachers would understand the instruments in a similar way. The data collected was analysed. By so doing, the researcher was able to see shortcomings in the instruments before starting with the

actual data collection process. To ensure trustworthiness of the instruments, the researcher used two teachers who taught Grade 6 for many years and two university lectures to check areas that were ambiguous before the actual study. The researcher was convinced that the interview questions yielded valuable discussion concerning the PCK of Grade 6 teachers in the teaching of decimal fractions. By so doing, the researcher gained confidence before the main study. The researcher then conducted the main study positively and with a higher level of proficiency (Du Toit, 2013). After examining the instruments, the researcher then began with data collection as discussed in the next section.

3.6. DATA COLLECTION

Data collection lasted for two weeks. This assisted the researcher to re-establish the facts in cases where the researcher did not understand. Data were collected in various ways in order to provide a more convincing and accurate case study (Casey & Houghton, 2010). For that reason, semi-structured interviews, non-participant observations and document analysis, were used to collect data and to gain a deep understanding (Creswell & Poth, 2017) of Grade 6 mathematics teachers in this study. Since the study followed a case study design, data collection was in-depth and detailed (Nisbeth, 2015). The researcher collected data until no new information was found. Ness (2015) calls this process data saturation. The next section highlights the most frequently used data collection techniques used in qualitative research. In addition, the way in which collected data were managed is also discussed.

3.6.1 Method of data collection

3.6.1.1 Classroom observation

Although observation might seem to be time consuming, it gave the researcher ample opportunity to obtain direct insight into what was taking place during the teaching and lesson process. There are four types of observation that are normally used in qualitative

research, namely, complete observer, observer as participant, participant as observer and complete participant. ‘Observer as participant’ observation is opted for this type of study. Nieuwenhuis (2012b) indicates that in ‘observer as participant’ observation, the researcher gets into the situation, but only concentrate on his or her role as observer. This serves as an essential point because this study followed the ‘observer as participant’ observation as the researcher played the role of a detached observer and the dynamics of the setting was not influenced (Nieuwenhuis, 2012b). This means that the researcher observed Grade 6 classes wherein learners were taught decimals, but without being involved in the lesson process.

Prior observations, the researcher arranged with Grade 6 mathematics teachers, more especially because lesson observations were conducted while the teachers were teaching. The researcher had a classroom observation guide that was used during observation period. (Appendix C).In this study, observations took place in three different Grade 6 classrooms in three schools. Classroom observation lasted for a period of two weeks during the teacher’s contact time with the learners. Lesson observation lasted for a period of five days per school. Each teacher was observed for five days with eight lessons being observed in each school. Three teachers were available for observations. Thus, the observation period was shared amongst the three teachers. Teacher A and B were observed in the same week, that is, during the first week of the observation period. Teacher C was observed a week after the observation with Teacher A and Teacher B. .

The researcher was fortunate because mathematics periods at sampled schools were at different times and this gave the researcher the opportunity to observe mathematics periods every day for five days in each school, more especially because those schools were not far from each other. These classroom observations gave the researcher opportunity to investigate and understand in-depth the phenomenon in the classroom situation and ascertain how viable information regarding teaching and learning of decimal fractions from the literature translates into existing classroom practice (McMillan & Schumacher, 2010).

Initially, the researcher wanted to use a video recorder during the observation period. The researcher believed that video recordings would assist in various ways. For example, in verifying the accuracy and validity of the research findings, and in capturing details of both sights and sounds as well as details of verbal and non-verbal behaviour (LeBaron, Jarzabkowski, Pratt, & Fetzer, 2018). The researcher wanted to use the video recordings to verify how the teachers behaved when teaching decimal fractions to learners and how they responded to questions posed by learners. The researcher also wanted to check how learners behaved during the lesson. Unfortunately, the participants in the study refused to be video-recorded for reasons that were beyond the researcher's knowledge. Teachers' refusal to be video-recorded implicated the research methodology that was to be used. The researcher then decided to alter the methodology and used a voice recorder in each observation setting to record the classroom observation.

During the observation period, the researcher made sure that she sat in front of the class just next to the chalkboard but in such a way that learners were not obstructed. The researcher ensured that she faced at a direction faced by most learners. Additionally, a self-planned observation sheet was used to record non-verbal behaviours or any other occurring behaviour of both teachers and learners in order to add to recorded discourses (Nieuwenhuis, 2012b). The observation sheet used is attached as Appendix B. The researcher reflected on the observation immediately after each observation session. At the end of the observation period, semi-structured interviews were conducted.

3.6.1.2 Semi-structured interviews

It is important to complement observation with interviews in order to learn what is in someone's mind to reduce subjectivity in the study (Du Toit, 2013) and to find more about the participant's ideas, beliefs, views, opinions and behaviours (Nieuwenhuis, 2012b). There are three types of interviews conducted in qualitative research, namely, unstructured interviews, semi-structured and structured interviews (Nieuwenhuis, 2012b). However, in the context of the current study, semi-structured interviews were

conducted because they allow probing and clarification of answers as well as the defining of the line of inquiry (Nieuwenhuis, 2012b). However, this type of interview has disadvantages. For example, participants losing focus of the interview.

A voice recorder was used during interview session with the three participating teachers. The interviews were not difficult to handle since both the principals of the selected schools and Grade 6 mathematics teachers thought their schools would benefit from the interviews. Such interviews were conducted separately with Grade 6 mathematics teachers at their different schools. The researcher agreed with teachers to conduct interviews after school in order not to disturb the normal running of the school. However, it was different with one teacher who opted to be interviewed earlier during flexi time as she explained that she is using a common transport.

The researcher played a role of the interviewer in this study. Five audio-taped interviews were conducted with each teacher. These interviews enabled the researcher to sustain eye contact to show interest in the interviewees (Nieuwenhuis, 2012b). The interviews were semi-structured and teachers were expected to answer predetermined questions (Creswell, 2012) related to their PCK. All the participating teachers were asked similar questions that were asked in the same order. The main questions were general and were followed by follow-up questions. Follow-up questions enabled the researcher to uncover rich, detailed and in-depth responses from Grade 6 mathematics teachers (Nisbeth, 2015).

More importantly, the researcher was able to probe and consequently the teachers were able to clarify themselves. The teachers were guided and encouraged to explore their PCK and views regarding the teaching of decimal fractions in Grade 6. The researcher therefore got a profound understanding of the PCK of Grade 6 teachers in the teaching of decimal fractions. That is, from these interviews the researcher got a deep understanding of the teachers' CK and PCK related to decimal teaching. The interview schedule used is attached as Appendix A. The interviews were transcribed verbatim and no alterations were effected to maintain their integrity (Cole, 2012). The researcher

played the tape recorder several times to ensure that no point was missed during transcriptions. After the interviews, there were follow-up discussions for accuracy checks and thereafter the researcher proceeded with document analysis.

3.6.1.3 Document analysis

After the interview the researcher collected documents such as teachers' lesson plans and learners' mathematics classwork books and analysed them to triangulate with other data sources. This was done with the intention to develop a better understanding of the PCK of Grade 6 mathematics teachers in the teaching of decimal fractions. More importantly, documents are deemed important because they are valuable sources of data and might be collected jointly with observation and interviews (Punch, 2013). The current study conducted an analysis of three lesson plans and three mathematics classwork and homework books obtained from Grade 6 mathematics teachers from the participating schools. That is, one lesson plan of teacher A, teacher B and teacher C as well as one mathematics classwork and homework book of one learner from the participating schools (Section 4.4.3). The learners' books were randomly selected from a minimum of 20 books per school requested from the participating teachers. The selection was merely an assortment of books. The 20 books were then grouped according to learners' ability in responding to questions given as an activity. For clarity, the template that guided data analysis as part of data collection is attached as appendix (See Appendix D).

Copies of the teachers' lesson plans and learners' workings would be attached as figures (see Section 4.4.3.1; 4.4.3.2; 4.4.3.3). Teachers' lesson plans and learners' mathematics activity books are highlighted in the next section:

(i) Teachers' lesson preparations

By examining teachers' lesson preparations, the researcher was able to establish as to whether the sampled teachers prepared their lessons prior the implementation of the lessons or not. The researcher expected their lesson plans to have the following:

- Topic;
- Date;

- Aims;
- Methods of teaching;
- Resources used;
- Teachers and learners' activities;
- Challenges; and
- Teaching and assessment strategies.

By accessing teachers' lesson plans, the researcher intended to find out the following information:

- Whether learners were given an opportunity to work individually and as a group;
- Whether teachers were able to recognise learners' problems and difficulties concerning decimal fractions; and
- What teachers planned to do in assisting learners who struggle with decimals and how they intend to stimulate learners' understanding.

(ii) Learners' mathematics activity books

Learners were informed through their teachers that their mathematics activity books will be studied. These kinds of documents would enable the researcher to find out:

- Whether learners used their own strategies while solving problems at their disposal;
- Whether learners followed procedures outlined by their teacher if that was the case; and
- How learners structured their workings.

3.6.2 Data management

Following data collection, the researcher verified the transcriptions of interviews and discussions during lessons observation by playing the tape recorder ensure whether what has been audio-taped match with the transcriptions. Moreover, the researcher saved data for each participant in individual folders created electronically by the

researcher. A password was created for electronic files so that only the researcher could access them. Thereafter, all saved data were printed as hard copies and were locked in the researcher's personal cupboard in her study room at home.

Teachers' lesson plans together with copies of learners' class activities were scanned and saved electronically in folders already created. Observation sheets and the researcher's note book wherein field notes were recorded during observation settings were also locked away in the researcher' personal cupboard at home. The researcher decided to keep all these data safely for at least six years after collecting data and the publication of the study. After that period, the data will be destroyed.

3.7. DATA ANALYSIS

Qualitative data analysis seeks to understand how participants make meaning of a particular phenomenon by analysing their knowledge, perceptions, experiences and understanding (Nieuwenhuis, 2012c). Analysis of qualitative data is best accomplished by inductive analyses that enable communal themes to emerge from data (Caddy, 2015). Based on this, thematic analysis was considered to be the best analysing strategy to be used to look for similarities and discrepancies or themes (Braun & Clarke, 2006) in interviews with Grade 6 mathematics teachers. In addition, thematic analysis was used because it allowed the researcher to take into consideration developing themes and developing categories (Vaismoradi, Turunen & Bondas, 2013).

The collected data consisted of textual data from observations, documents and transcripts from the interviews with the participants. Tape-recorded interviews were transcribed according to standardised rules (Maimela et al., 2015) and translated into English in instances where responses were given in other languages. Transcribed data were read several times, and codes and themes were generated (Braun & Clarke, 2006). Segments of data were coded with descriptive words, using inductive coding and categories. Themes were established in order to answer the research questions. In order to make sense of data, the study followed the four phases of theme development suggested by Vaismoradi, Jones, Turunen, & Snelgrove, (2016), namely: initialisation, construction, rectification and finalization (Section, 4.4.2). In other words, inductive

thematic analysis was applied (Maimela et al., 2015). Thereafter, bounded conclusions depending on the themes were drawn (Nieuwenhuis, 2012c). Data analysis followed Argyris, Putman and Smith's model (1985, cited in Luneta, 2011): the Ladder of Inference that follows three steps:

1. The first step represents data in their raw form;
2. The second step represents interpretations of data, in this case, the PCK of Grade 6 teachers in the teaching of decimals; and
3. The third step represents the researcher's interpretation of data consisting of assumptions which are solely kept by the researcher and not shared by everybody.

3.8 QUALITY CRITERIA

Various criteria are used to evaluate the rigour of qualitative research (Anney, 2014; Houghton et al., 2013; Korstjens, & Moser, 2018). Lincoln and Guba (1985); among others, identified the following criteria as the most popular in qualitative research, namely, credibility, dependability, confirmability and transferability. For the purpose of ensuring trustworthiness in this study, the listed quality criteria were applied.

3.8.1 Credibility

To ensure credibility of the data, the researcher read and reread the data, analysed and revised it accordingly. Korstjens, & Moser, (2018) maintained that there are strategies which are used to ensure credibility in qualitative research. These are: prolonged engagement, persistent observation, triangulation and member-check. Korstjens, & Moser, (2018) further advised that not all preceding strategies may be suitable in a study. It is the responsibility of the researcher to ensure rigor and trustworthiness of the study by determining strategies that will be suitable in a particular study.

3.8.1.1 Prolonged engagement

Anney (2014) asserts that the researcher's prolonged engagement in the field improves the trust of the participants. In this study, the researcher spent much time at the research site with Grade 6 teachers to gain full understanding of how they teach decimal fractions. To ensure credibility, the researcher asked several distinct questions concerning teachers' experiences with decimal fractions. Teachers were also encouraged to support their statements with examples where necessary. In addition, follow up questions were asked.

3.8.1.2 Triangulation

Triangulation was achieved through using the three different data collection methods: semi-structured interviews, observations and document analysis. The teachers were observed in their classrooms whilst teaching. After observation period, they were interviewed and thereafter, documents which include teachers' lesson plans and learners' educational materials were studied. Triangulation was safeguarded through the use of different data sets for example, codes that emerged throughout the analysis process (Korstjens, & Moser (2018).

3.8.1.3 Persistent observation

Anney, (2014: 278) posits that persistent observation provides an understanding of participants' world view and effects of the researchers' presence during field work. Korstjens, & Moser (2018) assert that codes, concepts and core category assist in examining the characteristics of the data.

3.8.1.4 Member check

Member checks is done to eliminate the researcher's bias when analysing and interpreting the results (Anney ,2014). The analysed and interpreted data was given back to the teachers for feedback concerning the interpretations that they were made by the researcher. Teachers were allowed to suggest changes in cases they felt that the interpretations were misreported. Teachers who participated in the study, were

supposed to check if ever what was transcribed and analysed is similar to what they planned to say. This was done in a meeting with them halfway towards the end of the study period. The aim was to allow them to correct the interpretations that they felt were not correct. In cases where the participants challenge the interpretations, corrections were immediately done. For example, if the researcher did not transcribe exactly what the teacher said, the latter would immediately correct the researcher by explaining what was initially said. In addition, after collecting and transcribing the data, the researcher took the transcriptions of the interviews to the supervisor for thorough checks. This was done for verification purposes to ensure that no theme was left behind. Furthermore, the researcher used supervisors to perceive if they agree to the data categories and the procedures followed to arrive at those categories (Houghton et al., 2013).

3.8.2 Dependability

To ensure dependability, the participants evaluate the findings, interpretations and recommendations of the study to ensure that they are solely supported by the data collected from participants (Anney, 2014). Nowell, Norris, White, & Moules (2017) assert that researchers should ensure that research process is logical, traceable and documented (p3)

3.8.3 Transferability

It is not possible for the researcher to know the sites that may need to transfer the findings. Nowell et al.(2017) therefore advise researchers to provide thick descriptions, so that it becomes easy for those who seek to transfer the findings to their site can judge transferability. It implies that results in a qualitative research can be transferred to other contexts using different participants

3.8.4 Confirmability

Anney, (2014), Korstjens, & Moser (2018) assert that confirmability concerns the extent to which the findings of the study are confirmed by other researchers. In the current study, the researcher ensured that the findings were derived from the data collected from the participants in their settings and but not own imagination. The researcher

remained neutral throughout the study. Furthermore, confirmability was ensured through audit trail. That is, the researcher ensured that complete set of notes made during the research process, including sampling procedure and data management were made available for the auditor to see the transparency of the research process (Korstjens, & Moser , 2018; Neuman, 2011). The auditor here refers to someone who did not form part of the research study but, an expert in grounded theory (Korstjens, & Moser, 2018: 122). Guba and Lincoln (1989, cited in Nowell, Norris, White & Moules, (2017), maintained that confirmability is established when credibility, transferability, and dependability are all achieved.

3.9. SIGNIFICANCE OF THE STUDY

The study could improve existing and future research in the teaching of decimal fractions in Grade 6 at the Rakwadu Circuit. In addition, researchers who are planning to conduct research in this field can also benefit from the findings of this study. That is, the findings may be useful to other stakeholders as regards to future research. This study may propose, through its findings, interventions to improve teachers' ability to teach decimal fractions without any difficulties.

Grade 6 mathematics teachers may reflect on the findings while teaching. The findings of the study assisted in filling the gap in the existing literature (Nisbet, 2015) pertaining to teachers and may assist in improving the PCK of Grade 6 mathematics teachers. Policy developers may also benefit from the findings of this study. Equally important, the study offered case studies that uncovered the PCK of Grade 6 mathematics teachers.

3.10 ETHICAL CONSIDERATIONS

The next section describes all the processes that the researcher followed in conducting this study. As this study was focused on selection of people and sites and gaining access to people and sites, it involved a wide range of ethical considerations. For that reason, the researcher had a huge responsibility of adhering to ethical issues.

3.10.1 Informed consent

Firstly, the researcher acquired the ethics clearance certificate from the University of Limpopo Research Ethics Committee. Secondly, after permission was granted by the Limpopo Provincial Department of Education to access the sampled schools, the researcher notified the Circuit manager at the Rakwadu Circuit of the approval and the intention to visit such schools. Thirdly, the principals of the sampled schools were informed of the purpose of the study. This was done to inform them of the intended research in their schools and for the purpose of managing time and security purposes. Fourthly, the targeted teachers were contacted and informed about the purpose and the nature of the study (Section 1.5). Teachers who agreed to be part of the study, consented by signing a consent form before commencement of the study which stated distinctly the purpose of the study (Kvale, 2006). Learners were also notified about the study (Section 1.8).

3.10.2 Voluntary participation

Participants were told that participation in the study was voluntarily and that they could withdraw at any time if they feel like (Gall et al., 2007). Besides, participants were also told that they must answer questions freely without any fear and that they were free to quit answering questions at any time whenever they felt uncomfortable.

3.10.3 Privacy

Participants were requested not to tell their names or the names of their respective schools or even their physical addresses when introducing themselves during interviews. This would assist in making it difficult to link them to events in the study. Participants' non-betrayal and deception, privacy and anonymity as well as confidentiality were guaranteed by using pseudonyms. This means that their names or the names of their schools were not used but instead they were identified by letters of alphabet.

The three schools that participated in the study were named as Schools X, Y and Z and teachers were identified as Teacher A (TA), Teacher B (TB) and Teacher C (TC). Participants were ensured that data collected will be kept confidential to protect them

from harm (Hammersley & Traianou, 2012). Participants were allowed access to data before compilation of the study. Finally, participants were also told that the information gathered was going to be used for the purpose of the research and nothing more (Jakachira, 2013).

3.10.4 Participant harm

In addition, participants were assured that they would neither be exposed to any form of harm nor subjected to stress (Leedy & Ormrod, 2010). Furthermore, participants were assured that neither their lives nor that of their families would be exposed to any form of danger either physically or psychologically if they partake in the study.

3.11 CONCLUSION

In this chapter, qualitative research methodology which is located within the interpretivist paradigm was discussed. Also presented in this chapter was the case study design which the researcher found to be suitable for this kind of study. Purposeful selection of participants, pilot study and data collection strategies were also discussed. Data were interpreted and analysed following what Argyris et al. (1985, cited in Luneta, 2011), called Ladder of Inference. Furthermore, the way in which data were managed and analysed were also detailed. Finally, quality criteria such as confirmability and credibility for ensuring trustworthiness along with significance of the study and ethical issues observed in the study were also discussed. The next chapter elaborates on the way in which data were analysed and interpreted.

CHAPTER FOUR: DISCUSSION, PRESENTATION OR INTERPRETATION OF FINDINGS

4.1. INTRODUCTION

Chapter three looked at the research methodology for the study. This chapter presents the findings from the classroom observations, interviews with sampled Grade 6 mathematics teachers and, finally, analysis of documents. The theoretical framework of Shulman's PCK was used to guide the study. Given that PCK is a wide area, the researcher focused on the following elements of it: content knowledge, flexibility in teaching, usage of resources, learner centeredness, richness in teaching and classroom environment. Furthermore, the researcher concentrated on aspects highlighted by Shulman (1987), such as, preparation of the subject matter, representation thereof, selection which entails a range of the content to be taught, instruction, evaluation and reflection.

To unpack the issues mentioned in the preceding paragraph, the chapter is therefore designed as follows: Firstly, the profile of schools where the data were collected is provided. Secondly, the profile of teachers who were the participants in the study is provided. Thirdly, results from interviews, observations and document analysis are presented.

4.2 PROFILE OF THE SCHOOLS

4.2.1 School X

School X was about 2km away from the researcher's own school. It was a very old school with broken windows and with very old furniture. It was a three block building consisting of two blocks (A and B) with four classrooms in each, whereas the third block (C) consisted of two classrooms which are not divided in between thus forming a hall. One class in Block B was used as the principal's office, which was closer to Grade 6 class (Block C). The Grade 6 classroom had cracked walls, with no posters on the walls. The only teaching resources available in the classroom were a loaf of bread, an orange and a decimal fraction chart drawn by the teacher, which was put on a chair and

only displayed during the lesson. The class was overcrowded with 90 learners. There was a cupboard and only one big table which the researcher used during observation period. The yard is not fenced; hence community members pass freely next to classes. The school is understaffed and as a result the participant in the study is responsible for all the subjects in Grade 6.

4.2.2 School Y

School Y is about 4km from the researcher's home. It is a very old school with old buildings. However, the school was fortunate enough to get two new blocks with four classes in each block; a kitchen used for school nutrition program; and a modernised administration block sponsored by the National Lottery (www.nlcsa.org.za). The school is next to a local clinic and a church. Different from School X, School Y was surrounded by a palisade fence that keeps villagers away from school grounds. The new blocks were meant for foundation phase (Grade R to Grade 3) and Grades 4 and 5 respectively. The old blocks were for Grade 6 and Grade 7. There were two Grade 6 classes and two teachers who were teaching mathematics in this school. However, the researcher decided to use only one teacher from this school (Section 3.4.2). Both Grade 6 classes were painted light blue, although the paint seemed to be worn out.

4.2.3 School Z

School Z is also 2km away from the researcher's home but in the opposite direction of School X. It was a new school consisting of two blocks of four classrooms each and a two-room building which was used as the principal's office and storage for the school nutrition program. One block was used for foundation phase (Grade R, Grade1, Grade 2 and Grade 3), whereas the other was meant for Grade 4, Grade 5, Grade 6 and Grade 7. The classes were well furnished but teaching and learning resources were inadequate. The school was well fenced and had a security guard who made it very difficult for strangers to access school premises. The total number of learners in School Z was two hundred and twenty. There was only one Grade 6 class in this school consisting of only twenty-five learners.

4.3. PROFILE OF TEACHERS

4.3.1 Teacher A

Teacher A was a middle aged man in his early forties working in one of the Primary schools located in the remote area under the Rain Queen Modjadji. He had an ACE certificate and, due to staff shortage, he taught all subjects in Grade 6, including mathematics. He has been teaching mathematics in this grade for almost two years.

4.3.2 Teacher B

Teacher B was a female teacher in her late forties. She was 48 years old and had been teaching mathematics in Grade 6 for fifteen years. She held Senior Primary Teachers Diploma (SPTD) and Masters in Inclusive Education. She was attached to one of the oldest schools in Modjadji area.

4.3.3 Teacher C

Teacher C was also a female teacher in her late forties attached to a very small school. She held the following qualifications: SPTD, BA and BEd Honours degree. She had been teaching mathematics in Grade 6 for four years. She was also responsible for teaching mathematics in Grades 4, 5 and 7 as well as social science in Grade 7.

4.4. Findings

4.4.1 Findings from the classroom observations

Lesson observation lasted for a period of five days per school. Each teacher was observed for five days with eight lessons being observed in each school (Section 3.6.1.1).

4.4.1.1 Classroom observation in Teacher A's class

This section explains the observations of Teacher A in his setting. Teacher A's class consisted of 90 learners. As observations were conducted during the second term, the researcher coincidentally happened to share the same table with a student-teacher from

a private college in a nearby town who was also doing her practical in Grade 6. In all the lessons observed, the student-teacher assisted in marking learners' previous work which the teacher could not attend to during the mathematics period, that is, either class activities or home activities previously marked by the learners themselves or engaged in her personal school work. Learners shared desks. Each small desk accommodated three learners which made it difficult for them to write freely.

During the first observation period in teacher A's class, learners habitually took out the mathematics textbooks that looked very old before the teacher could even start introducing the lesson. The books were not properly handled because, even though the Limpopo Department of Education supplies schools with textbooks after every five years, the books would not be as old as they looked. Similar problem was evident at the end of the third observation lesson of Teacher Awhen learners were requested to complete an activity in their workbooks supplied by the Department of Basic Education (DBE) each year. Most of the workbooks were old.

Mathematics lessons in this school were from half past seven to nine on Mondays and Wednesdays. During these two days, three periods each lasting thirty minutes were allocated for mathematics. Two periods per day were scheduled for Tuesday, Thursday and Friday immediately after break (10h30 to 11h30). Whether the lessons were before break or after break, the teacher never appeared to be troubled by learners making noise or coming late for class. Teacher A's lessons were sequenced as follows, following the order in which they were taught in the eight observed lessons: ordering decimal fractions; adding and subtraction of decimal fractions; and number lines with decimals fractions.
The setting in Teacher A's classroom can be illustrated in figure 4.1: The big rectangles are learners' desks and the triangles are the doors. The 'T' is the teacher.

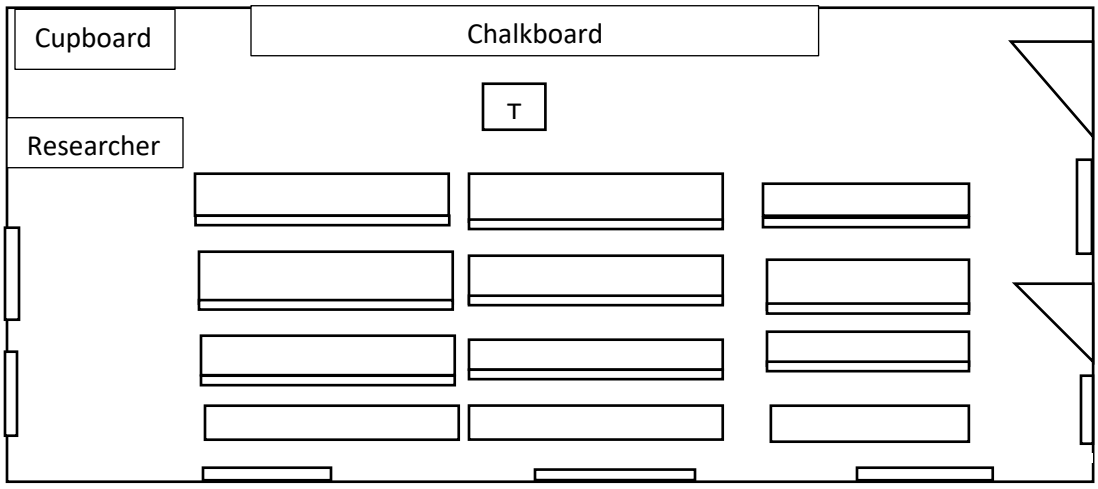


Figure 4.1: Setting in Teacher A's Classroom

The researcher's observation in School X was that the observed teacher revealed a lack of PCK since usage of resources was very poor. In addition, over crowdedness and class arrangement thereof impeded the teacher's interaction with learners and flexibility in teaching.

4.4.1.2 Classroom observation in Teacher B's class

This section describes the observation of Teacher B in her class during the researcher's five-day visit. In this class, two learners shared a small table but each had his or her own old chair. The top part of the tables were detached and moved sideways whenever learners leaned against or when writing. Similar to learners' sitting in Teacher A's class, learners in Teacher B's class had a similar problem in writing neatly. Mathematics lessons in both Grade 6 classes were scheduled as follows: two periods on Mondays and Wednesdays starting from ten O'clock till break at Eleven O'clock and from nine O'clock to ten O'clock on Tuesdays, Thursdays and Fridays. Teacher B was observed in the same week as Teacher A, but at different times.

The researcher was familiar with Teacher B. They met each other prior the observation when the researcher visited the teacher for arrangements. The researcher was never

late for observations as the schools were closer to each other. The researcher was introduced to the learners during the first observation period and she was welcomed.

A fraction panel chart and a chart with few number lines were hanging on the walls of Teacher B's classroom. There were also specimen of South African currency which were used when teaching addition and subtraction of decimals. Unlike Teacher A's class which was overcrowded, Teacher B's class consisted of only 40 learners. There was a very old cupboard and only one big table and a wooden chair belonging to Teacher B which the researcher used during the observation period. The teacher in the study was also responsible for teaching languages and life skills in both Grade 6 classes. Throughout the observation periods in this class, the researcher sat on the right hand side of the chalkboard in such a way that she could be in eye contact with both the teacher and the learners.

During the five day observation period, Teacher B taught different topics every day in the following order: place value of decimals, ordering of decimals, addition of decimals, and subtraction of decimals as well as conversion of decimal fractions. She introduced her lessons in a similar way throughout the observation period. She would ask one of the learners to tell the class about what they learnt in the previous lesson.

During the first observation period, Teacher B removed the fraction panel chart from the wall and pasted it on the chalkboard in order to remind learners of the equivalent fractions before introducing them to decimal fractions. The teacher then continued by drawing a place value table which included decimal numbers extending to the right of the units. After the lesson, learners were requested to complete the activity in their workbooks by placing numbers in their correct places on a place value chart.

During the second lesson, the teacher started by writing a number line with decimal numbers on the board and asked one of the learners to locate the given decimal numbers on their correct places. The learner struggled to do it and as such the teacher got irritated, as it was later indicated during the interview that she sometimes become impatient when working with learners. She then provided the learners with what was

expected, and continued with her next topic. After this lesson, learners were requested to answer questions orally.

The third lesson was about addition of decimal fractions. The teacher started by reminding them about the place value and the importance of considering a decimal point. Learners were also taught about addition of decimals, which requires carryings. Most learners were challenged. Learners were given exercises that they were required to complete as a group so that they can assist one another. This they did using specimen of South African currency where they had a corner in class used as a stall. Learners who were used to money managed to add decimals with ease but others still experienced difficulties. Learners were also given work to do individually at home.
Subtraction of decimals was also taught using specimen of South African currency a day after addition of decimals was introduced to learners. Like in the previous lessons, the teacher started by recapping the previous lesson before introducing the next lesson. Learners were grouped and the teacher gave instructions and then moved around to check if learners were doing as expected. Learners were given activities to complete at home.

The last observed lesson which was on conversion of decimal fractions was different from the previous lessons observed. The lesson lasted for only fifteen minutes. Learners were given close-ended questions whereby they were supposed to recall and apply procedures as illustrated by the teacher. Teacher B seemed to be unsure of what she was doing when teaching conversion of decimal fractions because, immediately after the lesson, she engaged herself in an informal conversation with the researcher and ignored learners who were struggling. Afterwards, learners were referred to a number of pages to complete individually at home.

Figure 4.2 represents the setting of learners and the researcher during the observation period in Teacher B' class. The triangle represents the door, whereas the small rectangles on the edges of the drawing are the windows. The big rectangles inside the

drawing are the learners' tables, and the small bars attached to the tables are learners' chairs. The 'T' next to the chalkboard represents the teacher.

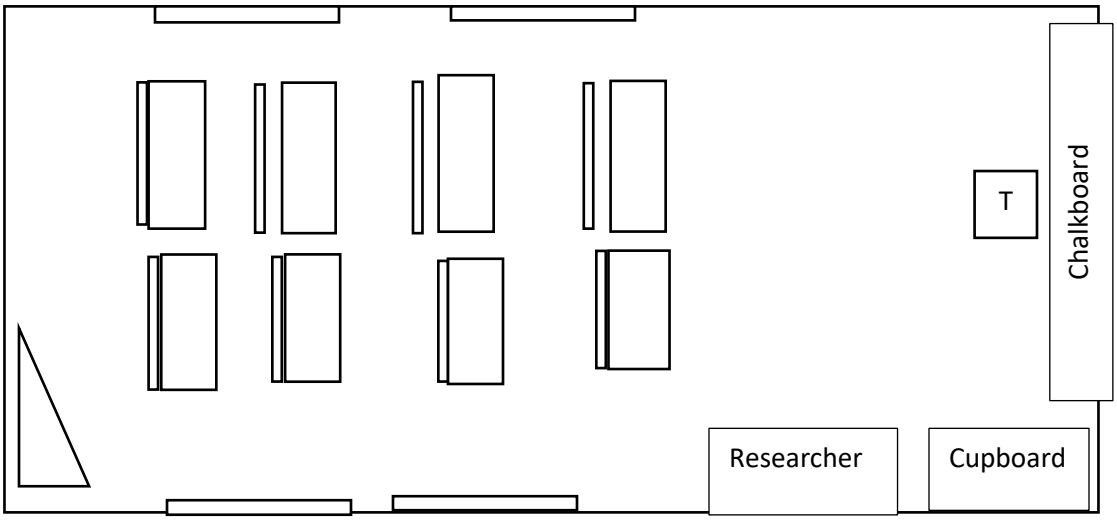


Figure 4.2: Setting in Teacher B's Classroom

Figure 4.3 represents samples of paper money that were used in the stalls in Teacher B's classroom during the lesson on addition and subtraction of decimal fractions.

Source: Pictures Taken from Internet (https://learningtools.co.za/shop/south-african-madiba-play-money/)

Figure 4.3: Pictures of money in Teacher B's classroom

According to the researcher's opinion, even though Teacher B showed elements of PCK in her class such as: reflection on prior lessons, lessons that were learner-centred, good usage of resources and good arrangement of learners, at times the teacher became uncomfortable when dealing with aspects that she was not sure of. According to the researcher's observation of this class, the Teacher B lacked flexibility and richness in

teaching because the teacher displayed inadequate knowledge of decimal fractions which is a sign of lack of PCK.

4.4.1.3 Classroom observation in Teacher C's class

This section explains the observation of Teacher C during the researcher's five day visit. Teacher C's classroom observation was carried during the second week when the researcher was done with Teacher A and Teacher B's observations. The researcher used the teacher's table throughout the observation period. The inside walls of the class were not plastered and only the calendar, place value chart and the class time table could be seen hanging on the wall. The counters and the abacus were in a box next to the teacher's table and were used only when required.

Unlike in Teacher A and Teacher B's classes, learners in Teacher C's class had no sitting problems. Learners were arranged in groups but seated in such a way that they could all see what was written on the board. Each learner occupied his or her own small desk with a drawer beneath to put own stuff. As learners were well seated, so was their working also good. Mathematics periods in this grade were scheduled as follows: two periods on Mondays starting from half past eleven till half past twelve and three periods for Wednesdays from half past eleven till one O'clock. Two periods were also used for mathematics on Tuesdays, Thursdays and Fridays early in the morning from half past seven till half past eight. All the periods were thirty minutes each.

The researcher had been to the research site before when arranging for observation as such the researcher was not strange to School Z. On the first day of observation of Teacher C, the researcher arrived earlier before the end of the second break and learners were giggling at seeing a stranger in their premises. Immediately after the bell rang, the researcher was shown a place to stay for all the observation period. She felt very comfortable as the table was closer to the chalkboard as she expected. The teacher introduced her to the learners and she was greeted excitedly. Teacher C' s observed lessons were taught in the following order; counting forwards and backwards

in decimal fractions, additions with carryings and subtraction of decimal fractions, multiplication, ordering, comparing and sequencing of decimal fractions and also length.

Teacher C introduced her first lesson by making use of the abacus and by pasting the place value chart on the chalkboard and then reminded learners of the place value of numbers, including decimals. She then presented her lesson on counting forwards and backwards in decimals which was followed by a group activity. While learners were busy working, she moved around checking if learners in all groups were on the right track. Those who struggled were assisted.

Before she could introduce her next lesson on additions with carryings and subtraction of decimal fractions, she first recapped on the previous lesson. Learners were given activities to complete individually. All remaining lessons were also presented in a similar way. That is, reviewing the previous lesson before continuing with next one, then give learners work to do individually in class or at home. She managed to control learners' work, but just like what Teacher A and Teacher B did, she also did not give learners constructive feedback. Figure 4.4 indicates the setting in Teacher C's classroom. The big rectangle attached to the wall is the chalkboard whilst the smaller rectangles inside the box represent learners' small desks arranged in groups. 'T' is the teacher.

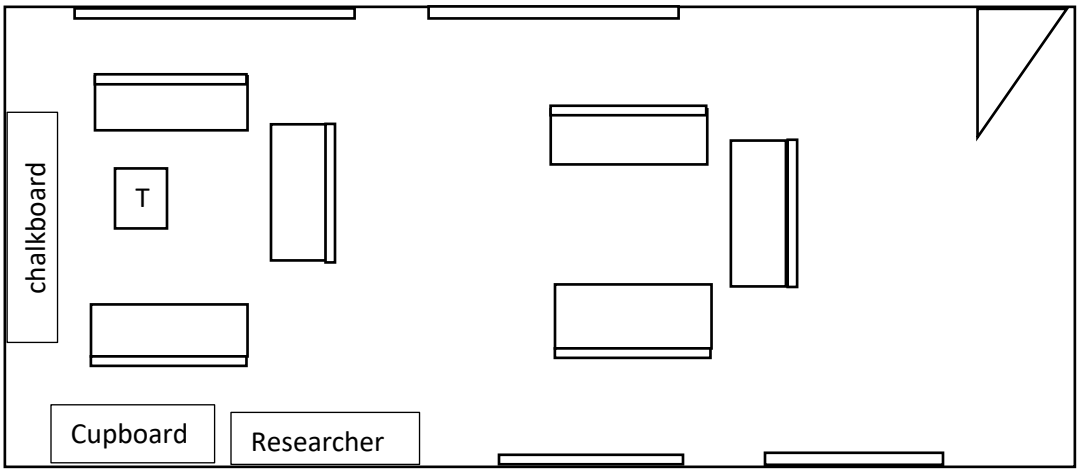


Figure 4.4: Setting in Teacher C's Classroom

Source: Picture Taken from Internet:
(https://www.eaieducation.com/Product/531004/Centimeter_Cubes_-_Set_of_1000.aspx)

Figure 4.5: Picture of Counters Used in Teacher C' Class

The researcher's observation of this class was that Teacher C showed elements of PCK. For example, the teacher displayed knowledge of learners' prior knowledge by recapping on what learners have already learnt before introducing a new lesson. In addition, her classroom arrangement, as shown in Figure 4.4, allowed interactions with learners: activities were given to learners and learners with difficulties were also assisted. However, Teacher C lacked another element of PCK in the sense that she could not give learners constructive feedback, which proved that the teacher's level of PCK was not up to standard.

4.4.1.4 Summary of classroom observation with Teachers A, B and C

In this section, the three teachers observed in their classrooms by the researcher are compared according to themes identified in Table 4.1.

Table 4.1: Summary of Classroom Observation with Teachers A, B and C

Aspects	Teacher A	Teacher B	Teacher C
Classroom management	Learners not grouped due to overcrowding and were not disciplined.	Learners arranged in groups and well disciplined.	Learners arranged in groups and well disciplined.
Learning environment	Not stimulating	Not stimulating	Slightly inspiring
Teaching and learning resources	Did not enrich learners' innovation	Did not enrich learners' innovation	Did not enrich learners' innovation
Mathematical context	The teacher used a loaf of bread and an orange cut into ten pieces to demonstrate decimal fractions. Then, learners were told that each piece is $\frac{1}{10}$which is the same as 0.1 as a decimal. Five pieces which is $\frac{5}{10}$ is similar to 0.5.	Specimen of South African currency, fraction panel and a chart with number lines used when teaching decimal fractions. For example R58.00- R20.00 = R38.00. Learners realised that R0.75c+ R0.32c= R1.07c is similar to 0.75+0.32=1.07	A game played with counters with different colours and a line drawn to separate whole numbers from decimal fractions to demonstrate place value of decimal fractions. An abacus was also used. For example, in 23.035, place value of 3 before a point is units, while the place value of 3 after the point is hundredths
Teaching strategies	Teacher based	Teacher and group based	Teacher and group based
Feedback to learners	Only a tick for work done correctly and a cross for incorrect workings. Feedback was not informative or constructive.	The teacher made a tick for work done correctly and a cross for incorrect workings. Feedback to learners was not informative or constructive.	The teacher made a tick for work correct work and a cross for incorrect workings. Feedback to learners was not informative or constructive.
Evidence of learners' misconceptions and problems	The teacher did not clarify where learners struggled. For example, why 2.135 was said to be smaller than 2.35.	Learners in need of clarity were ignored. For example, 28.34 +1.97= 30.31 and not 28.34+1.97=29.131 as written by the learner.	Learners were scared to ask questions. The teacher could not foresee whether they were challenged or not.
Learners' opportunity to share understanding	Learners were not given opportunity to share understanding with their peers.	Learners were given very little time to share their understanding with their group members.	Learners were given enough time to share their understanding with their peer**s.**
Conceptual knowledge	No evidence of conceptual knowledge. Only procedures taught.	No evidence of conceptual knowledge. Only procedures taught.	No evidence of conceptual knowledge. Only procedures taught.
Time given to spend on activities	Class works completed in class. Enough time for tasks completion. Tasks marked by the teacher and the student- teacher.	Time for tasks completion was too little. Not all learners wrote their home works. Books not marked in class were marked at home.	Enough time for tasks completion. Group activities and class works completed in class and marked by the teacher. Not all learners wrote home works.
Expertise	The teacher wrote few examples of common fractions on the board, like ½, ¼ before teaching decimal fractions.	The teacher recapped on the previous lesson before introducing a new lesson. Gave learners group or individual activities to complete. Checked learners' progress.	Recapped the previous lesson before introducing a new lesson on decimal fractions. Gave learners group or individual activities to complete. Checked learners' progress and assisted where necessary.

4.4.2 Findings from interviews

In Section 1.6.3 and in Section 3.6.1.2, it was stated that after conducting classroom observations with the three teachers, each teacher would be interviewed in order to understand each teacher's experiences and views regarding the teaching of decimal fractions in Grade 6. For the purpose of the current study, the researcher opted for a semi-structured interview whereby three teachers were interviewed based on the following advantages (Nieuwenhuis, 2012b:87):

a) It allows participants to answer a set of predetermined questions;
b) This data gathering technique allows for the probing and clarification of answers;
c) It defines lines of inquiry; and
d) Allows the researcher to guide the participants back to the focus of the interview in case they got side-tracked by unimportant issues not related to the study.

In the current study, data was collected in three ways: interviews, observations and document analysis. In analysing data from interviews, the researcher focussed on the responses of teacher A, B and C. Five interviews were conducted in Rakwadu circuit with three Grade 6 mathematics teachers (Section 3.6.1.2). The interview session lasted for 30 minutes with each teacher in different settings. The interviews were voice-recorded and then transcribed. As an example, one transcript has been included (see Appendix B). The transcriptions were read several times. For accuracy, the researcher also listened to the voice recordings of the three Grade 6 teachers. Data from observations (Section 3.6.1.1) and the official documents (Section 3.6.1.3) were also read several times and analysed.

The study used thematic analysis to analyse teachers' interviews. Vaismoradi, et al. (2016: 100) advised that theme development for qualitative data analysis helps to generate meaningful, credible and practical results. In making sense of the data collected from interviews, observations and document analysis. The study followed the

four phases of theme development suggested by Vaismoradi, et al. (2016) as highlighted in Section 3.7. These are the phases that qualitative analysis may follow in developing themes when analysing data, namely: initialization, construction phase, rectification phase and finalization phase (Section 3.7). During initialization, data collected from interviews, observations and document analysis were transcribed and read several times to have an understanding of the data. The researcher was careful of not losing important data. Data was reduced to manageable sections using coding system. Reflective notes were taken to assist the researcher remember, questions and make sense of data. The researcher then revised the codes and check for repeating codes. During the construction phase, the researcher compared the codes in terms of similarities and differences. The codes were revised and connected together to form a cluster. Each cluster of similar codes was labelled. It means codes were sorted into piles of similar meaning. These piles were then referred to as 'themes'. The coding was used to generate the eight themes, which are,: teacher's knowledge of decimal fractions, challenges in teaching decimal fractions, resources to teach decimal fractions, experience of teachers about learners in Grade 6, perception of teaching decimal fractions, making learning decimal fractions interesting, difficult decimal fractions and teaching strategies to improve learners learning of decimals. During rectification phase, the researcher verified the developed themes and integrates themes to subthemes. Lastly, during the finalisation phase, the researcher presented the narrative in which themes were described and linked to literature around which the content of themes in the study revolves. The eight themes that emerged from the data are discussed in Section 4.4.2.1 to Section 4.4.2.8

4.4.2.1 Teacher's knowledge of decimal fractions

The participants from the current study have revealed having different knowledge in relation to Grade 6 mathematics fractions and therefore, three (3) sub-themes were identified under knowledge of teachers, which are, namely: (a) Grade 6 mathematics fractions; (b) teaching methods; and (c) mathematical language and decimal fractions. These were thus analysed as follows:

Grade 6 Mathematics Fractions

The participants showed that they have similar understanding of the types of fractions taught in Grade 6:

> *"(…) firstly, we start with common fractions, and then we also deal with decimal fractions thus far."*
>
> (Teacher A)

> *"(…) in Grade 6 basically fractions that we dealing with are common fractions, equivalent fractions, decimal fractions they are the basics in Grade 6."*
>
> (Teachers B)

Decimal fractions were understood similarly by all participants and some practical examples were given to illustrate their understanding. Teachers were found to understand the areas which are covered in Grade 6 in the topic of decimal fractions and areas mostly mentioned were ordering, adding and subtracting.

> *"(…) decimal fraction is any number that has a decimal comma in it and then the word decimal from deci means one tenth."*
>
> (Teacher A)

> *"(…) I understand decimal fraction as fractions that have a decimal comma that separates the whole number from the fraction part. Here, one whole is cut into pieces of ten. This can best be shown by using the notation and place value columns".* (Teacher *C)*
> *"(…) the areas that are covered 'ehh' in decimal fractions we have ordering and then we also have adding fractions, subtracting fractions and then also on number lines. Ja, those are the areas covered in Grade 6 up to so far".*
>
> *(Teacher A)*

> *"(…) In decimal fractions the Grade 6 cover place value of decimal fractions, ordering of decimal fractions ,adding and subtractions of decimal fractions and conversion of decimal fractions."*
>
> (Teachers B)

> *"(…) Areas that are covered in Grade 6 are the following: count forward and backwards in decimal fractions; additions with carryings; and problem solving with decimal with carryings and addition, subtraction,*

multiplication, ordering, comparing and sequencing of decimal fractions and also length".

(Teacher C)

Teachers' insufficient knowledge which is a sign of lack of PCK, was found to be related to their different environments in which they acquired and learnt decimal fractions:

"I cannot lie that when I was still a learner that we were taught decimal fractions. I came across decimal fractions when I started teaching because, even in my three-year diploma, we were not dealing with decimal fractions in our mathematics".

(Teacher B)

"I only learnt decimals while I was in primary school".

(Teacher C)

"I learnt decimal fractions from my early ages when I was in primary level and then going to the college also introduced to decimals".

(Teacher A)

The findings of the current study show that some teachers have insufficient knowledge in relation to decimal fractions and they are confused when teaching in class. According to the researcher' view, these teachers were expected to have a deep understanding of decimal fractions and how to teach them to learners as proposed by Shulman' theory. However, the observed teachers lacked this element of a good PCK, which is a sign of lack of PCK:

"(…) another big challenge for me is that as teachers we got an insufficient knowledge of decimal fractions. For example, sometimes I am confused by comparison of decimal fractions e.g. 0.7 and 0.17; adding and subtraction of decimal fractions like 1.2 +1.35 and by conversions, either from common to decimals or from decimal to common".

(Teacher B)

"(…) the biggest problem I have with decimals is that at times I get confused as well while teaching decimals".

(Teacher C)

"the most challenging ones for learners and also for me maybe is when we add fractions on the number line or when learners try to find rules which were used on a number line and myself also find it a bit difficult

when we add or when we subtract or maybe when finding which one is smaller than the other or which ones are equal. That is the most difficult ones".

(Teacher A)

Teaching Methods

Teachers in Grade 6 from the schools participated in the study had different teaching methods for decimal fractions. Teacher A prefers to have leaners who are struggling to understand decimal fractions close to his table or chalkboard, whereas Teacher C starts by comparing and arranging decimal fractions in ascending order and vice versa. Teacher C also prefers using column method:

"(…) Err, firstly, I will take the learners…those learners who don't understand the decimals on a number line I have to let them come to my table or next to the chalkboard where I will be writing the number lines and writing those numbers as decimals".

(Teacher A)

"(…) I don't have to use only one method using many methods for them to understand. We can take a loaf of bread and divide it into slices and then I will explain to learners that each slice of bread is 1/10 and from that 1/10 is where we are going to make a decimal fraction and then working out saying 10 into 1 going zero times writing a zero and a comma and then adding zero to the 1 which will now be a ten".

(Teacher A)

"(…) I will start by teaching learners to compare and arrange decimal fractions in the order from smallest to biggest and vice versa. For example, counting from 0.1; 0.2; 0.3; 0.4; 0.5; 0.6. Then I will give more number lines to complete". "(…) I will make them understand that when zero is added to the last number after a decimal point, it has no value". "(…) I will use the number line to teach the learners counting in decimals from 0.1; 0.2; 0.3; … up to 1.1. Learners will now realize that the value of 1 before the comma as one whole and the value of 1 after a comma as 1/10".

(Teacher C)

"I will use the column method to help learners to understand the addition of decimals that requires carryings and subtraction of decimals that requires borrowing".

(Teacher C)

Teacher B prefers grouping learners to facilitate understanding of decimal fractions.

"*The first thing I do after I introduced the lesson and applied the methods, I group these learners and find the group leaders who can help and they work in groups of four that is co-operative or group method and the learners work as a group. After they have worked as a group, we correct the work and we come again to correct each group and learners will be indicating how they have worked. But in most of the time I move with the group to find out if they are lost and help them. So, it does not end there. I continue to give them work to work individually. After they have worked individually I would like to see those learners who didn't get correct answers. If there are still learners who didn't get the correct answers those will be my babies".*

(Teacher B)

Mathematical Language and Decimal Fractions

Teachers have a simpler way of making leaners to understand mathematical language and decimal fractions in Grade 6 by giving more illustrations when teaching in class:

"(…) I will tell learners that we should not write 0.10 instead we write 1.0 and continue counting from 1.0; 1.2; 1.3;…1.9 and the whole number continues to be 2.0".

(Teacher C)

"Supposes ½ if you want to convert it the learners must know that they are going to use their denominator to find out how many times does 2 goes into 1. In fact, it will give a zero answer and they must know that after a zero answer they must always put a comma and they add the zero on the 1 and when they say 2 into 10 it will give them five. Therefore the leaner must see that 0.5 is equal to ½ and so forth…"

(Teacher B)

"(…) *firstly you have to tell learners that the other method that we use is that one of division, dividing. If it is ½ I have to convert it to a decimal fraction such as 0.5.The first one you have to draw a line and then where you indicate that you are going to divide 1 by 2 asking learners how many times does 2 gets into 1. I think they will say 2 it does not go into 1 and then from there we write a zero and a comma as an answer, and I*

will also tell them that the decimal fraction is not yet complete". "(…) a whole number is out of 1, if is 4 is 4 over 1 but with a decimal fraction if is a tenth it becomes 1 over 10…. The difference between the two, the whole number is out of a one and decimals it becomes 1/10 which is a tenth like that and like that".

(Teacher A)

Literature also supports what has been said by the three teachers. For example, Huillet, et al. (2011); Maher and Muir (2011); Venkat and Adler (2012) posit that teachers are not comfortable with their own mistakes and have insufficient mathematical skills to teach confidently. Therefore the researcher is of the opinion that teachers are challenged in imparting what they are not familiar with, that is why they are confused when teaching decimals. Furthermore, the researcher maintains that the teachers' first encounters with decimals might be the contributing factor to teachers' lack of confidence in teaching decimals. To sum up, the researcher is of the opinion that for teachers to effectively teach decimal fractions, they should have a clear understanding of decimal fractions themselves which is sign of a good PCK.

4.4.2.2 Challenges in teaching decimal fractions

The current study has revealed that there are several challenges which are related to teaching decimal fractions in Grade 6. Some of the leaners do not have support from parents in doing school work at home:

"(…) the majority of learners in my class do not do their home works mainly they lack support from parents who don't encourage them to do their work." (…) I think parents' education level also contributes a lot".

(Teacher B)

"(…) the other reason is that they don't get help at home from family members".

(Teacher A)

Classroom overcrowding was found to be the other contributing factor to teaching decimal fractions as these cause limited learner individual contact with the teacher and leaners who are struggling are left behind in understanding decimal fractions:

> *"(…) challenges are caused by over crowdedness in the classes. You cannot apply individualisation to the learners you just work with the learners as a whole group and you can't focus on learners who are still struggling. Hence most of the learners struggle and will be left behind and when they proceed to the next grade that will be a challenge because the learners will have nothing".*
>
> (Teacher B)

The findings of this study also indicate that learners' conceptions of decimal fractions is very poor as some learners ignore the conversion rules when dealing with decimal fractions and they lack the awareness of the importance of denominators in common fractions:

> *"(…) In addition, learners' knowledge on decimal fractions and decimal value is very limited. For example, most learners in my class cannot perform simpler conversions like* $\frac{1}{10}$ *(0.1),* $\frac{1}{100}$ *(they mistakenly write it as 0.02) and* $\frac{1}{1000}$ *as 0.003 because they think that if the denominator in a common fraction increase so can he/ she increase the digits in a decimal as well".*
>
> *(*Teacher B)

Poor prior knowledge of mathematical concepts and operations involving fractions and decimals has been found to be one of the challenges in teaching decimal fractions and thus leaners have difficulties in learning.

> *"(…) Oh, I think I have to start with simple things. Maybe firstly talking about the common fractions teaching a little bit of prior knowledge to them and thereafter have to explain to them how from a common fraction we go to a decimal fraction trying all the methods".*
>
> (Teacher A)
>
> *"(…) When I teach decimal fractions, the most challenge that I am confronted with is learners who, most of the time when they come to Grade 6, they don't know how to place decimal fractions meaning that the teacher must start at the bottom so that they must know how to place them. But the most difficult one is when we come to conversions,*

because in conversions the learners has to know that suppose you want to change a common fraction into a decimal fraction the learners must know multiples and most of learners have got a challenge in multiplication and carrying of numbers and rounding off numbers".

(Teacher B)

"(…) the main stress is that the teacher when he is in class like myself most of the time I come to the conclusion that when the learners are coming into Grade 6 they do not have the basic you have to start from the beginning".

(Teacher B)

"(…) Hei, we are teaching learners 'ehh, ehh' who most of them don't understand most of the things in mathematics, so, in decimals, some of them when you explain you will find that maybe they just wonder what you talk about when you deal with fractions in mathematics so you will find that they find it to be a new lesson but their mentality cannot grasp 'ehh' the lesson".

(Teacher A)

The findings of the current study reveals that teachers might be challenged in teaching decimal fractions because of reasons such as: overcrowded classes or learners that might not be getting support from home. It is the researcher's view that learners in overcrowded classes, might be left behind as there is no chance for individual attention. As such they fail to do their home works, which leads to most learners to be left behind as there is no individual attention or it might be because of poor learner conceptions of decimals.

Literature verify what has been said by the three teachers that one of the challenges in teaching decimal fractions is that learners do not understand decimal fractions, like place value of decimals, multiplication of decimals, addition that requires borrowings, just to name a few. For example, Kastberg and Morton (2014) revealed that the source of these problems appeared to be weak understanding of place value units and link between units. In addition, researchers such as, Abuz and Yayan (2010); Girit and Akyuz (2016), maintained that reading scale, ordering numbers, finding the nearest decimal and doing operations like adding and subtracting are a challenge in teaching

and learning decimal fractions. The researcher therefore is of the idea that it would be appreciated if teachers' understanding of decimal fractions could be enhanced for teaching and learning of decimal fractions. This could lead to teachers' good PCK.

4.4.2.3 Resources to teach decimal fractions

A collection of resources for the teaching and learning of decimal fractions in Grade 6 were found to be related to several constructs in the current study. Some resources were found not to be available at schools and making it difficult for teachers to provide leaners with adequate information to learn decimal fractions:

> *"(…) we don't have more resources that are delivered by the department to make it simple for the learners to grasp the lesson. In fact, maybe if we had more learner support material, those things that I think maybe it will make it easy for learners to understand when we teach about decimals".*
>
> *(Teacher A)*

> *"(…) I should have relevant resources that will help in teaching decimal fractions". "(…) again our school has limited resources only one kind of mathematics textbook".*
>
> (Teacher C)

Teachers in the current study used other educational resources such as posters and examples of bread in teaching leaners how to identify and work with decimal fractions:

> *"(…) err; I think the use of teaching and learning aids like posters with decimals fractions can help a great deal".*
>
> (Teacher A)

> *"(…) because they are very vital or important as the saying say learners learn a lot through viewing. When they see the pictures or when using resources such as bread, pie charts, learners will enjoy the lessons when they see those pictures.*
>
> (Teacher B)

The Department of Basic Education (DBE) is engaged with developmental programs such as workshops to equip and enrich mathematics teachers on teaching skills to improve understanding of mathematics by leaners:

> *"(…) and also from the departmental point of view, they try to support us when we are at workshops".*
>
> (Teacher A)

> *"(…) But hence forth because of the workshops that we attended, and the teacher's guides that we have it was when I was confronted with decimals fractions per se for teaching a learner. "(…) Err, I think the fact that we are just given two hours micro-wave workshops twice a year might be having a great influence, more especially because in primaries teachers are just given subjects to teach without considering their knowledge in the subject".*
>
> (Teacher B)

Based on the findings from interviews with the participants, it was found that lack of resources supplied by the DBE might make it difficult for teachers to teach mathematics to learners effectively. In addition, it was also found out that, teachers in primary schools are just offered mathematics to teach just like with any other subjects without first considering the teacher's knowledge in mathematics. It is the researcher's view that the teachers in the study lacked good PCK. According to Shulman (1986), teachers with a sound PCK should know what they teach adequately, that is, they should have a deep understanding of mathematics and know how to teach it effectively as well as a profound knowledge of resources .

The researcher therefore is of the opinion that ample resources such as Cuisenaire rods or base-ten blocks be supplied to schools to facilitate teaching of mathematics, including decimals. Besides, teachers' expertise in mathematics should be also considered in primary schools in order for teachers to teach decimal in Grade 6 effectively.

4.4.2.4 Experience of teachers about learners in Grade 6

The teachers in the current study have different experiences with regard to learners in Grade 6 and mathematics subject in general. Some teachers find it difficult for leaners to learn how to subtract fractions using the borrowing method.

> *"(…) Learners find it difficult to add and subtract fractions that require borrowings and carrying over".*
>
> (Teacher C)

> *"(…) In fact fractions, dealing with fractions not only decimal fractions. They become more difficult to learners very difficult for them to grasp. I don't know what is happening to their minds but most of them really don't understand the decimal fractions it's hard for them to understand just because they have different minds but, we have most of them who don't understand I really cannot tell what is happening to their minds when you teach them fractions and you will even use different methods but still we have a lot of learners who don't understand".*
>
> (Teacher A)

Teaching mathematics to the slow learner is a challenging task for many teachers but it was found that the teachers in the current study understand that mathematics may be challenging for slow learner, but not impossible to handle. Therefore, teachers have some techniques to help slow learner by giving them extra attention and working with a small group of learners to respond effectively to each learner:

> *"(…) I think some of the learners can get the matter when you take them next to you and teach them alone because if you teach them with other learners who are progressed for, then it became difficult for them. But if you do remedial by taking them and putting them one side and showing much examples there as much as they can have, I think that will be of great help for them to understand. As you could see I had one learner in front of others he had to count on the chalkboard so that he could get the correct answer. So remedial is very important for the learners who don't understand".*
>
> (Teacher A)

> "*If there are still learners who didn't get the correct answers those will be my babies. I have to put them aside and give those who managed to get the correct answers some work to do. At the same time, I will be dealing*

with those who didn't master the concept. Tomorrow I check those who didn't manage to get the correct answers."

(Teacher B)

The findings from the interviews with the respondents indicated that teachers have different ways of dealing with slow learners regarding mathematics, for example, working with a manageable number of learners. Despite this, the researcher is still concerned by a huge number of learners who still struggle with decimal fractions. The researcher therefore believes that if these teachers know and understand learners' different learning styles which are one aspect of a good PCK, learners in their classes could excel in decimals. However, this was not the case in the observed classes, which clearly indicate that these teachers lacked PCK. The researcher is of the opinion that working with a manageable class, might be a challenge as most of the schools in the Rakwadu Circuit have overcrowded classes which might be difficult for teachers to apply individualisation to assist such learners.

4.4.2.5 Perception of teaching decimal fractions

It was found that teachers have negative attitude towards mathematics. Furthermore, teachers claimed that learners in their classes show no interest in learning mathematics which lead to poor performance. In addition, teachers emphasised that learners display a negative attitude towards mathematics and that learners' ability to conceptualise the contents of mathematics in class is affected.

"(…) many teachers and learners find mathematics being difficult and lose interest in mathematics learning".

(Teacher C)

"(…) the stress related to that is that the teachers do no longer enjoy teaching mathematics as a subject because they think learners don't want to learn mathematics forgetting that we ourselves don't give chance to learners". "(…) Besides, I am also puzzled by the attitude that learners have towards mathematics in general".

(Teacher B)

The understanding of fractions including decimal fractions is central for future mathematics attainment and for capability to prosper in many careers but the teachers in the current study found that learners have difficulties in understanding decimal fractions:

> *"(…) Hei, we are teaching learners 'ehh, ehh' who most of them don't understand most of the things in mathematics. So in decimals some of them when you explain you will find that maybe they just wonder what you talk about when you deal with fractions in mathematics so you will find that they find it to be a new lesson but their mentality cannot grasp 'ehh' the lesson".*
>
> (Teacher A)

> *"(…) The main stress is that the teacher when he is in class, like myself most of the time, I come to the conclusion that when the learners are coming into Grade 6 they do not have the basic, you have to start from the beginning and that you find that you have an attitude with the previous teachers who were teaching the learners and that displays the attitude or the impatience with the learners you find that you are rude and impatient when you work with the learners".*
>
> (Teacher B)

Emanating from the findings of interviews with participant, the researcher is of the opinion that if learners and teachers could have a negative attitude towards mathematics, South Africa might continue to be ranked least as compared to other countries. Literature also confirms this idea. For example, Spaull (2013) maintained that South Africa is ranked eighth for mathematics as compared to poorer countries like Tanzania, Swaziland and Kenya.

4.4.2.6 Making decimal fractions interesting

The teachers in the current study have different ways of making decimal fractions teaching thrilling and interesting. Teachers A and B make learning of decimal fractions interesting in the classroom situation, whereas Teacher C had plans to take learners for a trip to learn decimal fractions.

"I will organise trips to local shops to show them how prices in the form of decimals are marked on items. Lastly, I will rotate leadership roles in the groups to instil the love for decimals fractions and confidence in them. I think this will make decimals interesting."

(Teacher C)

"I use resources such as bread. Oranges can be used and then writing on the chalkboard using smaller pictures like people. I think that will be interesting for the learners…"

(Teacher A)

"In our school we have a mathematics kit and we have got paper money and coin money which are in the form of paper. Most of the time I group them in groups and I give each group a certain amount of money and we have a stall where they go and buy and have change in that way we deal with addition and subtraction and sometimes they need to go give each other how much will they need to give each other how much will they have in their group, that's where addition and subtraction come. They do not make mistakes most of the time because I am not just saying 0.25 add to7.23, now they are working with money at the end of the day they will be winners. The learners who have been able to do their calculations well they get something from the teacher for break".

"(…) Sometimes, even if I don't give money, we have a scale point that each and every week we put those groups who score high and at the end of the week we celebrate for those who got lots of points. You find that in decimal fractions most of the times to make decimals interesting I talk of money so that learners must integrate decimals with the money because at the end of the day knowing how to place decimal fractions will be able to learn money problems with ease".

(Teacher B)

The findings indicated that teachers have different ways of making decimals fractions interesting to learners. For example, using real life situations when teaching decimals like, bread, oranges, visiting local shops or playing games with counters. Literature also supports this, for example, Ubuz and Yayan (2010) maintain that learners who worked on contextualised decimal problems would have an improved scientific decimal knowledge as well as an amplified retention of decimal knowledge. For example, working on daily examples incorporated with mathematical problem posing such as price lists of pizza shops (Ubuz & Yayan, 2010).

The opinion of the researcher on this is that learners should be presented with suitable decimal fraction problems that are related to their everyday situation. This suggests that mathematics teacher should provide learners with increased opportunities to create their own knowledge and thoughts. In addition, teachers should be acquainted with learners' prior knowledge since experience is the best teacher.

4.4.2.7 Difficult decimal fractions

The findings in the current study indicate that teachers confirms that there are areas in decimal fractions that are difficult to teach and learn.

> *"Learners find it difficult to add and subtract fractions that requires borrowings and carrying over".*
>
> (Teacher C)

> *"Most learners are confused. They are unable to convert a simple fraction to a decimal." "(…) also find it a little bit difficult when we add or subtract…"*
>
> (Teacher A)

> *"The challenging ones are the conversions of decimal fractions. They are the most difficult ones in teaching learners".*
>
> (Teacher C)

The findings in the current study indicate that it is not easy to teach decimal fractions. This problem is also experienced worldwide. Literature also agrees to what has been said by the participants. For example, Ubuz and Yayan (2010) claims that primary teachers face problems that learners face. Further literature also support the idea mentioned concerning teaching decimals. For instance, Muzheve and Capraro (2012) attested that primary teachers experienced problems when working with concepts on place value, working with fractions, multiplication of decimal fractions, percentages, and measurement. Beswick et al. (2012) support this idea when saying that teachers and textbook authors rely on procedures in order to quickly generate correct answers.

The researcher's opinion on this is that teachers need to have PCK on decimal fractions as proposed by Lee (2010) in order for them to teach decimal fractions without difficulties.

4.4.2.8 Teaching strategies to improve learners learning of decimals

The teachers in the current study revealed that they use and prefer both general and specific strategies designed to enhance learner's performance in decimal fractions:

> *"(…) err; I think the use of teaching and learning aids like posters with decimals fractions can help a great deal. Peer teaching can also help. Besides I also believe that team teaching time and extra classes such as morning studies can be useful". "(…) I don't have to use only one method using many methods for them to understand".*
>
> (Teacher A)

> *"(…) Ja, I think co-operative learning can work. Err, here you find that a concept is introduced to learners and follow steps of how calculate. Then the learners proceed to work as a group and help each other. The size is reduced and until individually, they calculate separately. Again, I think individualization as a strategy can work. Here I will focus on those who could not manage to get correct answers during group work. The last strategy that I will be using is remedial exercise. Here I will be working with those who find it difficult to cope".*
>
> (Teacher B)

> *"(…) as a mathematics teacher I can cultivate the learners' love for decimal fractions by developing a game played with counters. I will draw a line on the floor and let two learners stand to the right side of the line and the other 2 learners to the left side of the line. The line shall be the comma. Each learner will be given 10 counters. Each learner will have a colour different from the others. Learners on the left hand side will be whole numbers that is, Units and Tens, and learners on the right hand side of the line will be the tenths and the hundredths. A learner with hundredth will count the counters up to ten, then the learner holding the tenths counter will drop one (1). So on and so on. The learner holding the tenths counters will count his/her counters until he/ she reaches ten, the learner holding the unit counters will drop the counter until ten and so follow the one holding the tens counters. The game will go on and on. That will show addition of decimal fractions and the reverse thereof will show subtraction".*
>
> (Teacher C)

The findings in the current study revealed that teachers have a variety of strategies to make teaching decimals easy. Literature also supports this idea. For example, Nisbet, (2015) claims that teachers need to have a variety of strategies derived from both investigations and knowledge to supply learners with more clarifications. Furthermore Durkin and Rittle-Johnson (2015) support this idea when they maintained that learners could master decimals to improve their learning in more advanced mathematics only if teachers could develop strategies that could assist them.

Therefore, the researcher's view regarding this is that mathematics teachers in Grade 6 should employ countless teaching and learning strategies when teaching decimal fractions to avoid teaching procedures and making learners memorise the rules. This would in turn assist learners to understand and apply mathematics for future use. The findings from interviews with the three teachers can be summarised in Table 4.3:

Table 4.3: Summary of interviews with Teachers A, B and C

Themes	Teacher A	Teacher B	Teacher C
Teachers' knowledge of decimal fractions	The teacher learnt decimal fractions at Primary level and at the college. Learners and teacher are challenged in adding fractions on the number line or when learners try to find rules which were used on a number line.	The teacher did not learn about decimals at school or at college. Another big challenge is insufficient knowledge of decimal fractions, comparison of decimal fractions and conversions, either from common to decimals or from decimal to common.	The teacher learnt about decimals in Primary school. The teacher also got confused while teaching decimals.
Challenges in teaching decimals	Most learners don't understand most of the things in mathematics. Learners are puzzled by decimals and find it difficult to understand.	Most learners in class cannot perform simpler conversions like $\frac{1}{10}$ (0.1), $\frac{1}{100}$ (they mistakenly write it as 0.02) and $\frac{1}{1000}$ as 0.003" because they think that if the denominator in a common fraction increase so can he/ she increase the digits in a decimal as well".	Teacher faces challenges in introducing decimals because learners cannot *differentiate between whole numbers and* fraction *part*
Resources to teach decimal fractions	Bread, oranges and smaller pictures like people.	Fraction panel number line, bread, sample of South African currency and pie charts.	Abacus and a place value chart showing the number line, counters and a textbook.
Experiences to decimal teaching	Most learners do not understand decimal fractions.	Learners' knowledge on decimal fractions and decimal value is very limited.	Learners find it difficult to add and subtract decimal fractions that requires borrowings and carrying over.
Perceptions of teaching decimal fractions	Learners wonder when taught about decimals. The teacher find it difficult to teach decimals	Puzzled by learners and teachers' attitudes towards mathematics. Teacher do no longer enjoy teaching mathematics.	Many teachers and learners find mathematics difficult and lose interest in learning it.
Making decimals interesting	Use pieces of bread and oranges. Use pictures of small people in completion of number lines.	Give groups of learners sample paper money to buy in stalls when dealing with addition and subtraction of decimals.	Visit local shops to see how prices are marked in decimals. Use a game of counters. Rotate leadership roles.
Difficult decimals fractions	Conversion, addition, subtraction and ordering of decimal fractions.	Conversions, place value and meaning of decimals, for example, addition of decimal fractions with carryings and subtraction of decimal fractions with borrowings.	Addition involving carryings and subtraction involving borrowings
Teaching strategies	Peer and team teaching as well as remedial classes.	Co-operative learning, individualisation and remedial work.	Use game of counters and team teaching.

4.4.3 Findings from document analysis

The current study conducted an analysis of three lesson plans and three mathematics classwork and homework books obtained from Grade 6 mathematics teachers from the participating schools. That is, one lesson plan of teacher A, teacher B and teacher C as well as one mathematics classwork and homework book of one learner from the participating schools (Section 3.6.1.3).

4.4.3.1 Teacher A

Teacher A's lesson planning

In Section 3.6.1.3 , it was discussed that the researcher used documents such as teacher's lesson plans in order to check how teachers apply their knowledge in the classroom in order to make judgments concerning lesson outline in own classroom. This would assist in answering the research question number (a). The format of Teacher A's lesson plans were the same in all lessons observed. The lesson template always started with the specification of the grade level, the name of the subject, the topic of the lesson, duration and date of the lesson. In addition, the lesson template indicated the content and concepts followed by teaching methods be used and then the aims and objectives of the lesson.

However, the portion on prior knowledge remained blank in all Teacher A's lessons. Furthermore, Teacher A indicated the manner in which the teaching would unfold by writing the activities of both the teacher and the learner during the lesson, as well as the teaching and assessment strategies, resources to be used and the teaching reflection. Learners were never grouped in all his observed lessons though indicated in his planning that learners would work as a group. Instead, learners spontaneously replied whenever a response was needed.

As a result, learners did not have a chance to share their understanding with their classmates but followed procedures given by their teacher. They worked individually whenever an activity was given. On his lesson plan, it was indicated that learners who

did not understand the lesson would be given remedial work, but that never happened. Teacher A's lessons did not indicate possible difficulties and misconceptions that learners might have as expected by the researcher. According to the researcher, Teacher A's lesson preparation and instruction thereof revealed lack of PCK. Teacher A's lesson plan is indicated as Figure 4.6.

LESSON PLANNING

Intermediate and Senior Phases

(Grade 6)

Subject: Mathematics

Grade: 6		
Topic: Decimals	Duration: 1 hours	Dates: 3 May 2017
Contents and concepts: Numbers, operations and relationships.		

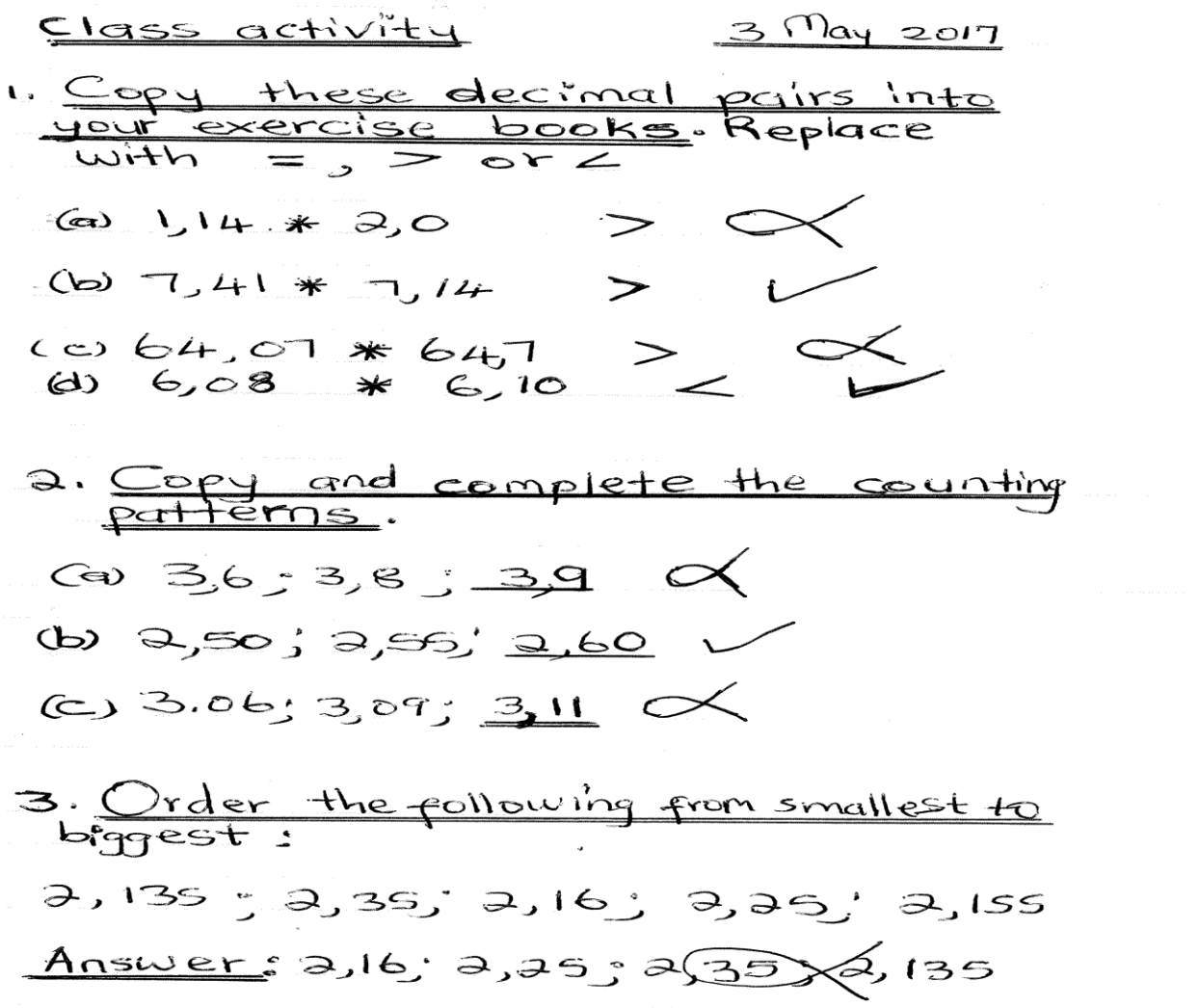
Prior knowledge:	Content knowledge:
Learners know common fractions	Decimal fractions. Ordering decimal fractions.
Teaching methods Groups and Individual	Calculations with decimal fractions.
Aims and objectives Develop the concept of decimal fractions	

Teacher Activity	Learner's activity
Teach learners to count to at least two decimal fraction e.g. 11,2 11,205 11,21 11,25.	Learners work in groups to count forwards in decimal fractions to at least two decimal places.
Teach learners how to add and subtract decimal fractions of at least two decimal places. let them estimate their answers before calculating.	Learners add and subtract decimal fractions.
Teaching Strategies Expanded Assessment Strategies Opportunity	Assessment Strategies
Helping learners who do not understand the learners (Remedial)	Learners are given a Class Activity on Counting and Substracting
Resources Learners' book Workbook Chalkboard	Teaching Reflection The lesson was completed and learners understood.

Figure 4.6: An example of Teacher A's Lesson Planning

Learners' class and homework books

Given that three learners shared a small desk (see, Section 4.4.1.1), learners' working was untidy and some were difficult to read. During the last observed lesson on ordering decimal fractions on a number line, most learners were still confused. Those who managed to get it right were those whose could recall the procedures as shown by Teacher A. Figure 4.7 shows an example of mistakes made by Teacher A's learners.


Class activity 3 May 2017

1. Copy these decimal pairs into your exercise books. Replace with =, > or <

(a) 1,14 * 2,0 > ✗

(b) 7,41 * 7,14 > ✓

(c) 64,07 * 647 > ✗

(d) 6,08 * 6,10 < ✓

2. Copy and complete the counting patterns.

(a) 3,6; 3,8; 3,9 ✗

(b) 2,50; 2,55; 2,60 ✓

(c) 3.06; 3,09; 3,11 ✗

3. Order the following from smallest to biggest:

2,135; 2,35; 2,16; 2,25; 2,155

Answer: 2,16; 2,25; 2,35 ✗ 2,135

Source: Questions adapted from Viva Mathematics ***Grade*** *6: 2012*

Figure 4.7: Mistakes of Teacher A's learner

Looking at the learner's working (Figure 4.7), it could be assumed that the learner did not understand the procedures laid by the teacher. Teacher A 's posing of activity 1 was challenging. The instructions in activity 1 were not clear, and possibly confusing to a Grade 6 learner. For example, learners were not sure of what they should be "replacing". If learners do not understand the instructional strategies adopted by the teacher, errors are likely to occur (Luneta, 2015). It is the researcher's view that the teacher's posing of the task 1 in Figure 4.7 is poor, which also questions the teacher's PCK. It shows that PCK requires a teacher to not only to have mathematical knowledge, but also to be able to communicate such knowledge (including task instructions) meaningfully to learners. If mathematical knowledge is miscommunicated to learners, it may be misunderstood, thus resulting in misconceptions that will manifest themselves in learners' work as errors (Luneta, 2015). In addition, the researcher believed that this might be due to the fact that throughout the observation period, Teacher A was not confident enough when teaching or it might be that the teacher was not sure of what was being taught. All the lessons lasted for 20 minutes. The teacher spoke very fast and did not consider giving learners time to share their understanding. At one incident, Teacher A stopped two learners who were looking for clarity about what was taught, but instead those learners were told to reserve their question till the end of the lesson. Unfortunately, they were never attended to. Despite this, learners' problems might be related to the fact that Teacher A did not have time to attend to and correct mistakes made by learners during teaching.

Teacher A did not manage to mark or control all learners' class works or home works during mathematics periods and, as a result, the remaining books were marked by the student-teacher on the next lesson, while the teacher was busy offering another lesson in other subjects that he was responsible for teaching. A tick was accorded for work done correctly, but those who did not get it right the teacher simply wrote comments such as, 'not right' or that 'redo it again'. This indicated that learners did not receive constructive feedback which led many of them frustrated.

Generally speaking, the amount of work that Teacher A gave to the learners was not enough for Grade 6 learners. Habitually, the teacher would as an illustration give four or five examples in an hour period and then refer learners to complete an activity in their textbooks or workbooks supplied by the Department of Basic Education. Generally speaking, the learners' work in Teacher A's class displayed lack of the teacher's PCK as his lessons lacked flexibility in content delivery and richness in the teaching of decimal fractions.

4.4.3.2 Teacher B

Teacher B's lesson planning

Teacher B used the same style in all her lesson planning. In all lessons that were observed, the outline of the lesson plans were as follows: Subject, grade, date, duration, content, context and the topic for the day. In all the lesson plans, Teacher B allocated time as follows; ten minutes that would be used for oral and mental work, ten minutes for correction of previous work, twenty minutes for lesson presentation, and fifteen minutes for problem solving where learners would be working either individually or as a group to work on problems given.

Furthermore, the teacher indicated the form of assessment to be used, the method of teaching, expanded opportunities and the reflection by the teacher. Surprisingly, all the lesson plans did not indicate the objectives of the lesson. Though Teacher A used fraction panel, a chart with number lines and a specimen of South African currency in some of the lessons, the column on resources to be used on a particular lesson remained blank at all times. Similar to lesson planning in Section 4.4.3.1, Teacher B' lesson plans did not accommodate possible difficulties and misconceptions that learners might have as expected by the researcher. This indicated the teacher's lack of PCK. Teacher B's lesson plan is indicated as Figure 4.8

Subject: Mathematics School: ..... Grade:
Date: 9/05/2017
Educator: ..... Duration: 1hour Week: ..

CONTENT: Numbering operations and relationships
CONTEXT: Decimal fractions
Link with previous lesson: counting of decimal numbers
Link with next lesson: comparing of decimal numbers

Topic:	Concept and skills:
	Oral and mental work: (10 min) Learners will count verbally, backwards and foward on specific given sets e.g. Counting in 0,5's from 10,5 to 20,0
Addition and Subtraction Of decimal numbers	**Review and correction of Homework: (10 min)** Previous work, correc **Introduction of concepts: (20 min)** Learners will be given the following numbers to calculate. e.g. 0,75 + 25,45 • Learners should be aware of the following :- placing numbers in order to add correctly • Observing numbers next to the comma to follow or be on same point. $\begin{array}{r} {\scriptstyle 1\ \ 1} \\ 0,75 \\ 25,45 \\ \hline 26,20 \end{array}$

1

• Learners will be given similar number to subtract :- 82,45 – 7,252 correctly.
› They must place numbers correctly
› They must observe a decimal point

e.g.
$$
\begin{array}{r}
82,450 \\
-\ 7,253 \\
\hline
75,192
\end{array}
$$

Problem solving: (15 min)

Learners will be given classwork on the following : (1) 20,0 – 18,45
(2) 28,34 + 1,1

In their groups : ~~they w~~
They will at the same time link decimal numbers with money problems.
e.g. Hoto used her pocket money, R15,50 she saved for the week, to buy a ruler for project by R1,75. How much left in her money box?

Homework: (5 min)

Learners will have to use all the answers of problems they have solved, and put them in ascending order.

Assessment: Peer Assessment	**Method:** group-based	**Form:** Classwork / homework	**Tool:** Memoranda.

Resources:

Expanded opportunities: If learners can add / subtract decimal numbers will help them to solve money problems with ease.

Teacher reflection: The teacher will use homework or classwork given to check if they all understood. In cases where others are falling behind, they will go for an extra class.

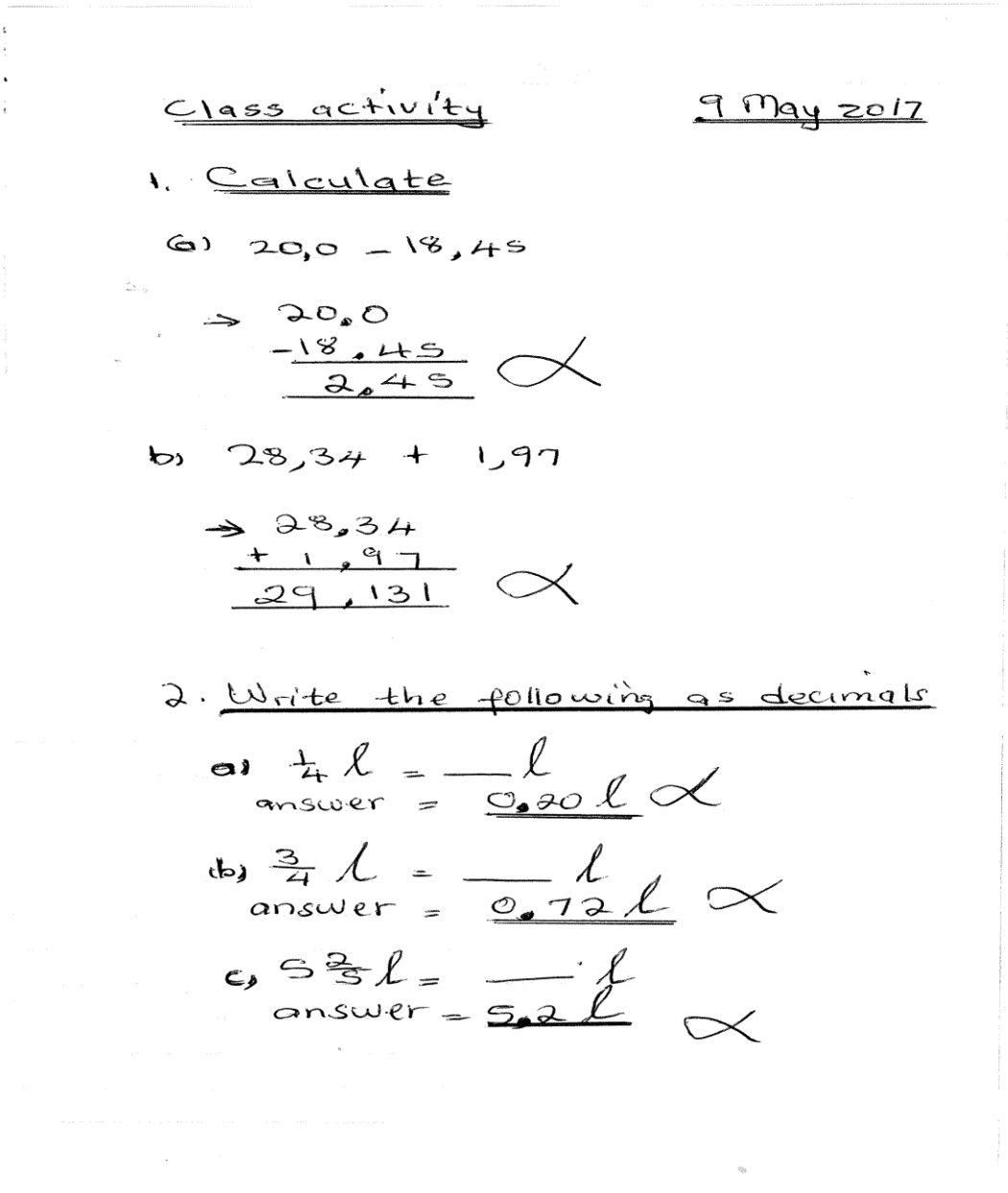
2

Figure 4.8: Teacher B's lesson planning

Learners' class works and homework books

By studying learners' class works and homework books (see Section 1.8), the researcher sourced information regarding learner performance, mistakes and misconceptions which would in turn reveal the teacher's PCK. Such information could be reflected by the kind of questions handed to learners, the types of strategies that learners used in order to find solutions to problems as well as the feedback provided by the teacher. The researcher's observation of this class was that the above-listed elements of PCK were missing, which revealed the teacher's lack of PCK as far as decimal fractions is concerned.

Though Teacher B's classroom looked very old, the learners' books looked much better as compared to learners' books in Teacher A's class. Despite the fact that their works were not neat, learners worked out the given problems going down to the bottom of the page. The teacher managed to mark few learners' books after a lesson and the remaining ones were collected and marked at home by the teacher. Figure 4.9 provides an example of learner's working in Teacher B' class


Class activity 9 May 2017

1. Calculate

a) 20,0 − 18,45

→ 20,0
−18,45
2,45 ✗

b) 28,34 + 1,97

→ 28,34
+ 1,97
29,131 ✗

2. Write the following as decimals

a) $\frac{1}{4}\ell$ = ___ ℓ
answer = 0,20 ℓ ✗

b) $\frac{3}{4}\ell$ = ___ ℓ
answer = 0,72 ℓ ✗

c) $5\frac{2}{5}\ell$ = ___ ℓ
answer = 5,2 ℓ ✗

Figure 4.9: Mistakes made by Teacher B's learners

Due to her impatience with learners, Teacher B's feedback to learners was not informative. After marking the learner's work she simply wrote 'go and try again' but not indicating where or how the learner went wrong. Most of the learners got embarrassed and became passive in the next lessons.

4.4.3.3 Teacher C

Teacher C's lesson planning

All Teacher C' s lesson plans were structured using the same format indicated in Figure 4.10 as; subject, topic, grade, resources, prior knowledge, teaching and learning activities as well as consolidation. Just like the other participants in the study, Teacher C did not indicate the aim or objectives of the lesson and also the teaching method to be employed. Figure 4.10 provides an example of Teacher C's lesson planning.

After examining Teacher C's lesson planning, the researcher could quickly detect that most important elements of a good lesson like, the aim or objective of the lesson and teaching and learning methods were missing which indicated the teacher's lack of PCK.

SUBJECT: Mathematics GRADE: 6

Term: 2

DURATION: 1 Hour

1. CONTENT AREA: Numbers, Operations and Relationships
2. Topic: **Decimal** fractions
3. Concepts and skills: By the end of the lesson learners should be able to compare an order decimal fractions to at least two decimal places
4. Resources: Text book
5. PRIOR KNOWLEDGE: Count forward and backwards in decimal fractions to at lea two decimal places.
6. **INTRODUCTION** (Suggested time: 10 minutes)

Activity 1

1.1 **What is the value of each underlined digits?**

a. 0,0$\underline{8}$

b. 0,$\underline{2}$5

c 0,7$\underline{3}$

1.2 What is the value of the 5 in each decimal?

a. 0,52

b 0,5

c 0,55

7 LESSON PRESENTATION/DEVELOPMENT: (Suggested time: 25 minutes)

TEACHING ACTIVITIES	LEARNING ACTIVITIES
The position of the digit in a number gives the place value of the digit. e.g 0,06 is six hundredths. 0,3 is three tenths. Hundredths are smaller than tenths. Therefore 0,06 is smaller than 0,3	Activity 1 1.1 Write < or > between the pair of decimals a. 0,5 ____ 0,05 b 0,45 ____ 0,05 1.2 Order each set of numbers fr smallest to biggest. a. 0,4 0,04 4,44 0,39 b 1,69 7 1,96 7,69

8 CLASSWORK (Suggested time: 15 minutes)

1. Insert the missing symbols
   a. 0,65 — 0,57
   b 2.4 — 0,42
2. Complete the sequence numbers
   a 0.056 0,66 0,76 —, —, —
   b. 0,56 1,56 2,56 —, —, —
3. **Write the numbers from the smallest to the biggest**
   a. 254 3,65 2,60
   b 2,53 4,68

9. CONSOLIDATION/CONCLUSION AND HOMEWORK (Suggested time: 10 minutes)

a. The teacher emphesises that when we compare the size of decimal numbers
   - We first compare the whole numbers
   - then digits in the tenths position
   - then compare digits in the hundredths position and so on.

b. Homework

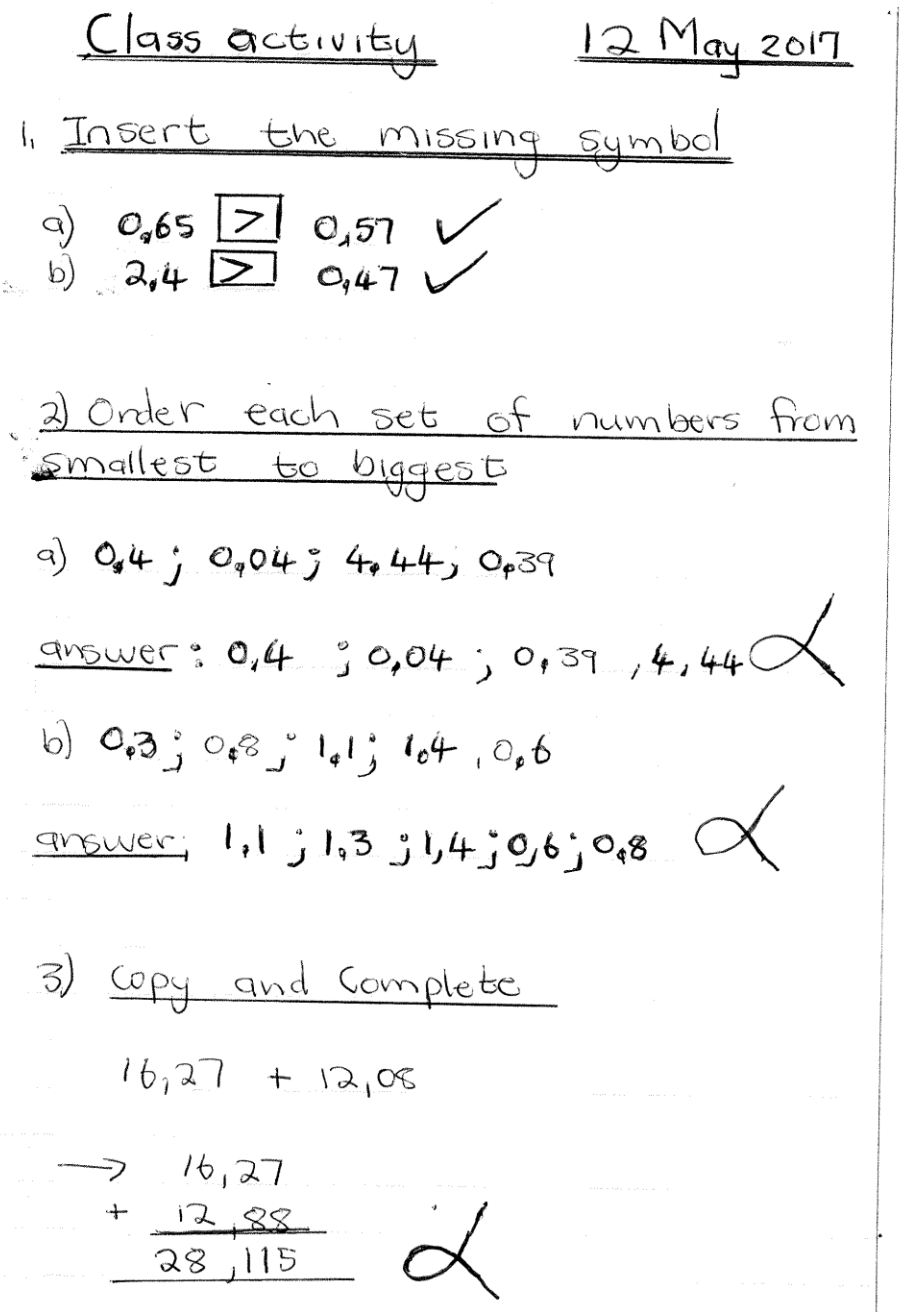
   - Solution for all Page 138. NO: 3, 4 and 5

Figure 4.10: Teacher C's lesson planning

Learners' class and homework books

Learners' classwork and homework books in Teacher C's class were very neat and could be read with ease. Learners' working started from top to bottom of the page. In all activities done, learners were instructed to follow procedures as given by the teacher. No learner applied a different strategy other than the one given by the teacher. Learners were not given chance to attempt problems using their own strategies. It is the researcher's view that teachers were not knowledgeable and were uncomfortable with strategies that learners might have used. It shows that teachers in the study lacked PCK The researcher thought that maybe this was due to the type of questions asked that were really not challenging.

The teacher marked all learners' books by only using a tick for work done correctly or a cross for incorrect working. Apart from this, learners did not get any further explanation or clarity on work done incorrectly. In doing that, learners did not get any informative feedback. According to the researcher, the preceding observations seemed to suggest that teachers lack PCK. Figure 4.11 provides an example of learner's working in Teacher C's class (questions adapted from Viva Mathematics Grade 6).


Class activity 12 May 2017

1. Insert the missing symbol

a) 0,65 [>] 0,57 ✓

b) 2,4 [>] 0,47 ✓

2) Order each set of numbers from smallest to biggest

a) 0,4 ; 0,04 ; 4,44 ; 0,39

answer: 0,4 ; 0,04 ; 0,39 , 4,44 ✓

b) 0,3 ; 0,8 ; 1,1 ; 1,4 , 0,6

answer: 1,1 ; 1,3 ; 1,4 ; 0,6 ; 0,8 ✓

3) Copy and Complete

16,27 + 12,08

→ 16,27
+ 12,88
28,115 ✓

Figure 4.11: Learners' working in Teacher C's class

4.4.3.4 Summary of Teachers A, B and C' lesson planning and their learners' workings

Table 4.4 summaries the lesson planning of Teachers A, B and C whereas Table 4.5 summarizes the learners 'workings in Teachers A, B and C's classrooms.

Table 4.4: Summary of Teachers A, B and C's lesson planning

Aspects	Teacher A	Teacher B	Teacher C
Subject, grade, topic and duration	Clearly marked	Clearly marked	Clearly marked
Resources	Indicated	Not indicated	Indicated
Algorithms	Well specified	Well specified	Well specified
Prior knowledge	Not stated	Not specified	Always indicated
Possible learners' misconceptions and difficulties	Not stated	Not stated	Not stated
Aims and objectives	Clearly stated	Not stated	Not stated
Assessment methods	Stated	Stated	Stated
Teaching and learning activities	Always indicated	Not always indicated	Always indicated

Table 4.5: Summary of Learners' Workings in Teachers A, B and C's Classrooms

Aspects	Teacher A	Teacher B	Teacher C
Design and tidiness	-Steps follow each other downwards -untidy work	-Steps follow each other downwards -untidy work	-Steps follow each other downwards -tidy work
Own problem-solving strategies used	Never used	Never used	Never used
Use of procedures outlined by teachers	Always	Always	Always
Marking of class works and home works	All learners work marked. Assisted by student-teacher	Only a few marked and the rest marked at home	Marked all learners 'work in class

4.5 CONCLUSION

In this chapter, data that were collected from the three teachers in different schools, were analysed and interpreted. The profiles of the three sampled schools were highlighted, followed by profiles of the three teachers in various classrooms. Then followed the findings that were discussed in the following order: findings from observations followed by findings from semi-structured interviews with the three

teachers. Finally, the teachers' lesson planning and learners' classwork and homework books were also assessed. To sum up, the preceding stated themes and subthemes helped the researcher in answering the research questions of the study (Section1.5).

CHAPTER FIVE: SUMMARY, RECOMMENDATIONS AND CONCLUSIONS

5.1 INTRODUCTION

Chapter Four presented and analysed the data that were collected from participants. This included classroom observation, interviews with the three sampled teachers and document analysis of teachers' lesson plans and of learners' class works and homework books in each teacher's classroom. This analysis and interpretation of data led to the answering of the research questions of the study (Section 1.5). In this chapter, the research findings concerning the research questions are examined.

Therefore, this chapter presents the summary, recommendations of the research study and conclusions. The chapter is arranged as follows: Firstly, a summary of the findings is provided. Secondly, a brief discussion of the findings by interpreting them in relation to theoretical framework and by comparing and contrasting them with literature is given. Thirdly, implications of the findings to practise is provided. Fourthly, limitation of the study is given. Fifthly, recommendations for future research is also highlighted. Lastly, concluding remarks are offered. Based on the preceding, conclusions, summary and recommendations were drawn from literature review and the current study.

5.2 SUMMARY OF THE MAIN FINDINGS

The purpose of this study was to explore the PCK of teachers in the teaching of decimal fractions to Grade 6 learners (Section 1.5). The study followed a qualitative research approach where a case study design was adopted (Section 3.3). Following the case study design, three Grade 6 teachers were recruited from ordinary public primary schools through a purposive sampling strategy to form part of the study (Section3.4). Data were collected through three methods, semi-structured interviews, observations and document analysis (Section 3.6.1).

Generally, the study revealed that Grade 6 mathematics teachers lacked PCK in the teaching of decimals (Section 4.4). This finding is consistent with findings from other studies, for example, the study by Lee (2010) revealed that teachers' lack of PCK in the teaching of mathematics seems to have a negative impact on the learning of mathematics. Even though the findings from Lee (2010) and the current study displayed a similarity, there is a difference in these studies. The study of Lee (2010) explored PCK of playschool mathematics teachers, whereas the current study explored PCK of Grade 6 mathematics teachers in the teaching of decimal fractions. Another difference of the two studies concerns the demographic information of the teachers. Lee (2010) discovered that teachers' demographic information. That is, earned degrees and teaching experience was related to their PCK.

In addition, Ubuz and Yayan (2010) also revealed similar findings with the current study. For example, though Ubuz and Yayan's (2010) study was about teachers' Subject Matter Knowledge (SMK) on decimal fractions, whilst the current study was on teachers' PCK, their findings are much related because both studies found that teachers lack PCK in the teaching of decimals. In this current study and that of Ubuz and Yayan (2010), literature explored shows that teachers who taught decimals for a long period, were experiencing similar difficulties in decimals just like teachers with few years.

Shulman's (1986) theory of teacher knowledge was used to make sense of the data. The study came up with eight main findings, namely: teacher's knowledge of decimal fractions; challenges in teaching decimal fractions; resources to teach decimal fractions; experience of teachers about learners in Grade 6; perception of teaching decimal fractions; making learning decimal fractions interesting; difficult decimal fractions and teaching strategies to improve learners' learning of decimals.

The outcomes of the current study have implications of a negative reaction pertaining to the PCK of Grade 6 mathematics teachers, since lack of good PCK affects learners' future mathematics learning. These findings though not generalizable to a wider population, provide useful information for further research and insights on the PCK of

Grade 6 mathematics teachers in the teaching of decimal fractions. They also have implications for teacher-education institutions as they may restructure their teaching programmes, both for pre-service and in-service teachers.

5.3 DISCUSSION OF INDIVIDUAL FINDINGS EMANATED FROM THE STUDY

The findings of the study mentioned in section 5.2 are discussed in this section.

5.3.1 Main finding 1: Teacher's knowledge of decimal fractions

5.3.1.1 Interpretations of finding in relation to Shulman's Theory

Shulman (1986: 5) wrote that: "The person who presumes to teach subject matter to children must demonstrate knowledge of that subject matter as a prerequisite to teaching". According to Shulman's theory of PCK, teachers should understand the content that they teach and how to teach it. This Shulman calls 'comprehension' which is one form of pedagogical reasoning. However, the findings in the current study revealed that teachers lacked this form of pedagogical reasoning as they confessed that they were confused in teaching decimal fractions to Grade 6 learners. This suggests that the teachers who participated in the current study, showed lack of teaching for conceptual understanding. Based on the preceding finding, teachers in the current study seemed to be unable to provide a solid foundation for successive teaching. This shows that they lacked PCK of decimal fractions.

Shulman (1987) further proposed another way of displaying teachers' PCK. This requires teachers to undergo pedagogical reasoning and actions such as 'instruction' in order for them to teach effectively. Shulman means that teachers are expected to organise and manage their classrooms, give learners work, including group work, and discuss feedback thereof, associate and interact with learners by giving them more questions and clarifications. It was found that teachers in the present study lacked this kind of pedagogical reasoning.

According to the researcher, this might be due to the fact that classes were so overcrowded and teachers were impeded in teaching decimal fractions. Shulman (1986) further proposed that to be able to teach, it is essential for teachers to understand the set of ideas related to the content at hand in various ways. This suggests that Grade 6 mathematics teachers should not only be conversant with decimal fractions but should also understand other fraction concepts that learners already knew in order to identify the sources of misconceptions.

5.3.1.2 Comparison and contrasting of the finding with the literature

Other scholars support what Shulman (1986) proposed concerning the importance of teacher‘s PCK. For example, a study by Leinhardt (1986) indicated that mathematics teachers need content knowledge and as well as PCK in order to convey the knowledge to learners. Carpenter et al.(1989) also confirm that teachers with good PCK of mathematics can promote learners' mathematical problem-solving skills as compared to those who are deficient of it.

From the current study, teachers found it difficult to display conceptual understanding of decimal fractions. This could be related to teachers' lack of PCK as regards to decimal teaching. To cite an example, Teacher B indicated that, "another problem for me is that as teachers we got an insufficient knowledge of decimal fractions, for example, sometimes I am confused by comparison of decimal fractions..." (Section 4.4.2.1) This finding is supported by a study conducted by Lee et al. (2011); Depaepe et al. (2015); Ubuz and Yayan (2010), which showed that teachers display their insufficient decimal knowledge as they get confused in teaching decimals.

Furthermore, the current study indicates that teachers' insufficient knowledge, which leads to lack of conceptual understanding of decimal fractions, could be related to the environments in which they learnt decimal fractions (Section 4.4.2.1). These findings are consistent with the results of the study by Patrick (2010) who indicated that though teachers could be exposed to various environments with the intention of acquiring knowledge, it does not automatically implies that they had acquired new knowledge or

improved their teaching (Section 2.3.2.2). Literature further maintains that teachers were not comfortable with their own mistakes and had insufficient mathematical skills to teach confidently (Huillet et al., 2011; Maher & Muir, 2011; Venkat & Adler, 2012). Therefore, it is important that teachers should have knowledge about the types of mistakes that learners might commit when taught about decimal fractions.

5.3.2 Main finding 2: Challenges in teaching decimal fractions

5.3.2.1 Interpretations of finding in relation to Shulman's Theory

Shulman (1987) claims that teachers should be capable of showing and representing ideas in order to enable others to understand and to differentiate those ideas. For example, teachers in the current study should be able to show learners that addition of decimals that requires carryings, is different from addition of decimals that do not require carrying (2.79 + 0.35 and 2.79 + 0.20). Unfortunately, teachers in the current study lacked this kind of PCK.

5.3.2.2 Comparison and contrasting of the finding with the literature

The current study revealed that teachers experience problems in teaching decimal fractions because they claimed that they were never exposed to decimal fractions before. For an example, Teacher B claimed: "I cannot lie that when I was still a learner that we were taught decimal fractions. I came across decimal fractions when I start teaching because, even in my three-year Diploma, we were not dealing with decimal fractions in our mathematics" (Section 4.4.2.1). This finding confirms what other scholars alluded to. To cite an example, Shulman (1986) mentioned that in most cases, teachers are expected to teach a topic that they had never been taught before.

Teachers in the current study struggled to understand the content that is supposedly to be conveyed to learners, which reveal lack of good PCK. It is for this reason that teachers resort to teaching rules and procedures which make it difficult for them to teach for understanding. Such teachers encourage memorization of rules and procedures. This idea is supported by many eminent scholars. For example, Beswick and Callingham (2012); Sarwadi and Shahrill (2014) maintained that teachers focus a

lot on emphasizing rules through drills and exercises. Despite this, Girit and Akyuz, (2016); Kastberg and Morton, (2014); Muir and Livy, (2012); Ubuz and Yayan, (2010), support this empirical finding. For example, in Section 2.5, it was mentioned that both teachers and learners are challenged in teaching and learning decimal fractions.

5.3.3 Main finding 3: Resources in teaching decimals

5.3.3.1 Interpretations of finding in relation to Shulman's Theory

Shulman (1986) highlighted that teachers must have a collection of illustrations in order to make the subject understandable to others. Shulman (1986) further proposes that different kind of teaching and learning materials related to the program should be available in order to assist learners to grasp the topic that is being taught. This implies that Shulman's (1986) theory called for teachers' curriculum knowledge which includes knowledge of the materials and programs that are used by teachers. This is what Shulman called "...the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances" (Shulman, 1986: 10). For example, textbooks, curricular or any other thing which affect what teachers do.

5.3.3.2 Comparison and contrasting of the finding with the literature

Literature also indicated that teachers' profound understanding of fraction concepts was required in order to be able to use visual representations such as diagrams, number lines, and many more in the classrooms to assist in developing conceptual understanding of decimal fractions and to be aware of difficulties resulting in using such visual representations, (Fazio & Siegler, 2011). Isiksal and Cakiroglu (2011) also support the use of figures, visual materials, as well as daily life examples in order to teach concepts effectively, for example, decimals as in the current study. This suggests that visual representations should be available for the teacher to use.

The findings in the current study do not support what Shulman (1986) expects of teachers because all the three teachers seem to be experiencing problems as regard to

teaching and learning resources needed to teach decimal fractions. However, the findings from the current study indicate that teachers lack relevant teaching and learning resources supplied by the department to teach decimal fractions effectively. The dominant teaching resources in all observed classrooms were the self- designed number lines charts and fraction panel charts. According to the researcher, besides the fact that the department do not supply adequate resources, this might be an indication that teachers in the study were not aware of other teaching and learning resources to be used in teaching decimals. This is an indication of lack of PCK.

5.3.4 Main finding 4: Experiences to decimal teaching

5.3.4.1 Interpretations of finding in relation to Shulman's Theory

Shulman (1986) is concerned more about how teachers transform their understanding of a particular content into lessons that could be understood by their learners. Shulman (1986) further claimed that a teacher with good PCK should be able to understand that certain topics are easy to learn, whilst others are not. Furthermore, Shulman (1986) stated that teachers should also be aware of the preconceptions and misconceptions that learners have.

5.3.4.2 Comparison and contrasting of the finding with the literature

The findings in the current study regarding the experiences to decimal teaching, concurs with the findings from literature which discovered that most teachers and learners, do not understand decimal fractions and have limited knowledge on decimal fractions (Girit & Akyuz, 2016; Widjaja et al., 2011; Whitacre & Nickerson, 2016). It is for this reason that learners develop misconceptions when trying to incorporate current with recent information, before experiencing deep conceptual change (Vamvakoussi & Vosniadou, 2010; DeWolf & Vosniadou, 2015; Ubuz & Yayan, 2010; Durkin & Rittle-Johnson, 2015; Isiksal & Cakiroglu, 2011).

In the current study, the participants who taught mathematics in Grade 6 for many years did not integrate their diverse PCK to inform practice as compared to those with limited teaching experience. For example, Girit and Akyuz (2016); Ubuz and Yayan (2010),

asserted that teachers who taught decimal fractions for many years, also experience problems in decimal teaching.

5.3.5 Main finding 5: Perceptions of teaching decimal fractions

5.3.5.1 Interpretations of finding in relation to Shulman's Theory

According to Shulman (1987), a teacher is supposed to be a primary source of learners' understanding of the subject matter. Shulman (1987) further maintained that this huge responsibility calls for the teacher's own understanding of the subject matter and teacher's attitudes and interests for what is communicated and learnt.

5.3.5.2 Comparison and contrasting of the finding with the literature

The current study revealed that teachers are seemingly not enjoying teaching mathematics as they think that learners do not want to learn decimal fractions because they have a negative attitude towards mathematics in general (Section 4.4.2.5) or lack the basics in mathematics (Section 4.4.2.2). Different from this finding, Barmby (2009); Bush and Karp (2013); Huber et al., (2014); Ubuz and Yayan, (2010); Vamvakoussi and Vosniadou, (2010), maintained that many learners found it difficult to learn decimal fractions and as such they loose interest in mathematics learning since they disregard decimals as numbers. This situation might lead to South Africa to perform poorly in mathematics (Spaull, 2013).

5.3.6 Main finding 6: Making decimal fractions exciting

According to the researcher, decimal fractions could be made exciting by using a variety of teaching and learning resources including games that could make learning fun and interesting (Section 2.5). For example, using decimal grids to find the equivalent form of decimal fractions. Therefore failure to make the teaching and learning situation lively by applying a range of resources, it's a sign of lack of knowledge in resources. This is a clear indication of lack of PCK in the application of teaching and learning resources.

5.3.6.1 Interpretations of finding in relation to Shulman's Theory

Shulman (1987:7) wrote thus: "…teaching necessarily begins with a teacher's understanding of what is to be learned and how it is to be taught. It proceeds through a series of activities during which the students are provided specific instruction and opportunities for learning…." According to Shulman (1987), teachers are responsible to include a range of activities in their lesson to make it stimulating.

5.3.6.2 Comparison and contrasting of the finding with the literature

From the findings of this study, it was evident that teachers had various ways of making decimal fractions interesting. For example, using real life situations when teaching decimal fractions such as, visiting local shops to check on price lists or learners playing games with counters. To support this idea, Ubuz and Yayan (2010) wrote thus: "The use of suitable cultural artefacts, such as price lists and menus of pizza shops fostered a grasp of the connection between symbols and referents" (p 800). However, Sapire and Sorto (2012) had a different opinion. To support their view, Sapire and Sorto (2012) claimed that South African teachers rarely engage learners in hands-on activities and slightly emphasised engaging discussions.

5.3.7 Main finding 7: Difficult decimal fractions

5.3.7.1 Interpretations of finding in relation to Shulman's Theory

Shulman (1986) asserts that there are certain topics that are difficult to learn which might lead to misconceptions. Shulman (1986) further claims that good PCK enables teachers to understand what is it that makes certain topics to be easy or difficult to learn. To cite an example, Shulman (1986: 9) wrote, "Pedagogical Content Knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: ..." (p.9).

5.3.7.2 Comparison and contrasting of the finding with the literature

Similar to what Shulman (1986) alluded to, teachers in this study indicated that there are areas in decimal fractions that are difficult to teach or learn (Section 2.5). As an example, Teacher C claimed, "[t]he challenging ones are the conversions of decimal fractions. They are the most difficult ones in teaching learners" (Section 4.4.2.7). This finding is consistent with the findings of the study conducted by Ubuz and Yayan (2010) who maintained that teachers' difficulties associated with meaning of decimals and place value are revealed in addition and subtraction of decimals, scale reading, ordering of decimals and finding the nearest decimal. For example, the study by Işeri, (1997, cited in Ubuz and Yayan, 2010) revealed that learners and teachers experienced problems in understanding the place value of decimals.

In addition, results related to Grade 6 teachers' difficulty in addition and subtraction of decimals, is consistent with the finding of Ubuz and Yayan (2010) that teachers experience problems in subtraction that requires borrowing. This might signify lack of Grade 6 mathematics teachers' PCK in the teaching of decimals.

5.3.8 Main finding 8: Teaching strategies

5.3.8.1 Interpretations of finding in relation to Shulman's Theory

Shulman (1986) claimed that teachers need to apply strategic knowledge when they are confronted with situations or problems that they are unable to solve. To support this idea, Shulman (1986: 13) wrote: "Strategic knowledge must be generated to extend understanding beyond principle to the wisdom of practice (p 13)".

5.3.8.2 Comparison and contrasting of the finding with the literature

Teachers in the current study relied more on teacher-centred pedagogical strategies. Teachers are cautioned to have knowledge of teaching and learning strategies in order to assist learners to reorganize their understanding that they already have. The finding in the current study showed that though teachers might be knowing strategies that could

be used to improve the teaching of decimal fractions, they relied more on teacher-centred strategies than on strategies that involve learners.

It was quite amazing to notice that participants in the current study mostly used teacher-centred pedagogical strategies when teaching decimal fractions which contradicts the findings from other previous research. For example, studies performed by Isiksal and Cakiroglu (2011); Ubuz and Yayan (2010) proposed strategies which could be employed by both teachers and learners to improve the teaching and learning of decimal fractions (Section 2.5). As an example, Isiksal and Cakiroglu (2011), maintained that teachers could use multiple representations, emphasise practise and give learners opportunity to express their thinking in order to teach concepts effectively.

5.4 IMPLICATIONS FOR PRACTICE

This section discusses the implications for practice regarding how teachers can improve their teaching of decimal fractions, lessons that can be learnt by policy makers and teacher-education institutions. Firstly, suggestions that teachers may follow in order to improve their teaching of decimal fractions in Grade 6 are highlighted below:

- In this study, it was evident that one day workshops conducted by curriculum advisors are not productive. Therefore, case studies from this research could be used to assist other Grade 6 mathematics teachers see their own mistakes with regards to decimal fractions and improve their teaching thereof.
- Teachers should be lifelong researchers in mathematics in order to stay informed with latest developments in the area of mathematics.
- Learners should be given chance to work jointly in a group in order share their understanding of decimal fractions
- Teachers should adapt their teaching to the context of the learners. This implies that teachers should offer decimal fractions in real-world context. For example, using sample money, or learners themselves even visiting local shops when teaching decimals so that learners could be familiar with how items are listed. Teachers should use concrete materials such as pizzas, pies, Cuisenaire rods or

base ten blocks before progressing with pictorial representatives such as place value charts or fraction panels and decimal fractions.

- Teachers should research on lesson planning in order to be informed on how to address all aspects of teaching decimal fractions that can accelerate effective learning.
- Lessons should be thoroughly planned following the pace setters given by the department and all elements of teaching should be addressed in order to promote effective teaching of decimal fractions. This should assist teachers to spot possible mistakes that may be made by learners, difficulties that may be encountered by learners and possible misconceptions.

To sum up, the information highlighted may help mathematics teachers in general to understand PCK experiences that Grade 6 teachers experience in teaching decimals and how improvements may be made to ensure a deep understanding of decimal fractions. Secondly, the findings of the current study can assist to inform policy makers at national level as indicated.

- Policy makers should review the teaching of mathematics starting at primary level. Currently, anyone with a diploma in teaching can be allocated to teach mathematics in South African primary schools irrespective of whether the individual specialised in mathematics or not. This might be due to scarcity of teachers who specialised in mathematics. Policy makers should therefore develop policies that will ensure that only teachers who specialised in mathematics are recruited to teach mathematics in primary schools;
- Policy makers should involve teachers in designing and making decisions about their own learning and progress;
- More importantly, the government should ensure that at least one week enrichment workshops are conducted during school holidays at the end of each term for mathematics teachers. Importantly, the following should be considered in such workshops: the need for on-going professional development on how to manage large classrooms; the need for relevant teacher- learner support materials; the need for teachers to be trained on learner-centred pedagogical

strategies and on how to teach fractions, including decimals, for conceptual understanding;

- The Department of Basic Education should ensure that the School Based Team (SBT) is regularly deployed to schools to help teachers with challenges that they might have concerning the teaching of mathematical concepts including decimal fractions;
- In addition, the government should build learning centres in the communities wherein learners could be assisted with home works since majority of parents in rural areas are illiterate; and
- The South African ministry of education should consider that national and international tests for mathematics teachers should be made compulsory to write to improve their knowledge.

Finally, the findings of this study may benefit the teacher-education institutions.

5.5 RECOMMENDATIONS FOR FUTURE RESEARCH

The findings of this study allow for future research on the teaching of decimal fractions. This section also recaps several recommendations emanating from the findings of the current study and dominant themes which were pinpointed. In order to have a better understanding of the PCK experiences of Grade 6 teachers in the teaching of decimal fractions, the following require to be considered for further research:

- Pedagogical Content Knowledge of Grade 6 mathematics teachers was studied in the current study, but findings of this study could be utilised to design a different study on PCK of teachers with mathematical qualifications;
- This current study involved only three participants, but future research could involve a larger population to have a thorough understanding of the PCK of Grade 6 teachers in the teaching decimals;
- The present study focused only on Grade 6 mathematics teachers, for that reason, it was not possible to investigate the experiences that other teachers in

other grade levels have in the teaching of decimal fractions. Hence, it is proposed that future research should concentrate on these sections in order to have a better understanding of PCK experiences of teachers in the teaching of decimal fractions;

- Strategies to improve the teaching of decimal fractions could be developed and studied as a portion of mathematics courses for teacher trainees in tertiary education;
- The current study was conducted in disadvantaged rural primary schools in the Rakwadu Circuit in Limpopo Province (Section 3.4.1 & 3.4.2), but future research could be conducted in other provinces in South Africa; and
- The Department of Basic Education in Limpopo is currently offering workshops to teachers. Despite this, teachers are still struggling in teaching decimal fractions to learners because there is evidence with regard to support during workshops and at school level. The researcher, therefore recommend that there is a need to establish if curriculum support given to teachers is properly administered by pertinent officials in order to enhance teachers' understanding of decimal fractions.

5.6 LIMITATIONS OF THE STUDY

The current study could be associated with the following limitations: Teachers who did not work under the Rakwadu Circuit while the study was conducted did not participate in the study. All participating teachers refused to be video-taped during class observation periods (Section 3.6.1.1). Instead, the researcher decided to use a voice recorder to record the voices of the teacher and the learners during the mathematics lesson and a note book to record other observable behaviours. Another limitation was that male teachers did not want to be part of the study, but the researcher managed to secure only one male teacher (Section 3.4.2). This could have limited the analyses of the results.

In addition, the researcher was from a very small understaffed school and as a result it was not easy for her to balance between work and her study. Besides, initially, the researcher wanted to involve Grade 6 mathematics teachers from neighbouring schools as well, but it was not possible, more especially because teachers did not want to be interviewed by someone they knew or be observed whilst teaching. Privacy of participants was not completely respected. For example, one of the participants was observed in the presence of the student-teacher (Section 4.4.1.1). Furthermore, most of the interviews were carried out after school whilst other teachers were still moving around the yard. This might have a negative impact on the data collected because the researcher believes that some people need their own space during interviews and observations. Finally, this study was also limited because it involved a sample of only three mathematics teachers who were all teaching in a remote rural area. Based on the above discussions, the results thereof cannot be generalised to a larger population but can be used as a basis in future research in order to draw larger samples.

5.7 CONCLUSION

The purpose of this study was to explore the PCK of Grade 6 mathematics teachers in the teaching of decimal fractions. (Section 1.5) In order to achieve this, research questions were formulated as indicated in Chapter One and executed in Chapter Three.

In Chapter One, the background of the study was presented. According to the researcher's view, the study was motivated by the fact that at the time of conducting this study the performance of mathematics was below standard when compared to poor countries. The study therefore wanted to check if the problem lies within teachers themselves or the curriculum that is currently offered. The latter is not investigated in the current study as it was not within the scope of investigation. The study further highlighted the PCK experiences of Grade 6 teachers in the teaching of decimal fractions.

Chapter Two provided a discussion of various literature that were reviewed in answering the research questions in this study. Literature was also used to validate the concerns from the problem statement (Section 1.2). Additionally, key concepts used throughout the study were also clarified.

Chapter Three elucidated how empirical data, which assisted in the fulfilment of the purpose of this study, were attended to. As the study was qualitative in nature, case study design was found to be relevant. The study involved three primary schools in the remote rural area in Modjadji (Section 3.4.1 & 3.4.2) and one Grade 6 mathematics teacher from each sampled school. Data were collected through semi-structured interview, classroom observations and document analysis. This was executed mainly to establish the PCK experiences of Grade 6 mathematics teachers in the teaching of decimal fractions. Quality criteria, significance of the study and, finally, the ethical issues that the researcher observed were also discussed.

Chapter 4 presented the findings from the classroom observations, interviews with sampled Grade 6 mathematics teachers and analysis of documents. The profiles of the three sampled schools were highlighted followed by profiles of the teachers. To sum up, the themes and sub-themes helped the researcher in answering the research questions stated in Chapter one.

The last chapter provided the summary of the findings and discussion of individual themes as well as recommendations on how teachers can improve the teaching of decimal fractions. In addition, lessons that can be learnt by policy makers and teacher-education institutions were also given. Finally, limitations that the researcher encountered in conducting the study were also presented.

To sum up, the main purpose of the study was met as the researcher established that teachers in the current study lacked PCK in teaching decimals. It was also discovered that the main reason for teachers' lack of good PCK was their weak understanding of decimal fractions.

REFERENCE LIST

Agrawal, J., & Morin, L.L. (2016). Evidence-Based Practices: Applications of concrete abstract representational across math concepts for students with mathematical disabilities. *Learning Disabilities Research & Practice*, 31(1), 34-44.

Aksu, Z., & Kul, Ü. (2016). Exploring Mathematics Teachers' Pedagogical Content Knowledge in the Context of Knowledge of Students. *Journal of Education and Practice*, *7*(30), 35-42.

Anney, V. N. (2014). Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS)*, *5*(2), 272-281.

Austin, P.Hechter,J., Zilpah,J., & Marchant,J.(2012). Viva Mathematics Grade 6. Vivlia publishers, 113-115.

Bailey, D. H., Zhou, X., Zhang, Y., Cui, J., Fuchs, L. S., Jordan, N. C., ... & Siegler, R. S. (2015). Development of fraction concepts and procedures in US and Chinese children. *Journal of Experimental Child Psychology*, *129*, 68-83.

Ball, D.L., Thames, M.H., & Phelps, G. (2008). Content Knowledge for Teaching: What makes it special? *Journal of Teacher Education*, *59*(5), 389-407.

Bansilal, S. (2012). Arriving at the Starting Point? Exploring a teacher's use of circular reasoning in a mathematics classroom. *Education as change*, *16*(1), 35-49.

Barmby, P. (2009). *Primary Mathematics: Teaching for Understanding: Teaching for Understanding*. McGraw-Hill Education (UK).

Bartell, T.G, Webel, C., Bowen, B., & Dyson, N. (2013). Prospective Teacher Learning: Recognizing evidence of conceptual understanding. *Journal of Mathematics Teacher Education,* 16(1), 57-79.

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan A. (2010). Teachers' mathematical knowledge, cognitive activation in the classroom, and student progress. *American Educational Research Journal*, 47(1), 133-180.

Bertram, C. (2011). What does Research Say about Teacher Learning and Teacher Knowledge? Implications for professional development in South Africa. *Journal of Education*, *52*(5), 26.

Beswick, K., Callingham, R., & Watson, J. (2012). The Nature and Development of Middle School Mathematics Teachers' Knowledge. *Journal of Mathematics Teacher Education*, *15*(2), 131-157.

Braun, V., & Clarke, V. (2006). Using Thematic Analysis in Psychology. *Qualitative Research in Psychology*, *3*(2), 77-101.

Bush, S.B., & Karp, K.S. (2013). Prerequisite Algebra Skills and Associated Misconceptions of Middle Grade Students: A review. *The Journal of Mathematical Behavior*, *32*(3), 613-632.

Caddy, S. (2015). *Exploring Strategies for Teaching Reading to English First Additional Language Learners in Grade 2* (Doctoral dissertation).

Carpenter, T.P., Fennema, E., Peterson, P.L., Chiang, C., & Loef, M. (1989). Using Knowledge of Children's Mathematics Thinking in Classroom Teaching: An experimental study. *American Educational Research Journal*, 26(4), 499-531.

Casey, D., & Houghton, C. (2010). Clarifying Case Study Research: Examples from practice: Dympna Casey and Catherine Houghton explore the use of case studies with examples from their research. *Nurse Researcher*, *17*(3), 41-51.

Charalambous, C.Y., & Pitta-Pantazi, D. (2005). Revisiting a Theoretical Model on Fractions: Implications for Teaching and Research. In *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 233-240).

Chetty, M., & Moloi, M.Q. (2011). The SACMEQ III Project in South Africa: A study of the conditions of schooling and the quality of education.

Chick, H., & Beswick, K. (2018). Teaching teachers to teach Boris: A framework for mathematics teacher educator pedagogical content knowledge. *Journal of Mathematics Teacher Education*, *21*(5), 475-499.

Coetzee, J., & Mammen, K. J. (2017). Science and Engineering Students' Difficulties With Fractions At Entry-Level To University. *International Electronic Journal of Mathematics Education*, *12*(3), 281-310.

Cole, Y. (2012). Assessing Elemental Validity: The transfer and use of Mathematical Knowledge for Teaching measures in Ghana. *ZDM*, *44*(3), 415-426.

Cotton, T. (2016). *Understanding and Teaching Primary Mathematics*. Routledge.

Creswell, J.W. (2012). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. SAGE Publications.

Creswell, J. W., Ivankova, N. V., & Piano Clarke, V. L. (2012). Foundations and approaches to mixed methods research. *First Steps in Research. Pretoria. Van Schaik Publishers Ltd*, 256-280.

Creswell, J.W., & Poth, C.N. (2017). *Qualitative Inquiry and Research Design: Choosing among five approaches*. Sage publications.

Delaney, S., Ball, D.L., Hill, H.C., Schilling, S.G., & Zopf, D. (2008). "Mathematical Knowledge for Teaching": adapting U.S. measures for use in Ireland. *Journal of Mathematics Teacher Education,* 11(3), 171–197.

Depaepe, F., Kelchtermans, G. & Verschaffel, L. (2013). Pedagogical Content Knowledge: A systematic review of the way in which the concept has pervaded mathematics educational research. *Teaching and Teacher Education*, 34, 12-25.

Depaepe, F., Torbeyns, J., Vermeersch, N., Janssens, D., Janssen, R., Kelchtermans, G. Verschaffel, L., Van Dooren, W. (2015). Teachers' Content and Pedagogical Content Knowledge on Rational Numbers: A comparison of prospective elementary and lower secondary school teachers. *Teaching and Teacher Education*, *47*, 82-92.

Department of Basic Education. (2012). Report on the Annual National Assessments. Pretoria: DBE.

Department of Basic Education. (2013). Report on the Annual National Assessment of 2013: Grades 1 to 6 & 9 (pp. 1–96). Pretoria.

Department of Basic Education. (2014). *Mathematical Literacy*. Government printing works: Pretoria, South Africa.

Desmet, L., Grégoire, J., & Mussolin, C. (2010). Developmental Changes in the Comparison of Decimal Fractions. *Learning and Instruction*, *20*(6), 521-532.

DeWolf, M., & Vosniadou, S. (2015). The Representation of Fraction Magnitudes and the Whole Number Bias Reconsidered. *Learning and Instruction*, *37*, 39-49.

Dietiker, L. (2015). Shaping mathematics into compelling stories: A curriculum design heuristic. *Educational Designer*.

Drake, C., Land, T.J., & Tyminski, A.M. (2014). Using Educative Curriculum Materials to Support the Development of Prospective Teachers' Knowledge. *Educational Researcher*, *43*(3), 154-162.

Durkin, K., & Rittle-Johnson, B. (2015). Diagnosing Misconceptions: Revealing changing decimal fraction knowledge. *Learning and Instruction*, *37*, 21-29.

Du Toit, G.F. (2013). *Teaching and Learning of Fractions in Primary Schools in Maseru* (Doctoral dissertation, University of the Free State).

Erlinda, N., & Surya, E. (2017). Mathematical Learning Strategy of Fractional form by using Learning Model of Gagne and Human Figure Line Media. *International Journal of Sciences: Basic and Applied Research (IJSBAR)(2017)*, *34*(2), 13-22.

Fauskanger, J., Jakobsen, A., Mosvold, R., & Bjuland, R. (2012). Analysis of Psychometric Properties as Part of an Iterative Adaptation Process of MKT Items for Use in Other Countries. *ZDM*, *44*(3), 387-399.

Fauskanger, J., & Mosvold, R. (2010). Undervisningskunnskap i matematikk: Tilpasning av en amerikansk undersøkelse til norsk, og læreres opplevelse av undersøkelsen [Mathematical Knowledge for Teaching: Adapting a US developed measure to the Norwegian context and how teachers experience the adapted measure]. Norsk Pedagogisk Tidsskrift, 94(2), 112–123.

Fazio, L., & Siegler, R. S. (2011). *Teaching fractions*. International Academy of Education.

Fennema, E., Carpenter, T.P., Jacobs, V.R., Franke, M.L., & Levi, L.W. (1998). A Longitudinal Study of Gender Differences in Young Children's Mathematical Thinking. *Educational Researcher*, *27*(5), 6-11.

Flick, U. (2015). *Introducing Research Methodology: A beginner's guide to doing a research project*. Sage.

Friedrichsen, P.J., Abell, S.K., Pareja, E.M., Brown, P.L., Lankford, D.M., & Volkmann, M. J. (2009). Does Teaching Experience Matter? Examining biology teachers' prior knowledge for teaching in an alternative certification program. *Journal of Research in Science Teaching*, *46*(4), 357-383.

Gall, D.M., Borg, W.R & Gall, J.P. (2007).*Educational Research: An introduction*. London: Longman.

Gess-Newsome, J., Taylor, J. A., Carlson, J., Gardner, A. L., Wilson, C. D., & Stuhlsatz, M. A. (2019). Teacher pedagogical content knowledge, practice, and student achievement. *International Journal of Science Education*, *41*(7), 944-963.

Girit, D., & Akyuz, D. (2016). Pre-Service Middle School Mathematics Teachers' Understanding of Students' Knowledge: Location of Decimal Numbers on a Number Line. *International Journal of Education in Mathematics, Science and Technology*, *4*(2), 84-100.

Govender, S. (2009). *Mathematical Knowledge for Teaching fractions and related dilemmas: a case study of a Grade 7 teacher* (Doctoral dissertation).

Grossman, P.L. (1990). *The Making of a Teacher: Teacher knowledge and teacher education*. Teachers College Press.

Hammersley, M., & Traianou, A. (2012). *Ethics in Qualitative Research: Controversies and contexts*. Sage.

Haylock, D., & Cockburn, A.D. (2008). *Understanding Mathematics for Young Children: A guide for foundation stage and lower primary teachers*. Sage.

Hilker, L. M. (2011). The role of education in driving conflict and building peace: The case of Rwanda. *Prospects*, *41*(2), 267-282.

Hoon, T.S., Yaakob, N.A., & Singh, P. (2016). Learning Fractions. In *7th International Conference on University Learning and Teaching (InCULT 2014) Proceedings* (pp. 131-140). Springer, Singapore.

Houghton, C., Casey, D., Shaw, D., & Murphy, K. (2013). Rigour in Qualitative Case-Study Research. *Nurse researcher*, *20*(4), 12-17.

Huber, S., Klein, E., Willmes, K., Nuerk, H.C., & Moeller, K. (2014). Decimal Fraction Representations are Not Distinct from Natural Number Representations–Evidence from a combined eye-tracking and computational modeling approach. *Frontiers in human neuroscience*, *8*.

Huillet, D., Adler, J., & Berger, M. (2011). Teachers as Researchers: Placing mathematics at the core. *Education as Change*, *15*(1), 17-32.

Isiksal, M., & Cakiroglu, E. (2011). The Nature of Prospective Mathematics Teachers' Pedagogical Content Knowledge: The case of multiplication of fractions. *Journal of Mathematics Teacher Education*, *14*(3), 213-230.

Izsák, A. (2008). Mathematical Knowledge for Teaching Fraction Multiplication. *Cognition and Instruction*, *26*(1), 95-143.

Jakachira, G. (2013). An Exploratory Study of the Interface of Child-Headed Households and Academic Performance: A case of primary school students in Beatrice resettlement area, Zimbabwe.

Jankvist, U.T., Mosvold, R., Fauskanger, J., & Jakobsen, A. (2012). Mathematical Knowledge for Teaching in Relation to History in Mathematics Education. In *12th International Congress on Mathematical Education* (pp. 4210-4217).

Jakobsen, A., & Mosvold, R. [Sa]. Mathematical Knowledge for Teaching in Africa: A Review of Empirical Research. *Mathematics, Science and Technology Education for Empowerment and Equity*, 115.

Jordan, N.C., Hansen, N., Fuchs, L.S., Siegler, R.S., Gersten, R., & Micklos, D. (2013). Developmental Predictors of Fraction Concepts and Procedures. *Journal of Experimental Child Psychology*, *116*(1), 45-58.

Joubert, M. [Sa]. Mathematics Education in South Africa: The Problems and the Perceived Causes. *Mathematics, Science and Technology Education for Empowerment and Equity*, 125.

Kastberg, S., & Morton, C. (2014). Mathematical Content Knowledge for Teaching Elementary Mathematics: A Focus on Decimals. *The Mathematics Enthusiast*, *11*(2), 311-332.

Kazima, M., Pillay, V., & Adler, J. (2008). Mathematics for Teaching: Observations from two case studies. *South African Journal of Education*, *28*(2), 283-299.

Kind, V., & Chan, K. K. (2019). Resolving the amalgam: connecting pedagogical content knowledge, content knowledge and pedagogical knowledge. *International Journal of Science Education*, *41*(7), 964-978.

Kleickmann, T., Richter, D., Kunter, M., Elsner, J., Besser, M., Krauss, S., & Baumert, J. (2013). Teachers' content knowledge and Pedagogical Content Knowledge: The role of structural differences in teacher education. *Journal of Teacher Education*, *64*(1), 90-106.

Korstjens, I., & Moser, A. (2018). Series: Practical guidance to qualitative research. Part 4: trustworthiness and publishing. *European Journal of General Practice*, *24*(1), 120-124.

Kvale, S. (2006). Dominance through Interviews and Dialogues. *Qualitative Inquiry*, *12*(3), 480-500.

Kwon, M., Thames, M.H., & Pang, J. (2012). To Change or Not to Change: Adapting Mathematical Knowledge for Teaching (MKT) measures for use in Korea. *ZDM*, *44*(3), 371-385.

Lai, M.Y. & Murray, S. (2015). Hong Kong, Grade 6 Students' Performance and Mathematical Reasoning in Decimals Tasks: Procedurally or conceptually based? *International Journal of Science and Mathematics Education,* 13(1), 123-149.

Lancaster, G.A. (2015). Pilot and Feasibility Studies Come of Age! *Pilot and Feasibility Studies*, *1*(1), 1.

Lange, K., Kleickmann, T., & Moeller, K. (2010). Measuring Primary School Teachers' Pedagogical Content Knowledge in Science Education with Open-Ended and Multiple-Choice Items. *Contemporary Science Education Research: Teaching*, 67-69.

LeBaron, C., Jarzabkowski, P., Pratt, M. G., & Fetzer, G. (2018). An introduction to video methods in organizational research.

Lee, J. (2010). Exploring Kindergarten Teachers' Pedagogical Content Knowledge of Mathematics. *International Journal of Early Childhood,* 42(1), 27-41.

Lee, S.J., Brown, R.E., & Orrill, C.H. (2011). Mathematics Teachers' Reasoning about Fractions and Decimals Using Drawn Representations. *Mathematical Thinking and Learning*, *13*(3), 198-220.

Leedy, P.D., & Ormrod, J.E. (2010). *Practical Research: Planning and Design*, *5*.

Leihardt, G. (1986). Expertise in Mathematics Teaching. *Educational Leadership*, 43(7), 28-33.

Lemonidis, C., Tsakiridou, H., & Meliopoulou, I. (2018). In-Service Teachers' Content and Pedagogical Content Knowledge in Mental Calculations with Rational Numbers. *International Journal of Science and Mathematics Education*, *16*(6), 1127-1145.

Le Roux, Z.J. (2015). *An Application_of_Brain-Based Education Principles with ICT as a Cognitive Tool: A case study of Grade 6 decimal instruction at Sunlands Primary School* (Doctoral dissertation, University of Cape Town).

Leung, A. (2009). A Preliminary Study on Hong Kong Students 'Understanding of Fraction. (Paper presented at the 3rd Redesigning Pedagogy International Conference June 2009. Singapore 27: 597-612.)

Lewis, S. (2015). Qualitative Inquiry and Research Design: Choosing among five approaches. *Health Promotion Practice*, *16*(4), 473-475.

Lincoln, Y.S., & Guba, E.G. (1985). *Naturalistic Inquiry* (Vol. 75). Sage.

Lortie-Forgues, H., Tian, J., & Siegler, R.S. (2015). Why is Learning Fraction and Decimal Arithmetic So Difficult? *Developmental Review*, *38*, 201-221.

Luneta, K. (2011). *Initial Teacher Education in Southern Africa: Mentorship and Teaching Practicum Supervision*. LAP LAMBERT Academic Publishing.

Luneta, K. (2015). Understanding students' misconceptions: an analysis of final Grade 12 examination questions in geometry. *Pythagoras*, *36*(1), 1-11.

Luneta, K., & Makonye, P.J. (2010). Learner Errors and Misconceptions in Elementary Analysis: A Case Study of a Grade 12 Class in South Africa. *Acta Didactica Napocensia*, *3*(3), 35-46.

Maher, N., & Muir, T. (2011). I Think They Think that Zero Point Something is Less Than Zero: Investigating Pre-Service Teachers' Responses to Mathematical Tasks. In *Australian Association for Research in Education Conference (AARE 2011 Conference)* (pp. 1-16).

Maimela, E., Geertruyden, J.P., Alberts, M., Modjadji, S.E., Meulemans, H., Fraeyman, J., & Bastiaens, H. (2015). The Perceptions and Perspectives of Patients and Health Care Providers on Chronic Diseases Management in Rural South Africa: A qualitative study. *BMC Health Services Research*, *15*(1), 143.

Mamede, E., Nunes, T., & Bryant, P. (2005). The Equivalence and Ordering of Fractions in Part-Whole and Quotient Situations.

McMillan, J.H., & Schumacher, S. (2010). Research in Education: Evidence-Based Inquiry, MyEducationLab Series. *Pearson*.

Mdaka, B.R. (2011). *Learners' Errors and Misconceptions Associated with Common Fractions* (Doctoral dissertation, University of Johannesburg).

Mohamed, M. (2015). Teaching Basic Meaning of Decimal as a Special Form of Fraction. *Journal of Emerging Trends in Educational Research and Policy Studies*, *6*(1), 1.

Molebale, J.J. (2005). The Role of Practical Work in Learning the Division of Fractions by Grade 7 Learners in Two Primary Schools In Mpumalanga Ward of Hammarsdale Circuit in KwaZulu-Natal.

Mosvold, R., Fauskanger, J., Jakobsen, A., & Melhus, K. (2009). Translating Test Items into Norwegian–Without Getting Lost in Translation. *Nordic Studies in Mathematics Education*, *14*(4), 101-123.

Mosvold, R., & Hoover, M. (2017). Mathematical knowledge for teaching and the teaching of mathematics.

Muir, T., & Livy, S. (2012). What Do They Know? A comparison of pre-service teachers' and in-service teachers' decimal mathematical content knowledge. *International Journal for Mathematics Teaching and Learning*, 1-15.

Muzheve M.T., & Capraro, R.M. (2012). An Exploration of the Role Natural Language and Idiosyncratic Representations In Teaching How to Convert Among Fractions, Decimals, and Percents .*The Journal of Mathematical Behaviour* ,31, 1–14 .

Ness, L. R. (2015). Are we there yet? Data saturation in qualitative research.

Neuman, W.L. (2011). *Social Research Methods: Qualitative and quantitative approaches,* 7th ed., Boston. MA: Pearson Education.

Ng, D. (2012). Using the MKT Measures to Reveal Indonesian Teachers' Mathematical Knowledge: Challenges and potentials. *ZDM*, *44*(3), 401-413.

Nieuwenhuis, J. (2012c). Analysing Qualitative Data. In K. Maree (Ed.). *First Steps in Research*, pp. 99-119. Pretoria: Van Schaik.

Nieuwenhuis, J. (2012a). Introducing Qualitative Research. In K. Maree (Ed.). *First Steps in Research, pp.* 47-66. Pretoria: Van Schaik.

Nieuwenhuis, J. (2012b). Qualitative Research Designs and Data Gathering Techniques. In K. Maree (Ed.). *First Steps in Research*, pp. 70-93. Pretoria: Van Schaik.

Nisbet, L. (2015). Mathematics Teaching Experiences of Elementary Preservice Teachers with High and Low Mathematics Anxiety during Student Teaching: A multiple case study.

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, *16*(1), 1609406917733847.

Olanoff, D., Lo, J.J., & Tobias, J.M. (2014). Mathematical Content Knowledge for Teaching Elementary Mathematics: A focus on fractions. *The Mathematics Enthusiast*, *11*(2), 267.

Palinkas, L.A., Horwitz, S.M., Green, C.A., Wisdom, J.P., Duan, N., & Hoagwood, K. (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and Policy in Mental Health and Mental Health Services Research*, *42*(5), 533-544.

Patrick, W. (2010). *Recognising Non-Formal and Informal Learning Outcomes, Policies and Practices: Outcomes, Policies and Practices* (Vol. 2009, No. 35). OECD publishing.

Phurutse, M.C. (2005). Factors Affecting Teaching and Learning in South African Public Schools. HSRC press.

Pitjeng-Mosabala, P., & Rollnick, M. (2018). Exploring the development of novice unqualified graduate teachers' topic-specific PCK in teaching the particulate nature of matter in South Africa's classrooms. *International Journal of Science Education*, *40*(7), 742-770.

Proctor, J. (2019). Mathematical Knowledge for Teaching in Elementary Pre-Service Teacher Training.

Punch, K.F. (2013). *Introduction to Social Research: Quantitative and qualitative approaches*. Sage.

Reddy, V., Prinsloo, C., Arends, F., Visser, M., Winnaar, L., Feza, N., & Ngema, M. (2012). *Highlights from TIMSS 2011: The South African perspective*.

Rollnick, M., Davidowitz, B., & Potgieter, M. (2017). Is Topic –Specific PCK Unique to Teachers?. In Cognitive and Affective Aspects in Science Education Research (pp. 69-85).

Sapire, I., & Sorto, M.A. (2012). Analyzing Teaching Quality in Botswana and South Africa. *Prospects*, *42*(4), 433-451.

Sarwadi, H.R.H., & Shahrill, M. (2014). Understanding Students' Mathematical Errors and Misconceptions: The case of year 11 repeating students. *Mathematics Education Trends and Research*, *2014*, 1-10.

Shulman, L.S. (1986). Those Who Understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4-14.

Shulman, L.S (1987). Knowledge and Teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1-23.

Spaull, N. (2011). A Preliminary Analysis of SACMEQ III South Africa. *Stellenbosch: Stellenbosch University*.

Spaull, N. (2013). South Africa's Education Crisis: The quality of education in South Africa 1994-2011. *Johannesburg: Centre for Development and Enterprise*.

Spaull, N., & Kotze, J. (2015). Starting behind and Staying behind in South Africa: The case of insurmountable learning deficits in mathematics. *International Journal of Educational Development*, *41*, 13-24.

Taylor, S. (2011). *Uncovering Indicators of Effective School Management in South Africa using the National School Effectiveness Study* (No. 10/2011).

Taylor, N., Van der Berg, S., & Mabogoane, T. (2013). What Makes Schools Effective? Report of the National Schools Effectiveness Study.1, 1-13.

Themane, K.M. (2015). *Teachers' Pedagogical Content Knowledge of Teaching Equivalent fractions in Grade 3* (Doctoral dissertation, University of Johannesburg).

Torbeyns, J., Schneider, M., Xin, Z., & Siegler, R. S. (2015). Bridging the gap: Fraction understanding is central to mathematics achievement in students from threedifferent continents. *Learning and Instruction*, *37*, 5-13.

Turnuklu, E.B., & Yesildere, S. (2007). The Pedagogical Content Knowledge in Mathematics: Pre-Service Primary Mathematics Teachers' Perspectives in Turkey. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, *1, 1-13.*

Ubuz, B., & Yayan, B. (2010). Primary Teachers' Subject Matter Knowledge: Decimals. *International Journal of Mathematical Education in Science and Technology*, *41*(6), 787-804.

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content Analysis and Thematic Analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences*, *15*(3), 398-405.

Vamvakoussi, X., & Vosniadou, S. (2010). How Many Decimals are there between Two Fractions? Aspects of secondary school students' understanding of rational numbers and their notation. *Cognition and Instruction*, *28*(2), 181-209.

Van der Berg, S. (2015). What the Annual National Assessments can tell us about learning deficits over the education system and the school career. *South African Journal of Childhood Education*, *5*(2), 28-43.

Van de Walle, J.A., Karp, K.S., & Bay-William, J.M. (2010). Elementary and Middle School Mathematics: Teaching Developmentally. USA: Pearson Education.

Venkat, H., & Adler, J. (2012). Coherence and Connections in Teachers' Mathematical Discourses in Instruction. *Pythagoras*, *33*(3), 1-8.

Venkat, H., & Spaull, N. (2015). What Do We Know About Primary Teachers' Mathematical Content Knowledge in South Africa? An analysis of SACMEQ 2007. *International Journal of Educational Development*, *41*, 121-130.

Whitacre, I., & Nickerson, S.D. (2016). Investigating the Improvement of Prospective Elementary Teachers' Number Sense in Reasoning about Fraction Magnitude. *Journal of Mathematics Teacher Education*, *19*(1), 57-77.

Widjaja, W., Stacey, K., & Steinle, V. (2011). Locating Negative Decimals on the Number Line: Insights into the Thinking of Pre-Service Primary Teachers. *The Journal of Mathematical Behavior*, *30*(1), 80-91.

www.news 24.com. / south africa/ …2015 -09-12 10:08

Zhang, L., Wang, Q., Lin, C., Ding, C., & Zhou, X. (2013). An ERP Study of the Processing of Common and Decimal Fractions: How different they are. *PloS one*, *8*(7), e69487.

Zhou, Z., Peverly, S.T., & Xin, T. (2006). Knowing and Teaching Fractions: A cross-cultural study of American and Chinese mathematics teachers. *Contemporary Educational Psychology*, *31*(4), 438-457.

APPENDICES

APPENDIX A: SEMI- STRUCTURED INTERVIEW SCHEDULE

I believe you received a letter and consented to be part of this interview, which concerns PCK of mathematics teachers in teaching decimal fractions in Grade 6 in our rural public schools. I would like to indicate that the purpose of this interview is to obtain your honest response, views and opinions regarding your perceptions on the PCK experiences of teachers in teaching decimal fractions in our local primary schools. I assure you that your information will be used only for research purposes and no names of participants, schools or any identifying data will be made known in the report. Please note that your personal details will only be used for statistical purposes only. If there is anything you need to be clarified on before we start with the interview, feel free to ask. I further request to audio record the interview as I need to listen to it afterwards again in order to write down what transpired in the interview for data analysis purposes.

1. Different people have different understandings of what decimal fractions mean. Could you please briefly explain to me what your understanding of by the term 'decimal fractions' mean to you? Where did you first learn about decimal fractions? How long have you been teaching fractions?
2. Which areas do Grade 6 cover for this topic on decimal fractions?
3. Which areas of decimal fractions do you enjoy the most and which ones do you find challenging?
4. Can you briefly tell me about the challenges that you face in the teaching of decimal fractions? How do you tackle them?
5. Where do you think learners experience challenges relating to decimal fractions and what will you do in order to assist and guide them?
6. What do you think is the main cause of stress in teaching mathematics, in particular, decimal fractions, in Grade 6?
7. Suppose you are busy teaching learners on scale reading, and you realise that some of the learners are still struggling in writing down a decimal for a specified position on a number line, what would you do to assist such learners?
8. What will you do to illustrate that fractions such as $\frac{1}{2}$ and decimal fractions such as 0.5 are equivalent fractions?
9. As you continue with your lesson, you realize that quite a number of learners apply the properties of whole numbers on decimal fractions. For example, thinking that zero added to the right end of the whole number is similar in value to zero added to the last number after a decimal point. How will you help them?
10. In addition, how will you help learners who struggle with subtraction of decimals that requires borrowings or addition of decimals that requires carryings?

11. What will you do to check if your lesson has been understood or not? Briefly explain.
12. According to your own perception, what role can you play as the mathematics teacher to cultivate learners' love for decimal fractions? How can you make decimal fractions interesting?
13. Which resources do you prefer to use in teaching decimal fractions and why?
14. What achievements have you accomplished since you were a mathematics teacher in Grade 6? Tell me about them and how you achieved them?

APPENDIX B: SAMPLE OF INTERVIEW TRANSCRIPTIONS

PURPOSE OF THE STUDY AND THE RESEARCH QUESTIONS

The purpose of this research paper is to explore the Pedagogical Content Knowledge *(PCK) of Grade 6 teachers in the teaching of decimal fractions in Primary schools in the* Rakwadu Circuit.

Research questions

♦What are the Pedagogical Content Knowledge experiences of Grade 6 teachers in the teaching of decimal fractions at primary schools?

(a) What are the knowledge of Grade 6 teachers concerning fractions?

(b) What are the teaching strategies in the teaching of decimal fractions?

INTERVIEW TRANSCRIPTS

TEACHER A

1. I can see you are placed in grade six this year so, how long have you been teaching mathematics in this grade?

-'Er' since 2015 in July and then the whole of 2016 up to now.

2. What is your professional qualification?

- My professional qualification I have now is ACE

3. Did you specialise in mathematics?

- Not in my ACE but I specialised in Mathematics at college level.

4. Today we are going to talk to each other about fractions. Can you give me types of fractions that are taught in grade 6?

- Firstly, we start with common fractions, and then we also deal with decimal fractions thus far.

5.We are not going to talk about all of those fractions, but our focus will be on decimal fractions. Different people have different understand of what decimal fractions mean. Could you please briefly explain to me what your understanding of the word decimal fraction is?

-According to my knowledge, decimal fraction is any number that has a decimal comma in it and then the word decimal from deci means one tenth.

5. Where did you first learn about decimal fractions?

-I learnt decimal fractions from my early ages when I was in primary level and then going to the college also introduced to decimal fractions.

6. Which areas do grade 6 cover for this topic on decimal fractions?

- Firstly,the areas that are covered 'ehh' in decimal fractions we have ordering and then we also have adding fractions, subtracting fractions and then also on number lines. Ja, those are the areas covered in Grade six up to so far.

7. Which areas of decimal fractions do you enjoy the most and which ones do you find challenging especially when you teach children?

- Those ones that are simple to me ehh is when we make the place value of the fractions.

What about the challenging ones?

- the most challenging ones for learners and also for me maybe is when we add fractions on the number line or when learners try to find rules which were used on a number line and myself also find it a bit difficult when we add or when we subtract or maybe when finding which one is smaller than the other or which ones are equal .That is the most difficult ones.

8. Can you tell me about the challenges that you face in the teaching of .

-Most learners are confused .They are unable to convert a simple fraction to a decimal.

Sir, but what do you think contributes to those challenges that you have just highlighted?

The learners seem passive. The other reason is that they don't get help at home from family members.

9. According to you, what strategies do you think can be employed to assist in improving the teaching of these decimal fractions?

Err; I think I the use of teaching and learning aids like posters with decimals fractions can help a great deal. .Peer teaching can also help. Besides I also

believe that team teaching time and extra classes such as morning studies can be useful

10. What do you think is the main cause of stress when you teach decimals in grade 6.

- Hei, we are teaching learners 'ehh, ehh' who most of them don't understand most of the things in mathematics so in decimals some of them when you explain you will find that maybe they just wonder what you talk about when you deal with fractions in mathematics so you will find that they find it to be a new lesson but their mentality cannot grasp 'ehh' the lesson. In fact fractions, dealing with fractions not only decimal fractions. They become more difficult to learners very difficult for them to grasp. I don't know what is happening to their minds but most of them really don't understand the decimal fractions it's hard for them to understand just because they have different minds but, we have most of them who don't understand I really cannot tell what is happening to their minds when you teach them fractions and you will even use different methods but still we have a lot of learners who don't understand.

  And also from the departmental point of view, they try to support us when we are at workshops but we don't have more resources that are delivered by the department to make it simple for the learners to grasp the lesson. In fact maybe if we had more learner support material, those things that I think maybe it will make it easy for learners to understand when we teach about decimals. The department is helping but it not that much that we get from the department. At least the curriculum advisors try to help us but when they come to us you find that there are no resources they just help us on the methods to teach and there are no resources at all. And also from the departmental point of view they don't deliver enough workbooks which will be of help so that we could give enough home works so that learners go and practice at home or maybe finding parents, brothers and sisters to help with decimal fractions.

11. Suppose you are busy teaching learners on scale reading and realize that quite a number of learners are struggling in writing a decimal for a specified position on a number line, what would you do to assist such learners?

"'Er ', firstly I will take the learners 'er'this is where I have to do remedial work. Those learners who don't understand the decimals on a number line I have to let them come to my table or next to the chalkboard where I will be writing the number lines and writing those numbers as decimals. I think some of the learners can get the matter when you take them next to you and teach them alone because if you teach them with other learners who are progressed for, then it

became difficult for them. But if you do remedial by taking them and putting them one side and showing much examples there as much as they can have, I think that will be of great help for them to understand. As you could see I had one learner in front of others he had to count on the chalkboard so that he could get the correct answer. So remedial is very important for the learners who don't understand."

12. What will you do to illustrate that ½ and 0.5 are equivalent fractions?

"To illustrate this firstly you have to tell learners that the other method that we use is that one of division, dividing. If it is ½ I have to convert it to a decimal fraction such as 0.5.The first one you have to draw a line and then where you indicate that you are going to divide 1 by 2 asking learners how many times does 2 gets into 1.I think they will say 2 it does not go into 1 and then from there we write a zero and a comma as an answer, and I will also tell them that the decimal fraction is not yet complete. The same very one we are going to add zero (0) and the number becomes 10 and then you ask them again how many 2s they will are there in in 10 and then they will have to do the multiples of 2 and then they will arrive at 10 and it will give the answer as 5. Then I will explain to them that now the decimal is complete and is now 0.5. Or maybe next to half you write the equal sign and you show them how many times does 2 goes into 1 and they will say it does not go and I will write '0' and a comma and add '0' to '1' and its now 10 .I will write on the board asking how many times does 2 goes into 10 and they will say 5 times. Then the answer will be written as '0,5'. "

13. As you continue with the lesson you realise that quite a number of learners apply the properties of whole numbers on decimal fractions. For example thinking that zero added to the right end of the whole number is similar in value to zero added to the last number after a decimal point. How will you help them?

"Ok, firstly I will write the whole numbers **2** or **3** for them to understand that they are not the same writing the numbers and explaining that this is a whole number and also explaining that we say a number is a whole number you tell them that they are characterized by place values explaining the place value of whole numbers and then putting a comma after a whole number writing the other numbers after a comma and then also explaining their place value , for example after a comma is where we find a tenth which is not the same as a ten on the whole number writing it as 1/10 and then the second number being a hundredth (1/100) and also giving examples. And then another thing that I can explain to them on the whole number is that a whole number differ from a decimal fraction

like this; a whole number is out of 1,if is 4 is 4 over 1 but with a decimal fraction if is a tenth it becomes 1 over 10 and I think that will show the difference between the two, the whole number is out of a one and decimals it becomes 1/10 which is a tenth like that and like that. Oh my God ‘ga ke tsebe ke arabile tsona naa’ (I don’t know if I answered it correctly, I am not sure).”

14. **As you continue with your lesson you realise that learners struggle with additions that requires carryings and subtractions that requires borrowings. How are you going to assist these learners?**

“Ok, let’s take for example we have decimal fraction like **21.08** and then I have to add **1.99** on it and then on the chalkboard I will show to learners that we have to add the first two numbers being number **8** and 9.I will ask learners to add 8 to 9 and they will answer by saying the answer is 17 and then writing down 7 and we take the 1 to next the digit and then taking it to the next digit it will be 1 plus 0 and it will give us 1 and we add that one to the number 9 and it will give us 10 and then we cannot write 10 but we are going to write 0 and we take 1 to the next digit and we will have three ones adding them together we have 3 and we will be left with 2 and we add it to ‘0’ it will give us 2. I will explain to learners that the answer to 21.08 and 1.99 is 23.07. That’s when we’re carrying then coming to subtraction, the very same numbers that we used in addition will be used for subtraction. I will write 21.08 – 1.99. The first two numbers will be 8 - 9 where they will say it is impossible and asking what to do they will say we must borrow from the next digit which is not possible to ask form zero and we will go to the next digit which is the units and we borrow from the units and we now have 10 and from that 10 we can borrow 1 and we have 18 and is easy to subtract and we say 18 – 9 will be 9. Now 9 - 9 is 0 before the decimal comma and we will be remaining with 0- 1 which is impossible to subtract then we go to the next digit which is the number 2 then we borrow 1 from it and add it to 0 it becomes a 10 and we subtract 1 from it and its gonna give us the number 9 and now we have 19.9.That is the decimals in borrowing”.

15. **What will you do to check if the lesson has been understood or not?**

“To check that the learners has understood what I was teaching, I will ask them questions to find out if they understood and then furthermore they have to work in groups to find out if they grasped the lesson. They will have to write a class activity or maybe the home activity and then when correcting the work it will show me if they understood the lesson or not”.

16. **According to your own perception, what role can you play as the mathematics teacher to cultivate learners' love for mathematics? How can you make decimal fractions interesting**?

"Oh, I think I have to start with simple things maybe firstly talking about the common fractions teaching a little being a prior knowledge to them and thereafter have to explain to them how from a common fraction we go to a decimal fraction trying to all the methods .I don't have to use only one method using many methods for them to understand. We can take a loaf of bread and divide it into slices and then I will explain to learners that each slice of bread is 1/10 and from that 1/10 is where we are going to make a decimal fraction and then working out saying 10 into 1 going zero times writing a zero and a comma and then adding zero to the 1 which will now be a ten. Then saying that 10 into 10 goes once and then writing 1 after a comma and the answer will be 0.1 and then going to the second one like that until we reach to a halve(½) and furthermore going to the whole .That's why I think learners will enjoy the lesson using pieces of bread."

17. **Which resources do you prefer to use in teaching decimal fractions and why?**

"I use resources such as bread. Oranges can be used and then writing on the chalkboard using smaller pictures like people I think that will be interesting for the learners and may be writing a pie chart on the board and also the textbooks are resourceful. The chalkboard can also work and also pictures that we buy from the bookshops explaining about decimal fractions. I think those are some of the resources to make the decimal fractions interested".

Why do you like using those resources?

"Because they are very vital or important as the saying say learners learn a lot through viewing. When they see the pictures or when using resources such as bread, pie charts, learners will enjoy the lessons when they see those pictures."

18. **What achievements have you accomplished since you were a mathematics teacher in grade six? Tell me about them and how you achieved them.**

"I enjoyed teaching the subject since I was teaching the subject I have more than 70% meaning that most my learners understand what I teach. I also have proof in the office that most of them can understand what I am teaching. And the competitions also we had circuit competitions last year. I took one of my learners to the competitions and she took position 2 and unfortunately she didn.t go to the cluster because only position 1 proceeded. Out of the primary schools at Rakwadu she too position 3.

How did you achieve that?

I took the learner who obtained position 3 from the classroom. I took her to the competitions. In class I can see she was participating well and when writing tests she obtained 90% + and then she was the one. I could not took learners who took position 1 and 2 because they were performing in other learning areas. In mathematics competitions they didn't allow us to use same learners who compete in other subjects. She is competing with others very well. She is the one I am using in most cases in the classroom when doing corrections. She is also helping others in her group. Those who cannot grasp very well. She was good and I was helping her a lot in class.

THANKS FOR YOUR COOPERATION

APPENDIX C: CLASSROOM OBSERVATION GUIDE

Date …….

School …….

Teacher's name…….

Grade……

Topic ……

Duration (time) ……

ASPECTS	DEMONSTRATIONS
1.Classroom management	
2.Learning environment	
3.Teaching and learning resources	
4.Mathematical context	
5.Teaching strategies	
6.Feedback to learners	
7.Evidence of learners' misconceptions and problems	
8.Learners opportunity to share understanding	
9.Conceptual knowledge	
10.Time given to spend on activities	
11.Expertise	

APPENDIX D: DOCUMENT ANALYSIS TEMPLATE

Criteria	Correctly answered	Partially answered	Incorrect	Not answered
1. Ordering decimal fractions				
2. Conversion of decimal fractions				
3. Subtraction of decimals that involves borrowing				
4 .Addition of decimal fractions				

APPENDIX E: LETTER TO TEACHERS

P.O Box 1429
Ga- Kgapane
0838
20th April 2017

Dear Teacher

RE: REQUEST FOR YOUR ASSENT TO TAKE PART IN THE RESEARCH

I, Moremi Ntsako Shereen, a distant student at the University of Limpopo, wish to ask for your assent to participate in the research which will be conducted at your school.

My topic is: Exploring the Pedagogical Content Knowledge of intermediate phase teachers in the teaching of decimal fractions in Grade 6 at Rakwadu Circuit in Limpopo Province.

I assure you that there will be no harm of any kind to you during the study. Your information will be kept private and the results will be presented in an anonymous manner. I further promise to furnish the Department of Basic Education with the necessary feedback on the research.

For any clarity, you are free to contact the University of Limpopo. I further alert you that if you feel like or want to withdraw from the research you are free to do so.

If you are interested in taking part, please indicate by writing your name and surname on the space provided in the space below.

Your positive response in this matter will be highly appreciated.

Yours faithfully

……
Moremi N.S

Your name …… Signature…….Date……....

APPENDIX F: DECLARATION FORM OF CONSENT BY THE PARTICIPANTS

I …….. (Full names of participant) hereby confirm that I consent to participate in the research study: “Exploring the Pedagogical Content Knowledge of intermediate phase teachers in the teaching of decimal fractions in Grade 6 at Rakwadu Circuit in Limpopo Province.”, and I agree to be interviewed. I also agree to participate in classroom observations and associated recordings. Unfortunately, I don’t consent to be video recorded. I further consent that I understand the content of the research study and the nature thereof as explained to me by the researcher. I also understand the result of the study and that any of my personal details will not be enclosed into the study report. I understand that I am free to withdraw from the study at any time.

I hereby provide consent to audio- record the interview.

PARTICIPANT

Name: ……. (print)

Signature: ……

Date: …….

RESEARCHER: Moremi N.S

APPENDIX G: APPLICATION LETTER TO THE DEPARTMENT OF EDUCATION

P.O Box 1429
Ga- Kgapane
0838
6th February 2017

The Circuit Manager
Rakwadu Circuit
Private Bag x 738
Ga-Kgapane
0838

Dear Sir

RE: APPLICATION FOR CONDUCTING RESEARCH IN SOME PRIMARY SCHOOLS AT RAKWADU CIRCUIT IN MOPANI DISTRICT

The above matter bears reference to:

I hereby request permission to conduct research in some primary schools at Rakwadu Circuit in Mopani District.

The title of my research dissertation is:

Exploring the Pedagogical Content Knowledge of intermediate phase teachers in the teaching of decimal fractions in Grade 6 at Rakwadu Circuit in Limpopo Province.

I am currently registered with the University of Limpopo as a *Magister Educationis* (Masters) student. The research is part of my study. The research is planned to inform myself as well as other educators and to inspire us in our teaching profession.

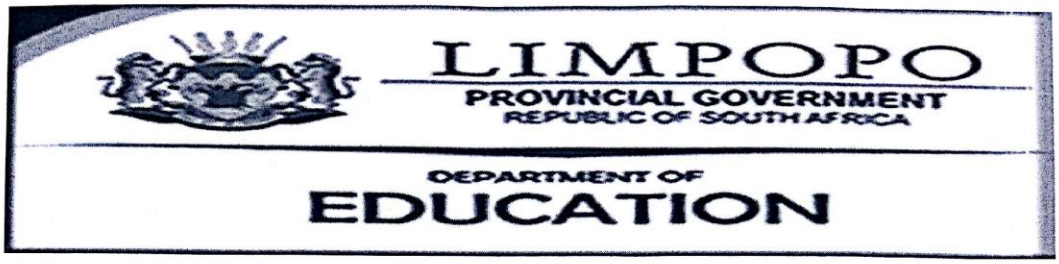
The study will be conducted in such a manner that it will not impede the usual running of the school. All ethical considerations will be observed, for example, protection of participants' identities and confidentiality of the results and findings.

Hoping that my request shall meet your positive and favourable response

Yours faithfully

Moremi Ntsako Shereen

APPENDIX H: PERMISSION LETTER FROM THE DEPARTMENT OF EDUCATION



Enq : MASENAMELA N.P Date : 08 February 2017

Contact No : 0828356293

The Executive Dean

Faculty of Humanities

University of Limpopo

Private Bag x 1106

Sovenga

0727

PERMISSION TO CONDUCT RESEARCH AT RAKWADU CIRCUIT

Ref: MOREMI N.S: Student No: 9131533

1. The matter above refers to;-

2. Permission is hereby granted to Moremi Ntsako Shereen a student at the University of Limpopo to conduct research at Rakwadu circuit.

3. However, the student must stick to ethical requirements and conditions as set by the University and recommended by the Department of Education.

4. Our office wishes Mrs Moremi N.S the best.

Faithfully yours

.....(CIRCUIT MANAGER)

DEPARTMENT OF EDUCATION
RAKWADU CIRCUIT
RECEIVED
2 2017 -02- 08
TEL: 015 328 3823 FAX: 015 328 4589
P/BAG X738 GA-KGAPANE 0736
LIMPOPO PROVINCE

APPENDIX I: ETHICS CLEARANCE CERTIFICATE FROM THE UNIVERSITY OF LIMPOPO

University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 2212, Fax: (015) 268 2306, Email:noko.monene@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE CLEARANCE CERTIFICATE

MEETING:	**24 April 2017**
PROJECT NUMBER:	**TREC/38/2017: PG**
PROJECT:	
Title:	Experiences faced by intermediate teachers in the teaching of decimal fractions in Grade 6 at Rakwadu Circuit in Limpopo Province
Researcher:	Ms NS Moremi
Supervisor:	Ms KM Themane
Co-Supervisor:	Ms K Maphutha
School:	Education
Degree:	Masters in Curriculum Studies

PROF TAB MASHEGO
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: **REC-0310111-031**

Note:
i) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee.**
ii) **The budget for the research will be considered separately from the protocol.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

Finding solutions for Africa

APPENDIX J: EDITOR'S CERTIFICATE

Mr MM Mohlake
University of Limpopo
Turfloop Campus
Private Bag x 1106
Sovenga
0727

14 April 2018

To Whom It May Concern

EDITING CONFIRMATION: N.S. MOREMI'S STUDY

This letter is meant to acknowledge that I, MM Mohlake, as a professional editor, have meticulously edited the main thesis of Ms Ntsako Shereen Moremi (Student number: 9131533), entitled "Exploring the Pedagogical Content Knowledge of Intermediate Phase Teachers in the Teaching of Decimal Fractions in Grade 6 at Rakwadu Circuit in Limpopo Province".

Thus I confirm that the readability of the work in question is of a high standard.

For any enquiries please contact me.

Regards

Mosimaneotsile M Mohlake
Freelance Professional Editor
(015) 268 2464
072 1944 452
<mosimaneotsile.mohlake@ul.ac.za>