

**LEARNERS' VIEWS OF PRACTICAL WORK IN
ADDITION OF FRACTIONS: A CASE STUDY**

BY

FORTUNATE GUGULETHU MDLULI

**THIS DISSERTATION IS SUBMITTED IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF EDUCATION**

**UNIVERSITY OF KWAZULU-NATAL
EDGEWOOD CAMPUS**

DECEMBER 2013

SUPERVISOR: PROFESSOR D. BRIJLALL

DECLARATION

I DECLARE THAT THIS IS MY OWN WORK AND THAT ALL REFERENCES HAVE BEEN DULY ACKNOWLEDGED, WITH THE ENTIRE SUPPORT OF MY SUPERVISOR PROFESSOR D. BRIJLALL.

F.G. MDLULI

STUDENT NUMBER: 201506658

DURBAN, SOUTH AFRICA

DECEMBER 2013

F.G. MDLULI

Signed:_____

PROFESSOR. D. BRIJLALL

Signed:_____

ACKNOWLEDGEMENTS

I would like to thank the following people for supporting me in completion of the study:

1. God the Almighty; it is by His grace that I had managed to finish this research.
2. Professor D. Brijlall, whose academic commitment and contributions to this study together with his scholarly guidance and patience helped to take this study to its successful conclusion.
3. The school, teachers and learners who willingly participated.
4. My children, Sizwe and Mngqobi, who sacrificed their right to their mother's time just to see me through.
5. My mother, Zamama Mdluli, who supported me by looking after my sons while I was busy doing this study.

DEDICATION

This work is dedicated to my late husband Funokwakhe Richard Hlongwa, who in his last days encouraged me to finish this study.

ABSTRACT

This study considered use of practical work as one of the strategies that may be used to teach and learn fraction concepts in primary school Mathematics. Although an educator and learners were participants in the study, the focus was mainly on the learners. The class educator's perception of practical work was investigated and the results confirmed the assumption that most educators use minimal or no practical work when teaching learners fractions.

The researcher carried out an experiment with learners to find out whether they saw any value in doing practical work. Data collection instruments used were an observation schedule which was collated by the researcher in teaching four lessons, written responses of learners to a series of activities they did as class work and their responses to interview questions. Data collected from learners confirmed that practical work did have value in the teaching of fraction concepts, especially addition of fractions.

Other than confirming the value of practical work, much other valuable data emerged from the findings. The data have important implications for the teaching and learning of fractions, especially addition of fractions, teacher training in practical work and also further research. These are intended to improve teaching of fractions, particularly addition of fractions.

TABLE OF CONTENTS

CHAPTER 1: OVERVIEW OF THE STUDY

	Pages
1.1 Introduction	1
1.2 Motivation	1 - 3
1.3 What is practical work?	3
1.4 Why do practical work?	4 - 6
1.5 Research problem	6 - 8
1.6 Relevance of the study	8
1.7 Key research questions	9
1.8 Aims of the study	10
1.9 Structure of the dissertation	10
1.10 Conclusion	11 - 12

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction	13
2.2 The nature of Mathematics	14
2.3 Learning of Mathematics	14 -16
2.4 Learning of fractions	16 - 17
2.5 Why is learning of fractions challenging?	17

2.5.1 Problem with terminology	17-20
2.5.2 Multiple representations of fractions.	20 - 21
2.6 Learners misconceptions on addition of fractions	22- 23
2.7 Teaching approaches	23-24
2.8 Conclusion	24 - 25

CHAPTER 3: THEORETICAL FRAMEWORK

3.1 Introduction	26
3.2 Constructivism defined	26 - 27
3.3 Historical perspective	27 - 30
3.4 Constructing meaning	30 - 32
3.5 Curriculum	32
3.6 Understanding Mathematics	32
3.7 Role of the educator	33
3.8 Mathematics classroom	34
3.9 Constructivist view on assessment	35
3.9.1 Types of assessment	36

3.9.2 Informal assessment	36
3.9.3 Formal assessment	37
3.10 Conclusion	37

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction	38
4.2 Methodology and research design	39
4.3. Dealing with validity and reliability	40
4.4. Participants	41
4.4.1 The educator	41
4.4.2 Learners	41
4.5 The experiment	43 - 45
4.6. Sampling	45
4.7. Research instruments	46
4.7.1 Naturalistic and participation observation	46
4.7.2 Interviews	47 - 48
4.8 Time frame	48-49
4.9 Analysis	50

4.10 Conclusion	50
-----------------	----

CHAPTER 5: PRESENTATION AND DISCUSSION OF DATA

5.1 Introduction	51
5.2 Learner engagement in four activities	62
5.3 Learners' perceptions of practical work	63 - 64
5.4 Conclusion	65

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction	66
6.2 Conclusions	66
6.2.1 Inclusion of practical work	67
6.2.2 Starting from what learners know	67
6.2.3 Usage of concrete objects	68
6.3 Further research	68

REFERENCES	69 - 76
-------------------	---------

APPENDICES	77 – 100
-------------------	----------

LIST OF TABLES, FIGURES AND PHOTOGRAPHS

Photo 1: Learners in action	47
Table 1. Observation tool	52

Table 2. Time frame	54
Table 3. Performance in activity one	52
Table 4. Performance in activity two	57
Table 5. Performance in activity three	60
Table 6. Performance in activity four	61
Figure 1. Written response of L 28 to task nine of activity one	52
Figure 2. Written response of L 26 to task nine of activity one	53
Figure 3. Written response of L 10 to task seven of activity one	54
Figure 4. Written response of L 15 to task seven and nine of act. one	56
Figure 5. Written response of L 26 to task two of activity two	58
Figure 6. Written response of L 30 to task ten of activity two	58
Figure 7. Written response of L 12 to task seven of activity two	59
Figure 8. Written response of L 10 to task seven of activity three	60
Figure 9. Written response of L 38 to task ten of activity four	61
Figure 10. Written response of L 28 to task four of activity four	62

CHAPTER 1

OVERVIEW OF THE STUDY

1.1 INTRODUCTION

The overview of this study commences with the motivation for it. Motivating factors behind this study emanated from experiences of the researcher in teaching learners and from knowledge-sharing forums with other teachers. From these interactions I discovered that some teachers had never changed the way in which they teach fractions. They still use what can be referred to as the ‘traditional method’, a method which I assumed to cause confusion and poor performance among learners. To provide part of the solution to this problem, in this study practical work is suggested as a method that might help learners to gain conceptual understanding of fractions.

Chapter one defines what practical work is, and tabulates reasons why it is seen as a better method for learning addition of fractions. The key research question and sub-questions that guide the study are analysed, as are the relevance and aims of the study, which explain how this study will benefit the people concerned.

1.2 MOTIVATION

When the researcher carried out class visits for a peer as part of Integrated Quality Management Systems (IQMS) it was observed that many Grade 6 learners experience difficulties with addition of fractions, despite the fact that they have studied this topic from Grade 3 or 4. To find out exactly whether the teacher knew about other methods of teaching fractions, I designed a questionnaire that helped me to discover that she only used one method, which I refer to as the ‘traditional method’. She knew little about what practical

work entailed, and cited reasons for not using it. Among other things she mentioned that practical work was time-consuming to prepare and also to teach, and that it was very difficult to teach fractions using concrete objects since the textbooks (which she follows rigidly) do not show practical activities that could be done with learners.

In the knowledge-sharing forum for Mathematics teachers, the teachers shared that when they teach fractions they do not usually go beyond drawing diagrams, where learners have to shade the given fractions or write symbolic representation of fractions. Some confessed that they don't even teach addition of fractions, because it creates a lot of confusion among the learners. If they do teach addition of fractions, the teachers indicated that many learners end up not able to solve given problems. Witherspoon (1993) argued that this limited exposure of learners to a single representation of the concept of fractions has been identified as seriously impairing learners' full development and understanding of the concepts and operations of fractions.

The above points provided evidence as to why learners perform poorly on fractions, particularly addition of fractions. It is clear that there has been no or little change in the teaching method of operations of fractions over the past few years. Learners still learn operations through intensive training and drilling in the use of algorithms for each operation. They have to memorise that for addition you find the lowest common denominator (LCD); those who were unable to memorise this failed to do their activity worksheet. Witherspoon (1993) challenges drilling methods and claims that learners learning in this way learn only a small part of the underlying concepts. This is confirmed by Sharp, Garofalo and Adams (2002, p.18) who argued that "procedural knowledge, such as algorithms for operations, is

often taught without context or concepts, implying that algorithms are an ungrounded code only mastered through memorisation”.

The appalling performance of learners from South African schools in the Trends in Third International Mathematics and Science Study in 1995 and 1999, also motivated this study. One of the areas learners were tested on was Fractions and Number Sense. This included whole numbers, fractions and decimals, integers, exponents, estimation, approximation and proportionality. The results of this test showed that the difference in average achievement between the highest- and lowest-performing countries was greatest for fractions and number sense, that is 308 scale points. South Africa was placed last with 300 (6.0) points, and an average significantly lower than the international average. (Howie, 1999)

With experience of teaching in the senior phase, I assume that the lack of understanding of conceptual meanings and processes on fractions among learners in the intermediate phase is a barrier to learning senior phase Mathematics concepts like ratios, percentages and algebraic simplifications. Successful learning of these concepts is achieved when learners are able to see the connections of these ideas when dealing with fractions. Practical work was assumed to be able to provide solutions to learners’ challenges in understanding the addition of fractions.

1.3 WHAT IS PRACTICAL WORK?

Practical work in fractions involves giving learners different representations and models to manipulate. It also entails hands-on activities involving manipulation of concrete objects and drawing diagrams and pictures. Witherspoon (1993) suggests that to gain complete understanding of fractions learners need to be exposed to the following representations:

symbols, concrete models, real-life situations, pictures and spoken language. Representations should be treated as essential elements in supporting students' understanding of mathematical concepts and relationships, and in communicating mathematical approaches, arguments and understandings to oneself and to others.

Concrete models are critical forms of representation and are needed to support students' understanding of and operations with, fractions. Other important representations include pictures, contexts, students' language, and symbols. Translating among all these representations makes ideas meaningful to students.

1.4 WHY DO PRACTICAL WORK?

The choice of practical work is based on the recent curriculum changes in South Africa: the changes proposed and key principles of the development and implementation of Curriculum 2005 and later the Revised National Curriculum Statement (RNCS), the Department of Education (DoE)'s policy, suggested participation and ownership (DoE, 2002) and learner-oriented approach (DoE, 1997). The Curriculum and Assessment Policy Statements (CAPS) for Grades R-12 (Department of Basic Education (DoBE), 2011) is also based on the principle of active and critical learning rather than rote and uncritical learning of given truths.

The type of learner that CAPS aims to develop suggests the use of practical work. The CAPS document expects the development of a learner who is:

1. Critically aware of how mathematical relationships are used in social, environmental, cultural and economical relations;
2. Confident and competent to deal with any mathematical situation without being hindered by a fear of Mathematics;
3. Appreciative of the beauty and elegance of Mathematics; and

4. Curious and with a love for Mathematics.(DoBE, 2011)

To the researcher's mind this cannot be achieved if learners still learn Mathematics in a rote fashion as before; Mathematics can only be learnt if learners are actively engaged in manipulation of hands-on material in attaining understanding of concepts, particularly fractions.

Dienes (1964) described three levels of conceptual development as understanding: pure concepts, notational concepts and applied concepts. Understanding of pure concepts is described as the understanding of intrinsic properties of numbers and operations on them. For example, in $\frac{7}{8}$ the learner will know what both numbers stand for; the notational concept is the written form of this fraction, and the applied concept is when the learner is able to apply the knowledge of this fraction. Learning this from Dienes made the researcher realise that a method that could help learners to attain these levels of conceptual development was practical work.

CAPS (DoBE, 2011) describes Mathematics as the subject that assists learners to develop mental processes that enhance logical and critical thinking, accuracy and problem solving that will contribute in decision-making. To achieve this, CAPS suggests active and critical learning among learners, thus encouraging an active and critical approach to learning rather than rote and uncritical learning of Mathematics. Learning of Mathematics aims at giving learners an opportunity to gain deep conceptual understandings in order to make sense of Mathematics and acquisition of specific knowledge and skills necessary for the application of Mathematics to physical, social and mathematical problems. CAPS also suggests the use of apparatus and diagrams, area models, length or measurement models and set models. This will be covered in more detail in chapter 2.

It has been argued that concrete experiences are a basic constituent for practical activities. Ott, Snook and Gibson. (1991) pointed out that “familiar concrete experience, actual or recalled should be the first step in the development of new abstract concepts and their symbolisation”.

Dienes championed the use of collaborative work, group work and concrete materials, as well as goals such as democratic access to the process of mathematical thinking, long before the dictates of constructivism. Dienes invented blocks which allowed students to explore the numeration system and how the operations on numbers were addressed by the system.

According to Piaget’s conceptual developmental stage, the concrete operational stage typically develops between the ages of 7-11 years. Intellectual development in this stage is demonstrated through the use of logical and systematic manipulation of symbols, which are related to concrete objects. Thinking becomes less egocentric with increased awareness of external events, and involves concrete references. With reference to Piaget’s suggestions the researcher saw practical activities as relevant for learners in Grade 6, who are about 11 years old, meaning that they are at the concrete operational stage. They need to be given an opportunity to manipulate objects in order to learn.

Other researchers accentuated the actual activity of doing Mathematics, which they proposed should predominantly consist of organising of mathematic subject matter taken from reality. It is believed that engaging learners in practical activities provides them with the opportunity for practical implementation of the ideals of outcomes-based education (OBE) as espoused in the RNCS and CAPS. This study had taken this into account, as we took fraction circles and diagrams, which are real-life objects, and gave learners an opportunity to manipulate and work with them.

1.5 RESEARCH PROBLEM

The motivation of this study is based on the assumption that the method of learning addition of fractions is a cause of failure of learners in Grade 6. Drilling and training methods are unable to help learners gain a clear understanding of fractional concepts. Over-generalisation of whole number concepts leads to confusion, and whole number operations are perceived as the same as those of fractions. Most learners in Grade 6 become confused when the teacher explains that when multiplying fractions products become smaller, because with whole numbers multiplying them makes the product larger.

The situation is worse with addition of fractions. When learners add fractions with the same denominators, e.g. $\frac{1}{2} + \frac{1}{2}$, the teacher has to explain that when the denominators are the same, we simply add the numerators only and take the denominator as it is. The common error that most learners make in this case is that they add the numerators together and the denominators together, thus getting $\frac{2}{4}$ instead of $\frac{2}{2}$ equals one.

When learners add fractions where one denominator is a multiple of the other denominator, e.g. $\frac{2}{2} + \frac{2}{6}$, learners are taught that they have to find the LCD, which is one of the denominators.

In adding fractions where the denominator is not a multiple of the other, e.g. $\frac{2}{3} + \frac{1}{2}$, they learn to find the LCD, which is totally different from the denominators that they have. The last instance in addition of fractions is the addition of mixed fractions, where learners need to add the whole numbers first and then add the proper fractions. The burden that learners have

is when they have to deal with simplification of fractions. For example, if the numerator is bigger than the denominator, a learner has to divide the numerator by a denominator to get a mixed number. In other cases where the numerator has a relationship with the denominator learners have to find the highest common factor of both numbers in order to simplify.

In learning all of these, most often learners have to memorise rules introduced to them by educators. This leaves them with a shallow understanding of the underlying conceptual meanings and processes, which in turn leads to their inability to apply their knowledge and skills in different situations.

1.6 RELEVANCE OF THE STUDY

This study explored learners' views of practical work in addition of fractions. Most previous studies of fractions have focused more on educators' views on practical work. Maharaj, Brijlall and Molebale (2006) emphasised that practical work is a crucial vehicle for learners to understand fractions. It is hoped that positive results of this study will serve as an encouragement for educators to include practical work in their lessons.

Teachers will also gain more knowledge on how to use practical work in the teaching of addition of fractions, particularly using fraction circles and diagrams. They will also learn how to set worksheets and assessments for practical work.

Teacher training institutions and in-service designers for teacher development programmes may use these data and offer more opportunities for in-service training on the use of practical work in the teaching of addition of fractions. This will also be of benefit to students specialising in Mathematics teaching.

Material developers may obtain guidelines on how to develop activities that include practical work.

1.7 KEY RESEARCH QUESTIONS

The key question of this study was: *How does learner engagement in practical work impact on their learning of addition of fractions?*

In order to unpack this critical question we considered the following sub-questions:

1. *What are learners' views of practical work?* This question helped the researcher to check whether learners ever engaged in practical work. This ensured that the researcher gave enough guidance as to how they should conduct themselves during a practical lesson and how to use the given materials.

2. *What are the learners' attitudes towards practical work?* This question helped to determine whether learners found it interesting to manipulate concrete objects that they had been given, and whether this helped them to understand the addition of fractions better.

3. *Which materials do learners prefer among diagrams and fraction circles?* This question helped the researcher to determine which materials used were preferred by learners. This would give the researcher the opportunity to look at why certain material is not preferred by learners, and if justifiable to omit in from teaching process.

4. *Do learners succeed after engaging in practical work, and if so why?* This is the focus of the main question. The purpose of the study is to explore whether practical work does help learners to grasp concepts better than when they are bombarded with rules. The findings will inform the interested parties concerned.

1.8 AIMS OF THE STUDY

The main aims of this study are as outlined below:

- To explain and demonstrate, using fraction circles and diagrams, what practical work entails. In this research Grade 6 learners were taught addition of fractions using fraction circles and diagrams. The first section of the study focused on addition of fractions with the same denominators, and fraction circles were used. Learners were given problems to solve. I found the fraction circle model to be the most powerful concrete representation for fractions. The circle model helped build understanding of the part-whole model for fractions and the meaning of the relative size of fractions. Fraction circles are also a powerful model for fraction addition.

The second, third and fourth sections focused on: a) addition of fractions with different denominators, b) addition of fractions where one denominator is the multiple of the other, c) addition of fractions where one denominator is not the multiple of the other, and d) addition of mixed fractions. Learners learnt how to solve these problems using diagrams.

- To determine whether using practical work enhanced learners' understanding of addition of fractions. The performance of learners engaged in practical activities and learners' responses to interview questions were used as an indication of proper understanding of addition of fractions.

1.9 STRUCTURE OF THE DISSERTATION

The subsequent part of this dissertation is divided into six chapters. The current chapter dealt with an overview of the study as a whole, and discussed the motivation, reasons for the study, practical work, research questions and aims of the study.

Chapter 2 provides a literature review on fractions. In this chapter the focus is on research that has been done on the concept of fractions: it first looks at research on fractions in general and then research specifically on addition of fractions.

Chapter 3 looks at the theory within which this study is based, that is constructivism. It defines what cognitive social constructivism looks at, the researchers who started the theory, and how learning of Mathematics takes place in constructivists' view.

Chapter 4 elaborates on the type of research methodology that was used in the study. This will introduce the type of methods used and tabulate reasons for preferences. Issues connected to the research, problems envisaged and proposed solutions are also discussed.

Chapter 5 discusses the research findings and results analysis. In this chapter the focus is on checking whether data collected do answer the key research question and sub-questions of the study. Results are recorded and analysed in order to confirm assumptions that had been made.

Chapter 6 is the conclusion of the study. It will also point out at recommendations on what teachers can use to improve learners' performance in addition of fractions.

1.10 CONCLUSION

This chapter presented the motivation of the study, and elaborated on reasons why practical work is regarded as a method that can facilitate understanding of addition of fractions. It also

presented the key research question: How does learner engagement in practical work impact on their learning of addition of fractions? This is the question from which all of the activities in this study were derived, since the aims of the study were to demonstrate by using fraction circles and diagrams what practical work entails, and to show whether practical work enhances learners' understanding of addition of fractions.

The next chapter provides a review of literature related to fractions in general and specifically on learning addition of fractions.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The literature review focuses on the nature of Mathematics and how learners learn Mathematics in general. It then considers research work carried out on learning of fractions, with a particular emphasis on addition of fractions. Regarding fractions the content and skills that learning should provide are clarified. The views of other researchers on what fractions are, why fractions are still regarded as important to learn and how fractions should be taught are also considered.

2.2 THE NATURE OF MATHEMATICS

Mathematics is known as evidence of conjectures and proofs that play an integral role in design, trading, communication and sustainable development (Moodley, Njisone & Presmeg, 1992). Mathematics develops the ability of precise record-keeping and capacity to measure even complex distances through its integral role. This integral role was evident in astronomical science, navigation, architecture, engineering, agricultural science and trading in Africa long before colonisation, making an application of numbers the basis of development. In describing the essence of Mathematics, the South African educational policy says:

Mathematics enables creative and logic reasoning about problems in the physical and social world and in the context of Mathematics itself. It is a distinctly human activity practiced by all cultures. Knowledge in the mathematical science is contracted through the establishment of descriptive, numerical and symbolic relationships.

Mathematics is based on observing patterns, with rigorous logic thinking and this leads to theories of abstract relations. Mathematical problem solving enables us to understand the world and make use of that understanding in our daily lives. Mathematics is contested over time through both language and symbols, by social interaction and is thus open to change. (DoE, 2003)

Moodley et al. (1992) and Maharaj et al. (2006) highlight the relevance of Mathematics, insisting that the academic content of this subject becomes valuable to a learner if it provides a valuable context for thinking about and using a particular aspect of Mathematics outside the school environment or in the world of work. Hence Ernest (1998) indicated that mathematical education at school ought to make students aware of themselves in relation to other people. Mathematics should make students perceive themselves as citizens of a country with certain obligations. These obligations carry with them certain responsibilities and require an attitude of understanding and patriotism. For that reason Turner, Gatienez and Sutton (2011) suggested linking mathematical ideas and procedures in a context that students value, and that motivates and develops their critical consciousness, thus linking Mathematics ideas to the depth of understanding and range of contexts in which they apply the Mathematics lens.

2.3 LEARNING OF MATHEMATICS

In 1997 the DoE introduced OBE with an intention of addressing the imbalances of the past in education. A review that took place in 2000 led to the first curriculum revision, and the *Revised National Curriculum Statement Grades R-9* (2002) and *National Curriculum Statement Grades 10-12* (2005) were introduced.

Another review took place in 2009, where the *Revised National Curriculum Statement* (2002) and *National Curriculum Statement Grades 10-12* were combined into a single document, which is called *National Curriculum Statement Grades R-12* (NCS). The NCS builds on the previous curriculum but also updates it and aims to provide clearer specifications of what is to be taught and learnt on a term-by-term basis.

The NCS represents a policy statement for learning and teaching and comprises Curriculum and Assessment Policy Statements (CAPS) for all approved subjects.

In CAPS (DoBE, 2011) Mathematics is defined as a language that makes use of symbols and notations to describe numerical, geometric and graphical relationships. It is a human activity that involves observing, representing and investigating patterns and quantitative relationships in physical and social phenomena and between mathematical objects themselves. It helps to develop mental processes that enhance logical and critical thinking, accuracy and problem-solving that will contribute in decision-making. Furthermore, CAPS (DoBE, 2011) suggests that teaching and learning of Mathematics aims to develop:

1. A critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations,
2. Confidence and competence to deal with any mathematical situation without being hindered by a fear of Mathematics,
3. A spirit of curiosity and a love for Mathematics,
4. An appreciation for the beauty and elegance of Mathematics,
5. Recognition that Mathematics is a creative part of human activity,
6. Deep conceptual understanding in order to make sense of Mathematics,
7. Acquisition of specific knowledge and skills necessary for:
 - 7.1 the application of Mathematics to physical, social and mathematical problems,

7.2 the study of related subject matter (e.g. other subjects) and

7.3 further study in Mathematics.

2.4 LEARNING OF FRACTIONS

The literature points out that teaching and learning of fractions continues to hold the attention of Mathematics teachers and education researchers worldwide. In what order should various representations be introduced? Should multiple representations be introduced early, or one representation pursued in depth once? Does it matter if fractions are introduced as counting or as measurement? What is the relative importance of procedural, factual, and conceptual knowledge in success with fractions? Does practical work play any role in learning the division of fractions? These and other questions remain debated in the literature. In the recent research on teaching and learning fractions suggestions are offered for practice, for locating resources having direct application in the classroom, and for further reading in the research literature.

It is suggested that fractions are still important to learn. For example, when the movement for the metric system argued that fractions were obsolete (since the metric system and calculators using decimal system were introduced), Usiskin (2007) counteracted this with a suggestion that fractions are important in that they provide a convenient way of representing many numbers and have different uses. Fractions are used in splitting up or sharing, calculating rate and proportions, in formulas and also in sentence-solving. The researcher concurs with Usiskin (2007) in that fractions, especially addition of fractions, is important to teach because this provides learners with an opportunity to solve practical problems where, for example, they have to share objects equally among themselves.

The suggestion of learning fractions in the early years came to the fore when mathematicians argued that learning of fractions should be eliminated from the primary school curriculum because of issues related to curriculum and instructional materials. This was counteracted, since it would deprive learners of the opportunity to develop an understanding of part-whole relationships and whole number knowledge. I am of the opinion that learning fractions in the early years lays a strong foundation for the learning of algebra in high school.

2.5 WHY IS LEARNING OF ADDITION OF FRACTIONS CHALLENGING ?

2.5.1 PROBLEM WITH TERMINOLOGY

Literature consulted revealed that other challenges are caused by the fact that mathematicians have different perspectives of what fractions are. For example Strydom (1983) defined fractions as equal parts of a whole. Koomen (2001) defined it by saying “we sometimes need to divide a whole object into equal pieces using numbers and these pieces are called fractions.” Siebert (2002) suggested that learning difficulties are caused by using fractions interchangeably with the terms ‘ratios’ and ‘proportion’.

Usiskin (2007) noted locations, ratios, counting units, variants of scientific notation, notations in algebra, scalars, multiplication across, division rates, division ratios and powering growth. Witherspoon (1993) viewed fractions as part-wholes, subsets, ratios, quotients and rational numbers and argued that although many perspectives of the concept of fractions are important for learners to know, this is not enough for a meaningful and holistic understanding of the concept itself. He suggested five representations of fractions: symbols, concrete models, real-life situations, pictures and spoken language.

Kieren (1976) proposed that the concept of fractions consist of four interrelated subconstructs: ratio, operator, quotient and measure. According to his initial conceptualisation, the part-whole personality of fractions permeated the aforementioned four subconstructs. It is for this reason that he avoided identifying the part-whole as a fifth subconstructs. Addition of fractions is said to fall under measure subconstructs, where a fraction is associated with two closely interrelated and interdependent notions. First it is considered as a number which conveys the quantitative personality of fractions and secondly is associated with the measure assigned to some interval.

Lamon (1999) also refers to a qualitative leap that students need to undertake when moving from whole to fractional numbers. She pointed out that in children's initial number theory, fractions are rejected numbers because they are not part of the counting sequence. This resistance to accepts fractions as numbers leads students to conceptualize fractions as two different whole numbers, a misconception that results in computational bugs, such as $\frac{1}{3} + \frac{1}{3} = \frac{2}{6}$. This concurs with Wu (2001) who argued that the challenging part of learning fractions is not computation, but conceptualisation. Maharaj et.al (2006) declared that a conceptual understanding of fractions and operations on them are necessary prerequisites if learners are expected to make sense of their learning of fractions.

Tzur (1999) saw children's initial reorganisation of conceptions of fractions as falling into three strands: (i) equidivision of wholes into parts, (ii) recursive partitioning of parts (splitting), and (iii) reconstruction of the unit (i.e. the whole). Recognising this division, Tzur (1999) suggested that teachers should consider one of these strands at a time in teaching rational numbers.

Taking a psychological approach Moss and Case (1999) suggested that for whole numbers children have two natural schemas, one for verbal counting and the other for global quantity comparison. In the realm of rational numbers they also saw children as having two natural schemas: one global structure for proportional evaluation and one numerical structure for splitting/doubling. They proposed then, as a plan for learning, that teachers need to refine and extend naturally occurring processes.

Similarly, based on her successful experience of teaching addition and subtraction of fractions and looking for a way to teach multiplication of fractions, Mack (1998) stressed the importance of drawing on students' informal knowledge. She used equal sharing situations in which parts of a part can be used to develop a basis for understanding multiplication of fractions, e.g. sharing half a pizza equally among three children results in each child getting one-half of one-third. Mack (1998) noted that students did not think of taking a part of part in terms of multiplication, but that their strong experience with the concept could be developed later.

Taking an information-processing approach, Hecht (1998) divided knowledge about rational numbers into three strands: (i) procedural knowledge, (ii) factual knowledge, and (iii) conceptual knowledge. His study isolated the contribution of these types of knowledge to children's competencies in working with fractions, and led him to two major conclusions:

1. Conceptual knowledge and procedural knowledge uniquely explained variability in fraction computation solving and fraction word problems set up accurately and
2. Conceptual knowledge uniquely explained individual differences in fraction estimation skills.

The latter conclusion supported the general consensus in current research that a holistic approach to teaching of fractions is necessary, with recommendations for a move away from attainment of individual tasks and towards development of global cognitive skills.

Ma (1999) conducted a study to compare Chinese teachers with American teachers in their understanding of fraction division. He found that Chinese teachers had a deeper understanding of the rationale of the algorithm, a more solid knowledge of abundant connections and much more flexible ways to solve problems than their American colleagues.

According to Irwin (2001) there is a great need for learners to learn algorithms so that teachers can unfold learners' experiences, thus making sense of the interaction taking place in the classroom.

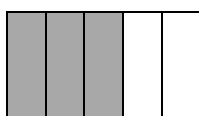
2.5.2 MULTIPLE REPRESENTATIONS OF FRACTIONS

Finally, researchers have identified considerable problems in the use of notation that can act as a hindrance to student development. These problems centre around teachers' perceptions that the notation used for rational numbers is transparent, while this has been shown not to be the case, especially with regard to decimal fractions (Hiebert, cited in Moss & Case, 1999).

One of the difficulties of operating with fractions is that they have a multiplicity of meaning.

Thus any particular number, for example $\frac{3}{5}$, can be interpreted concretely in many ways, all of which occur in everyday life applications. For example, the above fraction can be interpreted as:

1. A sub-area of a defined 'whole' region.

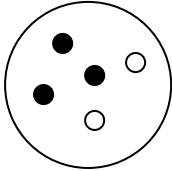


Hart (1980) studied children who were 12 and 13 year old and found that 93% of children

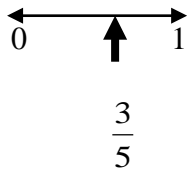
could correctly shade in parts of wholes

2. A comparison between a subset of a set of discrete objects and the whole set.

$\frac{3}{5}$ as:

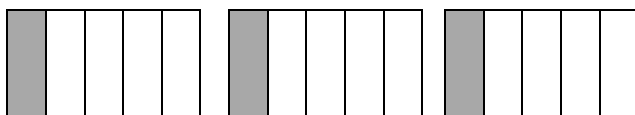


3. A point on a number line which lies at an intermediate point between two whole numbers.

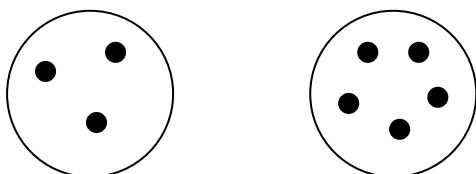


Payne (1976) reported on the number line model and cited in Payne (1976) are Maungnapoe (1975), William (1975), Galloway (1975) and Novillis (1976), in their investigations of hierarchical development, confirmed that using the number line model was significantly difficult for illustrating either the 'area part-whole' model or 'subset of a discrete set' model.

4. The result of a division operation (in the case, $3 \div 5$).



5. A way of comparing the sizes of two objects or two measurements.



2.6. LEARNERS MISCONCEPTIONS ON ADDITION OF FRACTIONS

The difficulty that learners show regarding fractions has been noted long time ago. In most cases the cause of difficulty originated from the fact that learners apply their knowledge of whole numbers to the arithmetic of fractions (Lamon, 1999). Secondly it is that traditional teaching methods that tend to value the use of symbols, which can often be an obstacle to the comprehension of logic subjacent to algorithmic actions in operating with fractions (Bezerra, Magina & Spinillo, 2002). In the MALATI (2004) project, it is noted that the traditional way of Least Common Denominator (LCD) in the addition of fractions does not foster understanding of equivalent fractions. For example, $\frac{1}{6} + \frac{2}{3}$, could be done as $\frac{1}{6} + \frac{2}{3} = \frac{1}{6}$.

This is emphasizing the same unity of measurement (6 units) then different quantities can be added. According to Newstead and Murray (1998) traditional teaching of fractions results in misconceptions. This concurs with Cooney (1990) who regarded the concept of fractions as the most difficult, because teachers use abstract symbols, terminology and forms of representation without developing meaning based on children's experiences.

A number of studies looking at learners' misconceptions found that misconceptions that learners have are tied to knowledge of whole numbers.(Irwin, 2001). This agrees with Mack (1995) who suggested that ability of students to relate to symbolic representation for fractions to their informal knowledge is influenced by their prior knowledge of symbolic representations of whole numbers. He suggested that learners may overgeneralize their prior knowledge of previously learnt mathematical symbol systems as they attempt to construct meaning for symbolic representations that are unfamiliar to them.

Peck (1981) stated that learners struggle with common denominator rule to add fractions like $\frac{1}{3} + \frac{2}{4}$ for instance in his study he gave the answer as $\frac{1}{5}$ when asked he gave an explanation that if you cancel 2 and 4 you get a $\frac{1}{2}$ and then you add 3 and 2 you get a 5. This is a misconception that when working with fractions and finding numbers that divide into each other you divide them. Also for this child to get 5 it means s(he) added the denominators. These are common mistakes that learners often make when adding fractions. When they add numerators they also add denominators. What one can assume is that perhaps the notion of cancelling stem from multiplication of fractions and adding denominators from addition of fractions. Observing these children's mistakes one can realise that they have sensible origins.

2.7. TEACHING APPROACHES

Spinillo (2004) in her study to investigate whether children are able to solve problems of adding fractions by way of *half*, discovered that children can successfully add fractions when the reference half is offered as an anchor, children exhibit and elaborate more strategies expressing equivalency schemas that are relevant to comprehension of addition of fractions.

Wardekker cited in Irwin (2001) mentioned that there is a need for specifically problems that are of appropriate level of difficulty for students so that conflict of informal knowledge on fractional concepts leads to successful scientific or “scholastic knowledge”) He emphasised the importance of reflection if students are to gain understanding so that knowledge becomes knowledge- in –action and that this reflection usually happens through dialogue.

Mack (1995) suggested that using symbolic representations with respect to real- world problems, could encourage learners to draw on their informal knowledge of fractions.

According to the Australian Education Council (1991) cited in Goos (2004), developing learners' communication and problem solving skills within which mathematical concepts are nurtured like conjectures, generalizations, proofs, refutations etc., should be the epistemological view of mathematics education.

According to Smith, learners are capable of constructing their own knowledge; therefore teachers should incorporate that knowledge within the instructed knowledge for the benefit of the learners' mental capability and interrelatedness.

Tirosh (2000) conducted a study on teacher knowledge in teaching of fractions and concluded that teachers need to pay considerably more attention to analysis of student errors. Most of the teachers still relied on textbooks that emphasise the algorithms that are not concrete but abstract for learners' comprehension of work. This concurs with Boaler's (2002) suggestion that "traditional, textbook approach that emphasizes computations, rules and procedures, at the expense of depth of understanding, disadvantages students, primarily because it encourages learning that is inflexible, school bound and of limited use". Educators need rich content knowledge, they need to learn to listen to students and sort out mathematical problems encountered by those learners, and they need to pose questions that will help them gain additional insights into students' thinking.

2.7 CONCLUSION

Literature reviewed suggested that it is very important to expose learners to diverse interpretations of the concept of fractions. This lays the foundation for a meaningful acquisition of the concept of addition of fractions. The literature reviewed also placed practical work at the centre of meaningful understanding of the addition of fractions. The

principle of moving from concrete to abstract remains important to acquisition of understanding the addition of fractions.

The next chapter will look at the theory upon which this study is based. This is the constructivist theory or model of learning that suggests that learners' understanding usually has to be constructed by their own individual efforts as well as their own mathematical ways of knowing, as they strive to be effective by restoring coherence to the world of their personal experience (Cobb, 1994).

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 INTRODUCTION

This study is based on social constructivism, which considers the social world of a learner as important. People such as teachers, friends and parents form the social world of the learner. The researchers that identify with social constructivism trace their ideas back to Vygotsky, a pioneering theorist in psychology who focused on the roles that society played in the development of an individual. Vygotsky (1978) stresses the importance of the socio-cultural nature of learning. He promotes ‘zonal proximity development’ where the educators are supposed to give guidance to learners, engaging them in discovery learning. His reason was that if learners are engaged with enough objects, symbols and language rather than blindly mimicking algorithms from textbooks, they could derive meanings of the concepts that make sense.

3.2 CONSTRUCTIVISM DEFINED

Constructivism is a philosophy of learning founded on the premise that by reflecting on our experiences, we construct our own understanding of the world we live in. Each of us generates our own ‘rules’ and ‘mental models’, which we use to make sense of our experiences. Learning, therefore, is simply the process of adjusting our mental models to accommodate new experiences.

Basically defined, constructivism means that as we experience something new we internalise it through our past experiences or knowledge constructs which we have previously established that meaning is constructed by the cognitive apparatus of the learner.

Saunders (1992) explains and agrees with Watzawick (1984) that constructivism can be defined as that philosophical position which holds that any so-called reality is, in the most immediate and concrete sense, the mental construction of those who believe they have discovered and investigated it. In other words, what is supposedly found is an invention whose inventor is unaware of his act of invention and who considers it as something that exists independently of him; the invention then becomes the basis of his world view and actions.

These past experiences are also referred to as our world view.

Wheatly (1991) suggests two principles of learning through the constructivist theory:

- Principle one states that knowledge is not passively received, but is actively built up by the cognizing subject. Ideas and thoughts cannot be communicated in the sense that meaning is packaged into words and ‘sent’ to another, who unpacks the meaning from the sentences. That is, as much as we would like to, we cannot put ideas into students’ heads, they will and must construct their own meanings.
- Principle two states that the function of cognition is adaptative and serves the organisation of the experiential world, not the ontological reality. Thus we do not find truth but construct viable explanations of our experiences.

3.3 HISTORICAL PERSPECTIVE

Constructivist theory has reached great popularity in recent years, but the idea of constructivism is not new. Aspects of constructivist theory can be found among the works of Socrates, Plato and Aristotle all of which speak of the formation of knowledge. Saint

Augustine thought that people must depend upon sensory experience in the search for truth. More recent philosophers such as John Locke thought that no man's knowledge can go beyond his experience. Kant explained that the "logical analysis of actions and objects lead to the growth of knowledge and the view that one's individual experiences generate new knowledge" (Brooks & Brooks, 1993, p. 23.).

Although the main philosophy of constructivism is generally credited to Jean Piaget (1896-1980), Henrich Pestalozzi (1746-1827), also from Switzerland, came to many similar conclusions over a century earlier. Pestalozzi maintained that the educational process should be based on the natural development of the child and his or her sensory influences. Pestalozzi's basic pedagogical innovation was his insistence that children learn through the senses rather than with words. He labeled rote learning as mindless, instead emphasising linking the curriculum to children's experiences in their homes and family lives.

However, Piaget is regarded as the father of constructivism and provided the foundation for modern-day constructivism. In Piaget's view intelligence consists of two interrelated processes, organisation and adaptation. People organise their thoughts so that they make sense, separating the more important thoughts from the less important ones as well as connecting one idea to another. At the same time, people adapt their thinking to include new ideas as new experiences provide additional information. This adaptation occurs in two ways, through assimilation and accommodation. In the former process new information is simply added to the cognitive organisation already there. In the latter, the intellectual organisation has to change somewhat to adjust to the new idea.

Piaget's view on children's intellectual development progressed through distinct stages: stage 1 is sensorimotor, where a child still relies on her or his senses to learn; stage 2 is pre-

conceptual, where a child learns a number of concepts, stage 3 is intuitive, concrete-operational, when learning is based on concrete material; and formal, which involves abstract learning.

Piaget is of the opinion that it is through learners' own efforts that they will truly understand. He also put more emphasis on construction of new conceptual structures through the use of past experience.

Constructivist theory in education is actually a branch of neo-Piagetian thought, which is rooted in personal constructivism (Von Glasersfeld, 1989). Constructivism or a constructivist view places the students, their interests and previous experiences and knowledge as paramount parts of understanding in designing curriculum. This has a particular impact when exploring the implications of pedagogy and teacher training.

The philosophy of constructivism has been discussed and debated by researchers such as Von Glasersfeld (1981, 1989, 1990); Cobb (1994); These authors are concerned about constructivism as a philosophy and through debate leave the practitioner in the field confused. What is the practitioner to do? What do we teach and model to our teachers in preparation? The purpose of this section is to explore which 'best practices' are associated with a constructivist teacher and how we can use them without relegating them to a set of prescribed methods.

Cobb (1994) contrasts the approach of delivering mathematics as 'content' against the technique of fostering the emergence of mathematical ideas from the collective practices of the classroom community. Emphasis is growing on the teacher's use of multiple epistemologies to maintain dialectic tension between teacher guidance and student-initiated

exploration, as well as between social learning and individual learning. Constructivism-related strategies such as these are starting to be used more often in Science and Mathematics classrooms, but perhaps not surprisingly have been common for a longer time in humanities subjects like Social Studies and Communication.

Cobb (1994) examined whether the 'mind' is located in the head or in social action, arguing that both perspectives are necessary as each is as useful as the other. What is seen from one perspective as reasoning of a collection of individuals mutually adapting to each other's actions can be seen from another as the norms and practices of a classroom community.

Salomon and Perkins (1998) suggested ways that these 'acquisition' and 'participation' metaphors of learning interrelate and interact in synergistic ways. Comparing the learner in a team to an individual in a social setting, they identified three main types of relations:

1. Individual learning can be less or more socially mediated;
2. Individuals can participate in the learning of a collective, sometimes with what is learned distributed throughout the collective more than in the mind of any one individual; and
3. Individuals and social aspects of learning in both of these senses can interact over time to strengthen one another in a 'reciprocal spiral relationship'.

3.4 CONSTRUCTING MEANING

The constructivist theory or model of learning is of the view that knowledge is not always transferred directly from teaching to learner in a form that can be immediately understood. Studies by researchers like Confrey (1990) show that learners' understanding of matter is always different in each teaching and learning context.

In order to achieve learning outcomes (DoE, 2005) it is important for the educator not only to be concerned about the construction of meanings and understanding, but also to understand the process of knowledge acquisition and knowledge transfer. Social interaction can play a major role in the process of knowledge acquisition and knowledge transfer. The true direction of learning and the development of thinking in our conception are not from the individual to the socialised, but from the social to the individual (Vygotsky, 1978 p. 36).

Vygotsky (1978) also understood learning as the outcome of internal developmental processes that are able to operate only when children are interacting with people in their environment and in cooperation with their peers. The idea of a zone of proximal development (ZPD) is defined by Vygotsky (1978) as the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. This provides the explanatory framework for learning as a whole, both in formal contexts such as in schools and the informal contexts in everyday situations (Newman & Holtzman, 1993).

Vygotsky (1978) argued that the development of higher cognitive functions is launched within the ZPD, and that most learning within the ZPD takes place when learners get involved with tasks or problems which go beyond their immediate individual capabilities, where educators or adults assist their performance or in collaboration with more knowledgeable peers. Educators should therefore predefine the kind of learning that will be achieved by the end of a learning process in terms of outcomes (Skinner, 1968).

Adler (1991) pointed out that with only 12% of black secondary school educators having a degree, Mathematics teaching by and large was bravely tackled by educators barely one step ahead of their learners. This resulted in authoritarianism and rote-learning methods

predominating. He also reiterates the idea that for so long learners in Mathematics classrooms have been socialised to believe that their own experiences, concerns, curiosity and purposes are not important. Mathematics is seen as being devoid of meaning, bearing no relevance either to their everyday experience or to pertinent issues in their societies. For these students learning Mathematics takes on more of the nature of obedience than of understanding.

Piaget suggested that it is through discussion and criticism among equals that effective learning will take place (Piaget, 1932). Discussion can assist learning at any level. The articulation of thoughts lays learners open for inspection and criticism, and the amendment that will lead to clarification and a coming together of understanding.

According to Doise (1990), children working together in dyads or triads tend to perform better or at a higher level than children working as individuals. The social constructivists' model is regarded as a socially constructed world that creates and is constrained by the shared experience of the underlying physical reality (Ernest, 1996).

3.5 CURRICULUM

Constructivism calls for the elimination of a standardised curriculum. Instead, it promotes using curricula customised to the students' prior knowledge. It also emphasises hands-on problem solving.

3.6 UNDERSTANDING MATHEMATICS

Mathematics learning, especially of fractions, should be based on understanding rather than on being able to repeat remembered routines and demonstrate particular basic skills. The above does not totally reject memory at the expense of understanding: it is true that some of the basic concepts need to be memorized in order to facilitate understanding. Orton and Frobisher (1996) argue that in relation to memory, the more readily one remembers, the

easier it is to think. Memory eliminates delay caused by searching for what can be likened to some missing piece of information. Less effort is required in pulling essential information to the forefront of the mind.

Learners whom educators regard as being particularly intelligent usually have swift retrieval systems, in that they recall things quickly and accurately. It is therefore clear that good memory is an essential part of the learning and understanding of Mathematics. Understanding helps one to construct meaning using memorised facts. It is therefore an essential requirement in the learning process. Orton and Frobisher (1996) distinguished two kinds of understanding: instrumental and relational understanding. The learning of many procedures, like adding and multiplying fractions, is called instrumental understanding. Instrumental understanding has to do with the ‘how’, while on the other hand knowing ‘why’ is dealt with in relational understanding.

3.7 ROLE OF THE EDUCATOR

In the constructivists’ view the responsibility of the educator is to design activities which will cause learners to participate actively in their learning (Orton & Frobisher, 1996). Furthermore, the NCS (DoE, 2003) of South Africa envisages an educator who, among other things, is the mediator of learning, interpreter and designer of learning programmes and materials, and a leader. OBE has seen a complete paradigm shift from previous traditional educational approaches used in South Africa, from a teacher-centred approach to an educator who poses as a facilitator of learning.

Faulkner, Littleton and Woodhead (1998) described the traditional class as teacher-centred, where the emphasis is on neatness, order and accurate reproduction of demonstrated procedures. In the past, relationships in the classroom during lessons were mostly restricted

to that between the educator and each individual learner. Paper and pencil tests and percentage marks for achievement were the only form of assessment and reporting in Mathematics. The implementation of the NCS changed all of the above. The NCS requires learners who are able to demonstrate the ability to think logically and analytically, as well as holistically and laterally. The learners are also expected to be able to transfer skills from familiar and unfamiliar situations (DoE, 2003).

3.8 MATHEMATICS CLASSROOM

The constructivists' view suggests that the classroom should be a pleasant environment where learners' interest is captured. To earn psychological investment (educators' expectation) educators have to work hard to produce a positive atmosphere in the classroom. This is achieved by developing lessons that are interesting and stimulating, and providing a safe environment for and appropriate support of learning.

The learning atmosphere changes learners in different ways: some are influenced by classroom layout, seating, temperature and smell as well as the quality of learner-educator interaction in class (Chaplain, 2003).

Mathematics learners are expected to think creatively. Classroom environment is crucial to fostering creative ability. An environment full of ideas, experiences, interesting materials and resources can stimulate creativity (Craft, Jeffrey & Leibling, 2001). The décor and organisation of a classroom should transmit what one expects to be going on in class. The Mathematics educator should link theories learnt in Mathematics (especially fractions) to the real world. In a Mathematics class posters and concrete objects on display are useful; they can rouse interest from learners and assist them in making sense of the subject.

The layout of the classroom also affects communication in the classroom. Eye contact, social distance, posture and gesture can all be enhanced by attention to the classroom layout. Some learners can easily feel excluded because of where they are positioned in class (Craft et al., 2001). To avoid this, the educator should reflect on who is sitting where and the reason for this. This exercise develops a positive relationship with learners who are at risk of social exclusion. Where the individuals are asked to sit, the nature of work they are given, the degree to which they are empowered to ask questions in class and the emotional warmth of the environment all have an influence on learners. The above influence how learners think, learn and feel about themselves and how they subsequently behave in class. Organising the classroom directly influences both the nature of the interaction and the style of teaching, and in addition should match the educators' behavioural goals.

3.9 CONSTRUCTIVIST'S VIEW ON ASSESSMENT

This theory defines assessment as a continuous planned process of identifying, gathering and interpreting information regarding the performance of learners, using various forms of assessment. It involves four steps:

1. generating and collecting;
2. evidence of achievement;
3. evaluating this evidence; and
4. recording the findings and using this information to understand and thereby assist the learner's development in order to improve the process of learning and teaching.

Assessment should be both informal and formal. In both cases regular feedback should be provided to learners to enhance the learning experience. This will assist the learner to at least achieve the minimum performance level of 40 – 49% required in Mathematics for promotion purposes.

3.9.1 TYPES OF ASSESSMENT

The following types of assessment are very useful in Mathematics and teachers are encouraged to use them to serve the purpose associated with each.

3.9.1.1 Baseline assessment

This type of assessment is done by the teacher, before he or she introduces a new lesson. It is used to ascertain whether the learners meet the basic skills and knowledge levels required to learn a specific Mathematics topic.

3.9.1.2 Diagnostic assessment

This informs the teacher about the learner's problem areas in Mathematics that have the potential to hinder performance, that is, content-related challenges and psycho-social factors.

3.9.1.3 Formative assessment

Formative assessment is used to aid the teaching and learning processes, and hence assessment for learning. It takes different forms, e.g. short class works during or at the end of each lesson, and verbal questioning during the lesson.

3.9.1.4 Summative assessment

Contrary to the character of formative assessment, summative assessment is carried out after the completion of a Mathematics topic or cluster of related topics. It is therefore referred to as assessment of learning since it mainly focuses on the product of learning.

3.9.2 INFORMAL ASSESSMENT

Assessment for learning has the purpose of continuously collecting information about learner performance that can be used to improve their learning. Informal assessment is a daily monitoring of learners' progress. This is done through observations, discussions, practical demonstrations, learner-teacher conferences, informal classroom interactions, etc. Learners

can assess themselves or be assessed by their peers. This gives them an opportunity to learn from and reflect on their own performance.

3.9.3 FORMAL ASSESSMENT

Formal assessment comprises school-based assessment and the end of the year examination. Formal assessment tasks are marked and formally recorded by the teacher for promotion purposes. The school-based assessment component may take various forms; for example, in Mathematics this takes the form of tests, examinations, projects, assignments and investigations. (DoE, 2011)

3.10 CONCLUSION

Practical work is based on the theory of social constructivism as it actively engages learners in addition of fractions as they construct their knowledge in the manipulation of objects. Learners tend to know what they are doing and why they are doing it.

The next chapter will introduce the methodology and design adopted for this study. It will also explain why the methodology was selected. Envisaged problems and proposed solutions will be discussed.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter will recap the factors that motivated this study to provide a clear picture of why a qualitative methodology was chosen. As mentioned in the first chapter, this study was based on the assumption that the method of learning (drill and training method) addition of fractions is the cause of failure of learners in Grade 6. The abovementioned method is said to be unable to help learners gain a clear understanding of fractional concepts. To remedy the situation practical work has been advocated as a method that might contribute towards attainment of conceptual understanding of addition of fractions by learners.

As a result of the above concern, the key research question was:

How does learner engagement in practical work impact on their learning of addition of fractions?

Sub-questions were as follows:

1. What are learners' views of practical work?
2. What are the learners' attitudes towards practical work?
3. Which materials do learners prefer among diagrams and fraction circles?
4. Do learners succeed after engaging in practical work, and if so, why?

The sub-questions of the study and all of the major areas which it intended to look at qualified the study as being categorised as qualitative. These are the type of questions that will probe learners' conceptions of fractions.

4.2 METHODOLOGY AND RESEARCH DESIGN

This study was immersed in an interpretivist paradigm aligned with a qualitative approach, because it dealt with observable phenomena and participants' thoughts, attitudes and beliefs. I used interviews to obtain data related to the learners' views of the use of practical work. This was a preferred method because it would probe learners' conception of addition of fractions.

Throughout the process the learners' context, experiences, attitudes, views and thoughts were taken into consideration. Observation and standardised open-ended interviews were the other two instruments used, and Patton (2002) argues that these two methods qualify a study as a qualitative inquiry.

To investigate the impact of practical work in the learning of addition of fractions required an in-depth inquiry into the perceptions of learners about fractions and addition of fractions. A naturalistic experiment on the effects of engaging learners with practical activities was done to find out if this had any positive benefits for the learning of fractions.

The qualitative nature of the study meant that it was to be both descriptive and explanatory. Qualitative research is descriptive, and therefore it could be able to reveal the nature of the situation in the classroom, including relationships between learners and educator. It will also explain explicitly the kind of conceptions that learners have, from actions observed and explanations provided during informal and formal interview proceedings. Qualitative research is a great tool for discovering and interpreting existing problems (Leedy & Ormond 2001).

4.3 DEALING WITH VALIDITY AND RELIABILITY

It is argued that bias on the part of the researcher can influence the results and undermine the quality of research, particularly the credibility of results. Bell (1993), cited in Mokapi (2002, p. 58) argued that this is because researchers as human beings are never neutral or explicit about their assumptions and orientations. To ensure that this was avoided the instruments used were tested as to whether they were valid and reliable.

Reliability refers to the degree of consistency with which instances are assigned to the same category by different observers or the same observer on different occasions (Hammersley, 1992, p. 67). Validity means the extent to which an account accurately represents the social phenomenon to which it refers (Hammersley, 1990, p. 57). For reliability the researcher recorded data during many observations: what actually transpired in actual, natural settings that were accurate and comprehensive in coverage. For validity two different methods of collecting data were used, which enabled comparison of findings. Findings from observations, learners' written responses to the tasks and learners' responses to the two sets of interviews were categorised and compared to determine whether the gathered information from different methods confirmed one another. This is referred to as triangulation.

Triangulation refers to combining multiple theories, methods, observers and empirical materials to produce a more accurate, comprehensive and objective representation of the object of the study. In this study observations and interviews were used. However, Bell (1993) indicated that a researcher can get reliable results when using valid instruments. This is because although a test may prove to be highly reliable, at the same time it may be highly invalid, since reliability does not imply validity (Hysamen , 1993).

Halldo'rsson and Aastrup (2002), citing Erlandson et al. (1993), suggested three issues to be stressed when evaluating research impact:

1. Truth value: Referring to that, credibility must be guaranteed;
2. Application: Which must be appropriate to the intended audience; and
3. External judgement and neutrality of findings: Enabling cross-checking of findings.

4.4 THE PARTICIPANTS

4.4.1 THE EDUCATOR

The educator I worked with is an intermediate phase teacher who teaches Mathematics for the whole phase. She has 11 years' experience of teaching in primary school, and 8 years in teaching Mathematics. She has a Bachelor's degree.

4.4.2 LEARNERS

The researcher was granted permission to do this study at one of the Combined Schools of Umhlali ward, which is in the Ilembe district. The enrolment of the school is currently about 760 learners and there are 22 educators.

In this school there are two classes in Grade 6: Grade 6 A and Grade 6 B. After negotiations with the management it was decided that I should work with Grade 6 B. The Mathematics teacher asked for permission to observe my lessons so that she could apply the same method with Grade 6 A.

Grade 6 B was a class of mixed ability with 42 learners. Their ages ranged from 11 to 15 years. Most of the learners had been at the school from grade 1 as they live on the farm around the school. The purpose was to uncover in-depth information about what happens

when learners learn addition of fractions using practical means. It is argued that “Qualitative inquiry typically focuses on relatively small samples, selected *purposefully* to permit inquiry into and understanding of phenomenon in *depth*”

During teaching learners were seated in groups (see photo 1). This arrangement allowed them to work together and help one another to solve problems. Problems were provided on activity sheets and the learners worked with fraction circles and diagrams. This gave the researcher an opportunity to move around and observe learners interacting with one another.

After group work learners were given enough time to complete their individual activity sheets. Each activity sheet had 10 problems to solve. While learners were working individually the researcher observed the learners, marked completed sums, and helped those learners who were struggling. All marked scripts were collected for data capturing.

The next day always started with revision of previous work and then new content would be introduced. This captured learners’ attention and kept them focused to what was done in the lesson.



PHOTO 1: LEARNERS IN ACTION

4.5 THE EXPERIMENT

Natural experiments are distinct from controlled experiments, in that the observer is present during real-world change (Patton, 2002). This is the kind of experiment that the study undertook on learners' use of practical means to add fractions, and it helped the researcher to document the phenomenon before and after change.

Obtaining reliable data from learners required full engagement of learners with practical activities. With the assumption that these learners had been exposed to fractions before (although not addition of fractions with different denominators), the decision was to engage them in four lessons on four consecutive days. Each day learners were given an activity sheet to complete. On day one they did activity one, on day two activity two, and so on. On the top of each activity sheet the learner did not write his or her name, but wrote a code. This was to ensure that the learners' information would be confidential. Learners' work was marked in the classroom and worksheets were collected. Marks from the worksheet were used to determine success.

The first lesson was on addition of fractions with the same denominators (Appendix A(1)). In this activity learners were asked to use fraction circles to find answers. This was done with the intention that learners should find it easy to add equal pieces that are of the same size, as this would capture their interest. Another aim was to prepare them for the next activity, in which the researcher wanted them to discover for themselves that:

- it is not possible to add fractions with different denominators in the way learnt in activity one;
- to add fractions it is always important to make denominators the same;

- once the denominators are the same, only the numerators are added and not the denominators;
- if the numerator is the same as the denominator, that makes a whole; and
- answers are always left in their simplest form, as this would help them to do factorisation in the senior phase.

The second lesson was ‘addition of fractions with different denominators’ (one denominator is a multiple of the other) (Appendix A (2)). Phase one of the lesson was group work. Each group was given fraction circles to solve a problem. Learners tried to match pieces that they were adding, but were unable to come out with the final answer. They did not know whether the answer was to be in sixths or thirds. It was very interesting to note that some groups were able to see that one-third equals two-sixths. It was at this time that diagrams were introduced.

Diagrams helped learners not only to learn addition of fractions, but also:

- the concept of equivalency;
- factors and multiples of numbers;
- drawing correct diagrams to represent fractions; and
- simplification of fractions.

The third lesson was on ‘addition of fractions with different denominators’ (none of the denominators is a multiple of the other) (Appendix A (3)). In this instance diagrams were used. In this lesson it was hoped that practical work would help to allow for:

- Equivalency to be consolidated; and
- The fact that different numbers can have the same multiples; for instance, for 3 and 4 they discovered that 4 and 3 divide equally into 12, so therefore 12 is a multiple of 3 and 4 and 3 and 4 are factors of 12.

In the fourth lesson the problems were mixed fractions (Appendix A (4)). In this case they discovered:

- that a whole is made of eight pieces if we talk about eighths using fraction circles; and
- how improper fractions are formed.

4.6 SAMPLING

For interview purposes the researcher focused on the use of worksheets for activity four. This was because activity four was designed to test all of the knowledge they obtained from previous activities, and in this activity scripts were put into five categories according to marks obtained. As there were two sets of interviews from each category the scripts were separated; one learner was selected for interview for learners' views on practical work and one for interview according to performance. The five categories were as follows:

Category 1: 10% - 20%

Category 2: 30% - 40%

Category 3: 50% - 60%

Category 4: 70% - 80%

Category 5: 80% -100%

Two scripts from each category were selected at random. Two learners from each category were believed to be representatives of each category. This was a flexible and a non-embarrassing way of selecting learners, especially those who performed in the first and second categories.

Truran and Truran (1998, p. 61) explain a clinical interview as a set of questions, some of which are prepared, and some following from the subject's responses to previous questions.

During these interviews the interviewer is “free to modify the sequence of questions, change the wording, and explain them” (Cohen, Manion & Morrison, 2000). According to Mokapi (2002), Piaget is regarded as the pioneer of the clinical interview method. Giensburg (cited in Mokapi, 2002) argues that this method is used by researchers in Mathematics education to probe learners’ conceptions about mathematical knowledge.

4.7 RESEARCH INSTRUMENTS

The research instruments that were used to capture the required data were specifically associated with qualitative studies, and were:

1. semi-structured observation during teaching;
2. semi-structured interviews with learners;
3. written responses of learners (learner activities)

4.7.1 NATURALISTIC AND PARTICIPATION OBSERVATION

Before each lesson began it was explained to the teacher and learners what the role of the observer was during the lesson. The specific material, for example the fraction circles or diagrams, were also shown to the learners. The aim for the researcher was to observe whether concrete objects helped them to solve problems.

During teaching learners were observed as to whether they benefitted from the usage of hands-on materials. To capture the unfolding events in depth a semi-structured observation schedule was used. According to Cohen et al. (2000), a semi-structured observation has an agenda of issues of interest, but gathers data in a far less predetermined and systematic manner. The semi-structured character of the observation suited the qualitative nature of this study.

4.7.1.1 Observation tool

The following table provides a set of questions that the researcher used in observing learners.

This is attached as appendix B.

TABLE 1: OBSERVATION TOOL

Questions	Researcher's notes
1. Are all learners able to solve given problems?	
2. Are learners using the given fraction circles and diagrams ?	
3. Observing gestures for example facial expression. Are learners finding it interesting to manipulate concrete object.	

4.7.2 INTERVIEWS

After a series of lessons were finished, 10 selected learners were interviewed. A semi-structured interview was conducted to find out learners' views on the usage of fraction circles and diagrams. This focused mainly on successes and challenges as they used the hands-on materials. This type of interview was preferred because interviewees were asked the same question, thus increasing comparability of responses. The researcher was able to probe learners with more questions and picked up on non-verbal cues showing learners' views and preferences. Also, as a group they were given an opportunity to make comments on the use of

the material. The researcher gave feedback to the interviewees and also the whole class on the average performance on activities

4.7.2.1 Interview tool

The interview used questions based on practical work with the usage of fraction circles and diagrams: This is attached as appendix C.

1. What did you understand about doing practical work when learning fractions?
2. Have you been engaged in doing practical work when you learn addition of fractions? If yes, what did you use and how did you use that?
3. In the four lessons that we had, we used fraction circles and diagrams. Which one did you find interesting to use? Explain for each one.
4. Did you enjoy learning addition of fractions using practical work? If so, why?

4.8 TIME FRAME

The school granted the researcher two weeks to complete the study. Each Mathematics period given was before break, and it was an hour long. It was only on Wednesdays that the lessons were 30 minutes, because it is a sports day. This was too short for the lesson to be completed, and the third lesson had to be completed the next day. A summary of the methodological process is as follows:

TABLE 2: TIME FRAME

Lesson	Activities	Research instrument
1	Activity one: Addition of fractions with the same denominator.	Observation Written responses to activity sheets
2	Activity two: Addition of fractions with the different denominators, where one denominator is the multiple of the other.	Observation Written responses to activity sheets
3	Activity three: Addition of fractions with different denominators, but where the LCD is different from both denominators	Observation Written responses to activity sheets
4	Activity four: Addition of mixed fractions	Observation Written responses to activity sheets
5	Activity five: Revision	Interviews

4.9 ANALYSIS

The literature consulted, observations during lessons, semi-structural interviews done with learners and learners' written responses from worksheets provided rich data that enabled us to draw conclusions. These data were grouped into categories in terms of patterns. Patton (2002) named this inductive analysis. This is supported by the argument that "Qualitative inquiry is particularly oriented towards exploration, discovery and inductive logic" (Patton, 2002, p. 55).

4.10 CONCLUSION

This study was qualitative in nature, as it dealt with the views and attitudes of learners. Observations and interviews were used to collect the necessary data from the learners. The data collected are discussed in detail in the following chapter.

CHAPTER 5

PRESENTATION AND DISCUSSION OF DATA

5.1 INTRODUCTION

This chapter presents and discusses data gathered during the teaching of four lessons on addition of fractions. Methods used to collect the data were semi-structured observations and clinical interviews conducted with ten selected learners. The results are presented in a table for each activity and samples of learners' written responses are interpreted.

5.2 LEARNER ENGAGEMENT IN FOUR ACTIVITIES

From observing learners' marks it was evident that of the class of 44 learners, almost all got their answers for activity one in lesson one correct. In this lesson they used colourful, easy to handle fraction circles. During the lesson it was also observed that it was easy for each learner to add fractions because each piece was labelled. Sometimes it is difficult for many learners to picture how big half is, but the fraction circles pieces which are the same in size.

Fraction circles made it easy for the researcher to explain and show learners, that if you add one-eighth and two-eighths they add up to three-eighths. In most cases when learners are taught without the use of hands-on material, they sometimes add numerators and also

denominators (for example, $\frac{1}{8} + \frac{2}{8} = \frac{3}{16}$). The example that is shown below shows how this

misconception was eradicated with the use of fraction circles.

Table 3 records learners' marks for activity one. It was noted for this activity that no learner got any task wrong. The majority (over 92%) of the learners got the tasks completely correct. Those learners who had partially correct answers are those who forgot to simplify their answers. For these tasks learners used fraction circles, and these seem to have contributed to the good performance.

TABLE 3: PERFORMANCE IN ACTIVITY ONE

Question No.	Correct response	Partially correct response	Incorrect response
1	39	2	1
2	40	2	0
3	42	0	0
4	42	0	0
5	41	1	0
6	42	0	0
7	40	2	0
8	42	0	0
9	40	2	0
10	40	2	0

Figure 1 shows the work of learner 28 (L28), which was coded as 'correct'.

The image shows a handwritten mathematical equation on a piece of paper. The equation is $\frac{3}{8} + \frac{3}{8} = \frac{6}{8} = \frac{3}{4}$. The fractions $\frac{6}{8}$ and $\frac{3}{4}$ are each enclosed in a blue square box. A red checkmark is drawn above the final result $\frac{3}{4}$.

Figure 1: Written response of L28 to task nine of activity one

For this task L28 was used to display her competency in addition of fractions. Her answer was marked correct. This could mean that L28 was reasonably successful in employing concrete objects (in this case fraction circles) to add fractions in activity one. The interview with the learner went as follows: .

Researcher: In the above sum your answer is $\frac{6}{8}$. I want you to help me understand how you

got this answer.

L 28: I took 3 eighths and 3 eighths and put them together and I got 6 eighths?

Researcher: Would I be wrong if I add 8 and 8 which are denominators?.

L 28: Yes, because when we add fractions we add only numerators not denominators.

Researcher: Okay, lets now move on. Your final answer there is $\frac{3}{4}$ can you explain?

L 28: I **simplified** $\frac{6}{8}$ by dividing both numerator and denominator with 2, which is

the highest common factor of these two numbers. I then got $\frac{3}{4}$.

The above example shows the important role of practical work (fraction circles) in facilitating understanding in learners. Fraction circles helped the learner understand that denominators should not be added, only the numerators are added

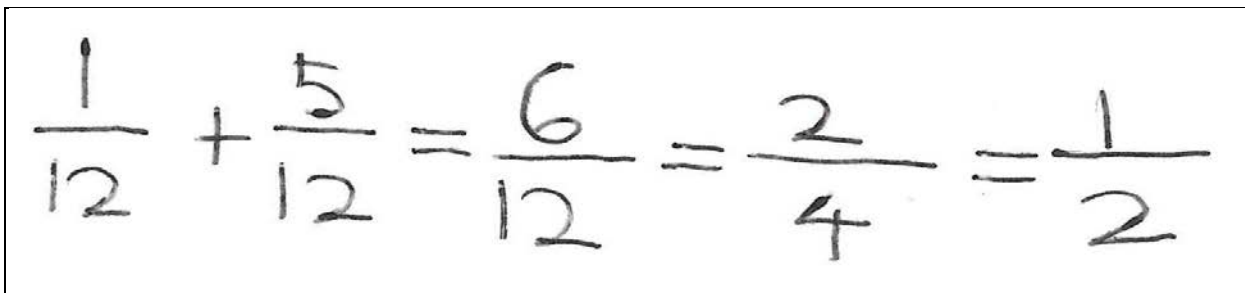

$$\frac{1}{12} + \frac{5}{12} = \frac{6}{12} = \frac{2}{4} = \frac{1}{2}$$

Figure 2: Written response of learner L 26 to task seven of activity one

Figure 2 shows how L 26 simplified the answer for task seven in activity one, where she added $\frac{1}{12}$ and $\frac{5}{12}$. In simplifying this fraction this learner did not use the highest common factor, but just chose 3 as one of the factors of 6 and 12, which gave an answer of $\frac{2}{4}$. This was further simplified as $\frac{1}{2}$. In this way this learner was able to discover another fraction that is equivalent to $\frac{6}{12}$, and fraction circles helped him to compare whether these two fractions are equal. Teachers using algorithms can be encouraged to use fraction circles when teaching addition of fractions, because this reinforces the concept of equivalency for learners.

9. $\frac{3}{8} + \frac{3}{8} = \frac{6}{8} = \frac{3}{4}$

Figure 3: Written response of learner L 10 to task nine of activity one

Learner (L 10) was marked partially correct for task nine. When marking this learner's work it was noticed that for tasks five to ten, as in the above example, she added the two fractions and simplified the answer correctly, but further simplification was always $\frac{1}{2}$ (see Figure 3).

An interview to query this ensued:

Researcher: I noticed that for tasks five to ten your answers are correct, but your last simplification is always $\frac{1}{2}$. Can you tell me why?

L 10: Madam, I copied from task two where we simplified $\frac{2}{4}$ as $\frac{1}{2}$ and then I thought all our answers should end with a $\frac{1}{2}$.

Researcher: Okay let's do this practically using fraction circles. For tasks two and five to ten compare your answers with a $\frac{1}{2}$ and tell me what you discover.

L 10: For task four I discovered that $\frac{2}{4} = \frac{1}{2}$, but for other tasks all answers are not equal to $\frac{1}{2}$.

Researcher: Okay, I think that is explaining to you why I marked your halves wrong. Simplifying a fraction meant breaking it down into a small fractions which are equal.

L 10: Okay, madam, I can see.

In this situation fraction circles worked well, because for each task a learner was asked to use fraction circles to compare with a $\frac{1}{2}$. In each case the learner discovered for herself that half was not equal to the fraction she thought it was equal to. This was done very quickly and very easily with fraction circles, and in the next activities the learner did not make the same mistakes. Doing practical work sometimes does help learners to learn quicker and easily.

7. $\frac{1}{12} + \frac{5}{12} = \frac{6}{12} = \frac{3}{6} = 2$

9. $\frac{3}{8} + \frac{3}{8} = \frac{6}{8} = \frac{3}{4} = 1\frac{1}{4}$

Figure 4: Written response of L 15 to tasks seven and nine of activity one

In exploring L 15's response to tasks seven and nine, the learner was marked partially correct. His response was correct for the first two answers, but the simplification was wrong. In this case when simplifying the answer the learner divided the denominator by the numerator to get a 2 and $1\frac{1}{4}$. In a dialogue this is what he said:

Researcher: For tasks seven and nine you did well to simplify your answers, but you further simplified $\frac{3}{6}$ as 2. Can you tell me how you worked that out?

L 15: I divided 6 by 3 and in task nine I divided 4 by 3 and that is what I got.

Researcher: When you simplified $\frac{6}{12}$ what did you do?

L 15: I divided both numbers by 2 to get $\frac{3}{6}$ and then divided by 3 to get a 2.

Researcher: Okay, using fraction circles compare $\frac{6}{12}$, $\frac{3}{6}$ and 2 and tell me what you discover.

L 15: $\frac{6}{12}$ and $\frac{3}{6}$ are equal, but 2 is big.

Researcher: Okay. Compare now $\frac{6}{12}$, $\frac{3}{6}$ and $\frac{1}{2}$.

L 15: They are all equal.

In this case the usage of fraction circles made things easy for this child to understand what simplification of fractions is all about. Teachers should be encouraged to use them for learners to gain an understanding of the concept.

TABLE 4: PERFORMANCE IN ACTIVITY TWO

Question No.	Correct response	Partially correct response	Incorrect response
1	42	0	0
2	42	0	0
3	38	0	4
4	42	0	0
5	42	0	0
6	40	0	2
7	42	0	0
8	38	1	3
9	42	0	0
10	39	1	2

For activity two more than 90% (see Table 4) of the learners got each task correct. This activity expected the learners to engage in using diagrams as a practical tool to solve the tasks. Diagrams were introduced by showing examples of addition of fractions. For the first two tasks diagrams were drawn for learners. Their task was to shade inside to represent the given fraction. This aimed to help learners see how correct diagrams are drawn; for example, in most cases some learners do not consider that diagrams should be the same in size. The result was that all learners got most answers correct for tasks one and two.

To highlight this category of responses we explore the written responses of learners L 26, L 30 and L 12 in Figures 5, 6 and 7 respectively.

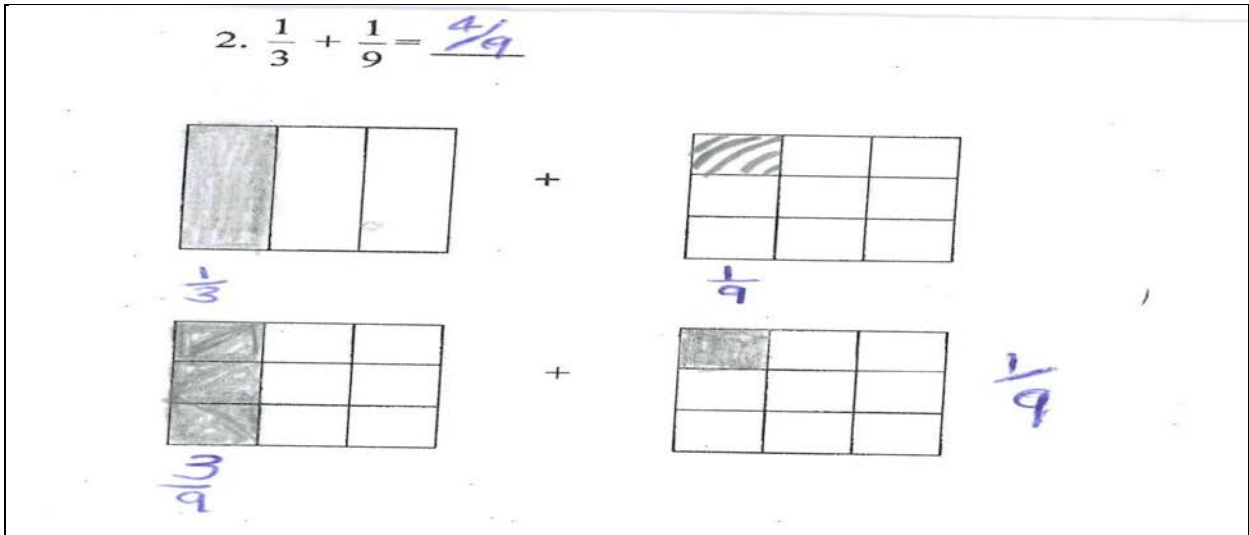


Figure 5: Written response of L 26 to task two of activity two

When one looks at the written response of learner L 26 for task two (see Figure 5), her answer was completely correct. In this instance the diagrams were drawn for the learners. The learner had to shade the correct spaces. Diagrams made it easy for the researcher to explain how $\frac{1}{3}$ became $\frac{3}{9}$. This could be one way of introducing LCD. Equal squares also demonstrate to learners that equivalent fractions are equal although not the same.

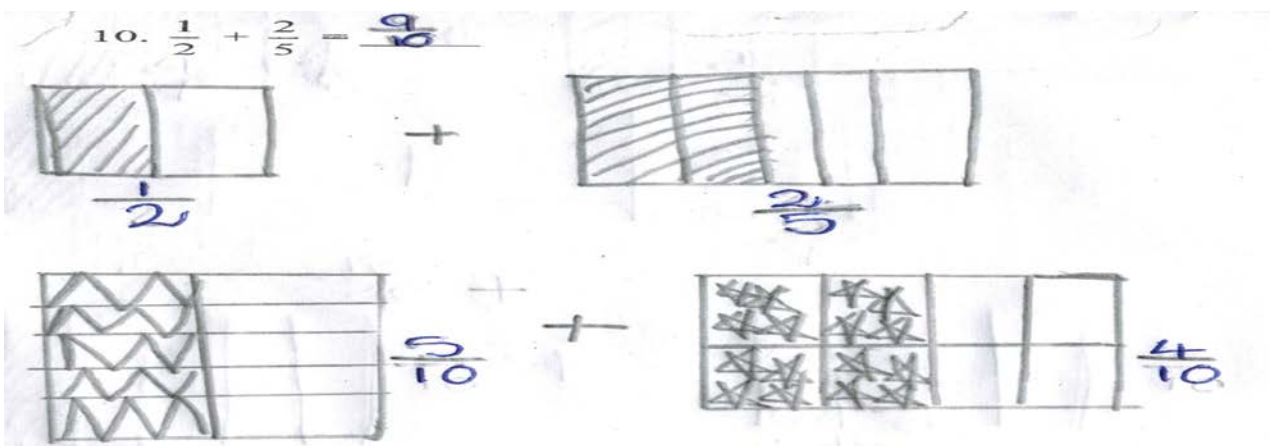


Figure 6: Written response of L 30 to task ten of activity two

This learner (L 30) was marked partially correct for drawing an incomplete diagram (Figure 6).

She labelled it as $\frac{4}{10}$ whereas it was $\frac{4}{8}$. In the above everything was correct except this minor mistake that she made. Educators should be very careful when they use diagrams, because they could be misleading if not correctly counted. In this respect learners should be reminded to check the number of blocks shaded after the task is completed.

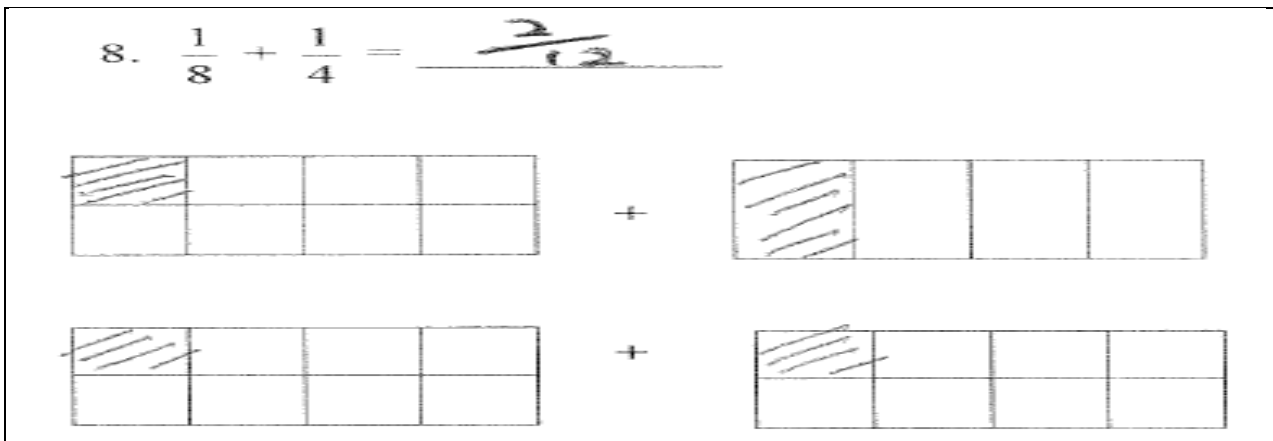


Figure 7: Written response of L 12 to task eight of activity two

Learner L12 managed to use the first pair of rectangles to denote the fractions $\frac{1}{8}$ and $\frac{1}{4}$ correctly. It seemed that L12 did not go back and reflect on the shaded squares in the second pair of rectangles. She therefore counted the two shaded squares. It also seemed that she merely added the denominators 8 and 4 to get 12 (Figure 7).

Activity three dealt with addition of fractions with different denominators, where one denominator is the factor of the other. In this activity learners used diagrams. Table 5 presents the results for each task.

TABLE 5: PERFORMANCE IN ACTIVITY THREE

Question No.	Correct response	Partially correct response	Incorrect response
1	42	0	0
2	42	0	0
3	41	0	1
4	41	0	1
5	38	0	4
6	31	10	1
7	38	1	3
8	39	0	3
9	39	3	0
10	37	0	5

Learner L 10 first decided to use two large rectangles and then divided them into 20 squares. We presume that he counted all the shaded squares and attained nine such and hence realised the number of shaded squares as a fraction of the total number of squares was $\frac{9}{20}$. We note that the diagrams aided conceptual understanding of the operation of fractions in this task. In fact those teachers who prefer algorithms could use diagrams as a basis to introduce the use of the LCD, in this instance using 20 as an LCD of 4 and 5. In using diagrams one should bring to the attention of the learners that the initial rectangles used must be of the same size and so should the smaller squares.

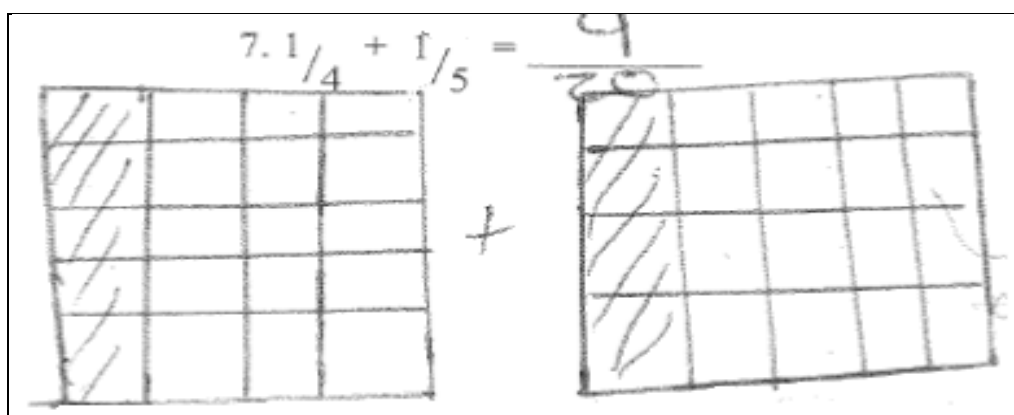


Figure 8: Written response of L 10 to task seven of activity three

Activity four was designed with tasks that involved the addition of mixed fractions. For this activity learners engaged the tasks using either of the practical tools (fraction circles or diagrams). Tasks one to four and six did not provide any difficulty for learners (see Table 6). The only task where a learner got an incorrect answer was task ten.

TABLE 6: PERFORMANCE IN ACTIVITY FOUR

Question No.	Correct response	Partially correct response	Incorrect response
1	42	0	0
2	42	0	0
3	42	0	0
4	41	1	0
5	41	1	0
6	42	0	0
7	42	1	0
8	42	1	0
9	42	2	0
10	41	0	1

We show written responses of learner L 38 to task ten of activity four in Figure 9.

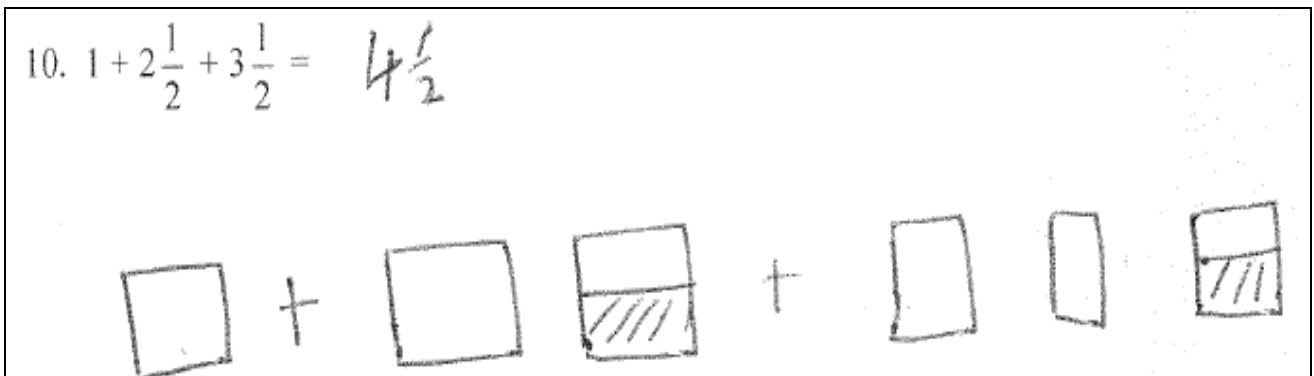



Figure 9: Written response of L 38 to task ten of activity four

In Figure 9 learner L 38 did not represent the mixed fractions with the correct diagrams. For

instance, the mixed fraction $2\frac{1}{2}$ should have been represented as 

Instead she drew two rectangles and then inserted the half of a rectangle into the one already drawn. This could mean that she did not have a complete conceptual understanding of the

concept of a mixed fraction from her previous year's learning. Present learning needs to take into cognizance prior learning to contribute to an effective Mathematics learning ecology.

For learners that got partially correct responses, their mistake was simplification of fractions. If we explore L 28's response for $2\frac{1}{2} + 1\frac{1}{2}$, we observe that he suddenly brings decimal number representations into his solution. This means that teachers need to stress simplification as a way of breaking down proper fractions, thus finding equivalent fractions, as well as changing improper fractions into mixed fractions or decimal fractions.

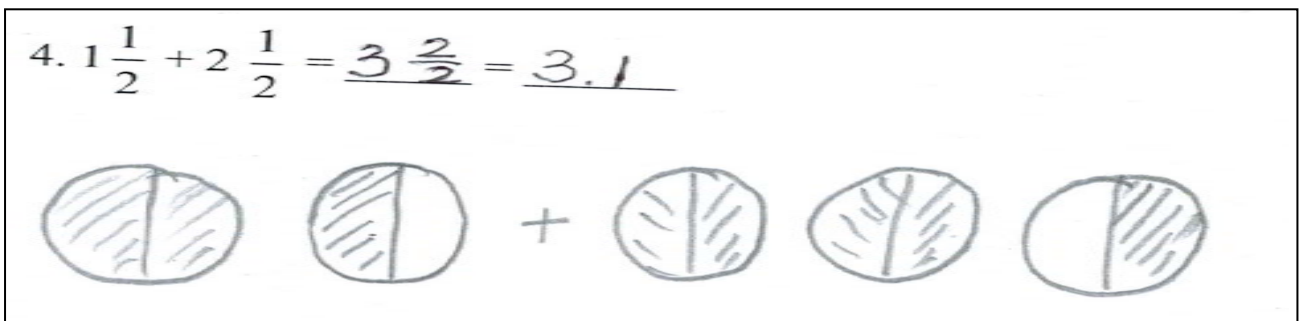


Figure 10: Written response of L 28 to task four of activity four

In the above case the learner was marked partially correct because he realised that $\frac{1}{2} + \frac{1}{2} = 1$,

but then his answer was written as 3.1. This is how an interview went:

Researcher: Do you understand why were you marked partially correct for task four?

L 28: No.

Researcher: Your answer there is written as 3.1. This is 3 x1 instead of 3 +1 = 4.

Three wholes and one whole equal to 4 wholes.

L 28: Oh! Madam, I did not know how to write this as one answer.

5.3 LEARNERS' PERCEPTIONS OF PRACTICAL WORK (OBSERVATION)

To gather information about the learners' perceptions of practical work the researcher observed the behaviour of the learners. Their facial expressions were observed; being young learners, it could be read on their faces when they encountered problems. Some do frown or smile when they were pleased and enjoyed the task they were given. In this class everybody, even those who were shy, communicated with others and showed via their facial expressions that they enjoyed what they were using, particularly the fraction circles. Some learners did struggle a bit with the diagrams, but finally they got into understanding how to draw them. In order to gather the learners' perceptions of or attitudes towards practical work, we carried out interviews with learners. The following dialogue ensued with learners L1 and L3.

Researcher: What did you understand about doing practical work when learning fractions?

L 1: In practical work we used fraction circles and drew diagrams to find answers to the questions.

Researcher: What did you understand about doing practical work when learning fractions?

L 3: It was when madam you asked us to use the pieces of fractions to complete our activities. We sorted these pieces to find answers.

These learners showed that they understood what entailed practical work. To them it was about using fraction circles and diagrams to find the answers in addition of fractions. Enquiring whether learners previously engaged with practical work, learners L1 and L4 provided the following verbal responses to queries raised by the researcher:

Researcher: Have you been engaged in practical when you learn addition of fractions? If yes, what did you use and how did you use that?

L 1: No. Our teacher in Grade 5 taught us to find the denominator of the two numbers.

Researcher: Have you been engaged in doing practical when you learn addition of fractions? If yes, what did you use and how did you use that?

L 4: No. I did not know practical work before.

This typical response highlighted the rare use of practical work by teachers.

Responses on preference of fraction circles or diagrams indicated that most learners preferred using fraction circles compared to diagrams. This was unpacked in a way that fraction circles were easy to handle and they were labelled, they were meant to work well with denominators that are the same and the main aim of using them was to eradicate the misconception of adding denominators. On the other hand diagrams were easy when they had to shade the given fraction, but they (diagrams) called for more thinking, as learners had to first think of a number which is a lowest multiple of given denominators. The aim of the use was twofold, finding a LCD and discovering equivalency. The following dialogue was used to demonstrate this.

Researcher: In the four lessons that we had, we used fraction circles and diagrams. Which one did you find interesting to use? Explain for each one.

L 3: I loved both of them, but I liked fraction circles more.

Researcher: In the four lessons that we had, we used fraction circles and diagrams. Which one did you find interesting to use? Explain for each one.

L 4: I liked using fraction circles.

Researcher: Why?

L 4: They were easy to use and they are beautiful.

Learners' responses showed that they enjoyed using practical work. They said everything became very easy for them. The following are some responses which demonstrated this:

Researcher: [Patting the learner's shoulders] You tried very hard, okay let's look at each question. In question five your diagrams are correct, but when you wrote your final answer, you wrote your denominator as 7 instead of 14, as your diagrams suggest. Why?

L 4: *Hawu! ngenze iphutha.* [I made a mistake.]

Researcher: Also your question seven, your first diagrams are correct, with second diagrams one is correct, but the other one has 38 pieces instead of 20. How come?

L 4: I don't want to lie, madam I was exhausted, I was lazy to count.

Researcher: Oh No! Your laziness has cost you marks.

L 4: I'm happy madam, because I know these sums.

Researcher: Okay, please we still have activity four to do; make sure you complete it.

L 4: Thanks.

5.4 CONCLUSION

Data collected in this chapter showed that practical work does impact on learners' performance on addition of fractions. The next chapter will focus on conclusions on the findings and then make recommendations on the teaching and learning of fractions.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

In this chapter the researcher will look at the study findings dealt with in Chapter 5, as it aimed to answer the main research question: *How does learner engagement in practical work impact on their learning of addition of fractions?* The findings from all four activities, observation and interviews will be used draw conclusions make recommendations.

6.2 CONCLUSIONS

During interviews learners indicated that they understand what practical work entails. Some of them indicated that it means working with hands on materials to find answers to the given tasks. Their response also showed that they have a positive attitude towards practical work. This was showed by enthusiasm that they had in manipulating concrete objects that they had been given, Observing learners' performance in the four activities for example activity 1 over 92% of learners got their answers correct. In other activities although the level of tasks were not the same performance was also excellent. This performance makes one to make the following recommendations.

6.2.1 INCLUSION OF PRACTICAL WORK

The study findings showed that practical work was enjoyed by the majority of learners in Grade 6. In their responses during interviews learners indicated that they enjoyed using practical working, because it made it easy for them to find answers. It was noticed also during observation in class they were relaxed and interacting with one another while they were using

fraction circles and diagrams learners. If learners' voices are to be listened to, it is therefore important that teachers should include practical work in their lessons as one of the strategies that can help them to teach addition of fractions. Teachers need to create their own activities because textbooks that they use do not provide activities which include practical work.

6.2.2 STARTING FROM WHAT LEARNERS KNOW

Starting from what learners know played a crucial role in introducing the series of lessons that learners were going to be engaged in. In Grade 6 they are actually supposed to do fractions that have different denominators where one is the multiple of the other. My reasons for starting with addition of fractions with similar denominators were as follows:

- to identify misconceptions that they had in addition of fractions; and
- to capture their interest in the lessons that they were to be engaged in for the next few coming days.

For example, in activity one there was a learner who got her addition of numerators correct, but also added the denominators. That was identified and rectified early, before tougher tasks were given.

6.2.3 USAGE OF DIALOGUE

The researcher recommends that dialogue between the teachers and learners is used throughout the lesson. This develops trust between the two participants and, most importantly, it gives the teacher the opportunity to investigate learners' conceptual understanding of mathematical concepts. This was evident in the case of most of the learners: when they drew their diagrams they just drew without taking note of the fact that fractional pieces should be equal and also labelling fractions did not matter to them. Only when they

were with the researcher assessing each script did the learners realize the importance of accurate drawing and writing of fractions.

During dialogue the learners were able to tell exactly how they got to their final answers, and this provided clarity and enabled the researcher to identify misconceptions that learners had. Using fraction circles and diagrams made it become easy for learners to discover their own mistakes.

6.3 FURTHER RESEARCH

Since this study was a small-scale study, further research is needed to answer some issues related to: 1) practical work in multiplication of fractions.

REFERENCES

1. Adler, J. (1991). Towards democratic mathematics education in South Africa. In C. Julie (Ed.), *People's Mathematics: Early Ideas and Debates*. Cape Town: University of the Western Cape.
2. Bell, J. (1993). *Doing your Research Project: A guide for First-Time Researchers in the Education and Social Science*. Buckingham: Open University Press.
3. Bezerra, F. Magina, S. & Spinillo, A.G. (2002). How to promote children's understanding of fractions? An exploratory study. *Proceedings of the 26th International Conference for the Psychology of Mathematics Education (PME)*, vol.2, pp. 89-96, Norwich, UK, July.
4. Boaler, J. (2002). Open and closed mathematics approaches: Student experiences and understanding. In L. Haggarty (Ed.), *Teaching Mathematics in Secondary Schools*. London & New York: Open University.
5. Brijlall, D., Maharaj A. & Molebale, J. (2007). Teachers' views of practical work in the teaching of fractions: A case study. *South African Journal of Education* 27(4), 597-612.
6. Brooks, J. & Brooks, M. (1993). *The case for a constructivist classroom*. Alexandria, VA: ASCD.
7. Chaplain, R. (2003). *Teaching without disruption in secondary school: A model for managing pupils' behavior*. London & New York: Routledge.
8. Cobb, P. (1994). 'Where is the mind? Constructivist and sociocultural perspectives on mathematical development'. *Educational Researcher*, Vol 23(7) : (pp13-20).

9. Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education*. London & New York: Routledge Falmer.
10. Confrey, K. (1990). A review of the research in student conceptions in mathematics, science, and programming. In C. B. Cazden (Ed.), *Review of Research in Education* (pp. 3-35). Washington, DC: American Educational Research Association.
11. Cooney, T. J. (Ed.). (1990). *Teaching and learning mathematics in the 1990s*. Virginia: The National Council of Teachers of Mathematics.
12. Craft, A., Jeffrey, B. & Liebling, M. (2001). *Creativity in education*. London: Continuum.
13. Department of Education. (1997). *National Curriculum Statement Grades R-9*. Pretoria: Department of Education
14. Department of Education. (2002). *National Curriculum Statement Grades R-9*. Pretoria: Department of Education.
15. Department of Education. (2003). *Revised National Curriculum Statement Grades R-9*. Pretoria: Department of Education.
16. Department of Education. (2005). *National Curriculum Statement Grades 10-12*. Pretoria: Department of Education.
17. Department of Basic Education. (2011). *Curriculum and Assessment Policy Statement Grades R-12*. Pretoria: Department of Education.
18. Dienes, Z. P. (1964). *Building up mathematics*. London: Hutchinson Educational

19. Doise, W. (1990). *The development of individual competencies through social interaction*. In H. Foot, M. Morgan & R. Shute, R. (Eds), *Children helping children*. Chichester: John Wiley.
20. Ernest, P. (1996). 'Varieties of constructivism: A Framework for comparison'. In L.P. Steffe, P. Nesher, P. Cobb, G.A. Goldin & B. Greer (Eds), *Theories of mathematical learning*. Mahwah, New Jersey: Lawrence Erlbaum Associates.
21. Ernest, P. (1998). *Social constructivism as a philosophy of Mathematics*. Albany: State University of New York.
22. Faulkner, D., Littleton, K., & Woodhead, M. (Eds) (1998). *Learning relationships in the classroom*. London & New York: Routledge.
23. Goos, M. (2004). Learning Mathematics in a Community of Inquiry. *Journal for Research in Mathematics Education*, 35(4), 258-291.
24. Halldo'rsson, A. & Aastrup, J. (2003). Quality criteria for qualitative inquiries in logistics, *European Journal of Operational Research*, 144(2), 321-332.
25. Hammersley, M. (1990). *Reading Ethnographic Research: a Critical Guide*. London: Longmans.
26. Hammersley, M. (1992). *What's wrong with Ethnographic Research? Methodological Explorations*. London: Longmans.
27. Hart, K. (1980). Fractions. In K.M. Hart (Ed.), *Children's understanding of mathematics: 11-16* (pp. 66-81). London: Alden Press.

28. Hatch, G. (2002). Maximizing energy in the learning of mathematics. In L. Haggarty (Ed.), *Teaching Mathematics in Secondary Schools*. London: Open University.
29. Hecht, S. A. (1998). Toward an Information-Processing Account of Individual Differences in Fraction Skills. *Journal of Educational Psychology*, 90(3), 545-559.
30. Hiebert, J. & Carpenter, T.P. (1992). 'Learning and teaching with understanding', in Grouws; D.A. (ed.) *Handbook of Research on Mathematics Teaching and Learning*. New York: MacMillan: (pp 65-98)
31. Howie, S. J. (1999) Third International Mathematics and Science Study Repeat (TIMMSR). Executive summary. Pretoria: Human Sciences Research Council.
32. Hysamen, K.C. (2001). *Psychological Measurement: An Introduction with South African Examples*. Western Cape: Academia.
33. Irwin, K.C. (2001). Using Everyday Knowledge of decimals to enhance understanding. *Journal for Research in Mathematics Education*, 32(4), 399-420.
34. Kieran, T.E. (1988). Personal knowledge of rational numbers: Its intuitive and formal development. In J. Hiebert & M. Behr (Eds.), *Number concepts and operations in the middle grades* (pp. 53-92). Reston, VA: National Council of Teachers of Mathematics.
35. Koomen, M. (2001). *Fractions: Making fair shares*. Mankato: Capstone Press.
36. Lamon, S.J. (199). *Teaching fraction and relations for understanding: essential content knowledge and instructional strategies for children*. Mahwah, NJ,: Lawrence Erlbaum

37. Leedy P.D. & Ormond J.E. (2001). *Practical research planning and design* (7th ed.). Upper Saddle River, New Jersey: Merrill Prentice Hall.
38. Litwiller, B & Bright, G. (Eds.), *Making sense of fractions, ratios and proportions* (pp. 247-256). Virginia: National Council of Teachers of Mathematics
39. Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and United States*. Mahwah, New Jersey: Lawrence Erlbaum Associates.
40. Mack, N.K. (1995). Confounding Whole-number and fraction concepts. *Journal for Research in Mathematics Education*, 26(5), 422-441.
41. Maharaj, A. Brijlall, D. & Molebale, J. J. L. (2006). *Teaching of fractions*. Unpublished paper, University of KwaZulu-Natal, South Africa.
42. Mokapi, C.M. (2002). *Form C's conceptions about fractions*. Unpublished level? thesis, School of Education, University of Witwatersrand, Johannesburg.
43. Moodley, M., Njisone, R. A. & Presmeg, N. C. (1992). *Mathematics education for in-service and pre-service teachers*. Pietermaritzburg: Shutter & Shooter
44. Moss, J. & Case, R. (1999). Developing Children's Understanding of the Rational Numbers: A New Model and an Experimental Curriculum. *Journal for Research in Mathematics Education*, 30(2): 122-147.
45. Murray, H., Olivier, A. & Human, P. (1996). Young students' informal knowledge of fractions. In K. Morrison (Ed.), *Second National Congress of the Association of*

- Mathematics Education in South Africa: Conference proceedings (pp. 41-48). Natal: Interpak.
46. Newman, F. & Holtzman, L. (1993). *Lev Vygotsky : Revolutionary scientist. London: Routledge.*
47. Ott, J. M. & Snook, D.L.Gibson (1991). Understanding partitive division of fractions. *Arithmetic Teacher*, 39(2), 7- 10.
48. Orton, A. & Frobisher, L. (1996). *Introduction to education: Insights into teaching mathematics*; Trowbridge, Wilshire: Redwood Books Limited.
49. Patton, M. (2002). *Qualitative research and evaluation methods*. Thousand Oaks: Sage
50. Payne, J.N. (1976) Review of Research on Fractions. In R. A. Lesh (Ed.), *Number and Measurement: Papers from a Research Workshop*. Ohio: ERIC/SMEAC.
51. Piaget, J. (1932). *The moral judgment of the child*. London: Routledge.
52. Salomon, G. & Perkins, D. (1998) Individual and Social Aspects of Learning, In P. Pearson & Iran-Nejad, A. (Eds), *Review of Research in Education 23* (pp. 1-24). Washington, DC: American Educational Research Association.
53. Saunders, W. (1992). The constructivist perspective: Implications and teaching strategies for science. *School Science and Mathematics*, 92(3), 136-141.
54. Siebert, D. (2002). *Connecting Informal Thinking and Algorithms: The Case of Division of Fractions*. In B. Litweller & G. Bright (Eds.). *Making Sense of Fractions, Ratios and Proportions*. Virginia: National Council of Teachers of Mathematics.

55. Sinicrope, R. & Mick, H.W. (1992). Multiplication of fractions through paper folding. *Arithmetic Teacher*, 40(2), 116-121.
56. Sinicrope, R., Mick, H.W. & Kolb, J.R. (2002). "Interpretations of Fraction Division, in Litweller, B & Bright, G. (eds.). Making Sense of Fractions, Ratios and Proportions:2002 Yearbook, Virginia
57. Skinner, B.F. (1998). *The technology of teaching*; New York: Appleton Century Crafts.
58. Soloman, J. (1987). Social influences on the construction of pupil's understanding of science. *Studies in Science Education*, 14, 63-82.
59. Steffe, L. (1990). On the knowledge of mathematics teachers. In R.B. Davis, C.A. Maher, & N. Noddings (Eds.), *Constructivists views on teaching and learning of mathematics*, *Journal for Research in Mathematics Education Monograph Series*, Number 4 (pp. 167 – 184). Reston, VA: National Council of Teachers of Mathematics.
60. Strydom, W. (1983). *Fractions*. Pretoria: Daan Retief Publishers.
61. Tirosh, D. (2000). Enhancing Prospective Teachers' Knowledge of Children's Conceptions: The Case of Division of Fractions. *Journal for Research in Mathematics Education*, 31(1): 5-25.
62. Truran, K.M. & Truran, T.M. (1998). Using Clinical interviews. In J.A. Malome (Ed), *Research and Supervision in Mathematics and Science Education*. London: Lawrence Erlbaum Associates.
63. Turner, E., Gatienez, R. J. & Sutton E. (2011). Student participation in collective problem solving an after school mathematics club: connection to learning and identity. *Journal of Science Mathematics and Technology Education*, 11(3): 1-24.

64. Tzur, R. (1999). An integrated study of children's construction of improper fractions and the teacher's role in promoting that learning. *Journal for Research in Mathematics Education*, 30 (4), 390-416.
65. Usiskin, Z. P. (2007). The future of fractions. *Mathematics Teaching in the Middle School*, 12 (7), 366-394.
66. von Glasersfeld, E. (1981). The concepts of adaption and viability in a radical theory of knowledge. In I. E. Siegel, D. M. Brodinski & R. M. Golinkoff (Eds.), *New directions in Piagetian theory and practice*. Hillsdale: Erlbaum.
67. von Glasersfeld, E. (1989). Cognition, construction of knowledge, and teaching. *Synthese*, 80(1), 121-140.
68. von Glasersfeld, E. (1990). *Environment and communication*. In L. Steffe & T. Wood (Eds.), *Transforming early childhood mathematics education: An international perspective*. Hillsdale: Erlbaum.
69. Vygotsky, L.S. (1978). *Mind in society: the development of higher psychological process*. Cambridge, MA: Harvard University Press.
70. Watzawick, P. (Ed.). (1984). *The inverted reality*. New York: W.W. Norton.
71. Wheatley, G. H. (1991). Constructivist perspectives on science and mathematics learning. *Science Education*, 75(1), 9-21.
72. Witherspoon, M.L. (1993). Fractions: in search of meaning. *Arithmetic Teacher*, 40(8), 482-485.
73. Wu, Z. L.S. (2001). Multiplying fractions. *Teaching Children Mathematics*, 8(3), 174-177.

APPENDICES

APPENDIX A: (1)

CODE: _____

ACTIVITY 1

INSTRUCTIONS: ADD THE FOLLOWING FRACTIONS USING FRACTION CIRCLES, WRITE YOUR ANSWERS ON THE SPACES PROVIDED.

1. $\frac{1}{2} + \frac{1}{2} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

2. $\frac{1}{4} + \frac{1}{4} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

3. $\frac{1}{3} + \frac{1}{3} = \underline{\hspace{2cm}}$

4. $\frac{1}{5} + \frac{1}{5} = \underline{\hspace{2cm}}$

5. $\frac{1}{8} + \frac{1}{8} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

6. $\frac{3}{10} + \frac{4}{10} = \underline{\hspace{2cm}}$

7. $\frac{1}{12} + \frac{5}{12} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

8. $\frac{2}{5} + \frac{3}{5} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

9. $\frac{3}{8} + \frac{3}{8} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

10. $\frac{1}{10} + \frac{4}{10} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

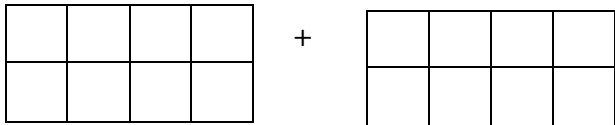
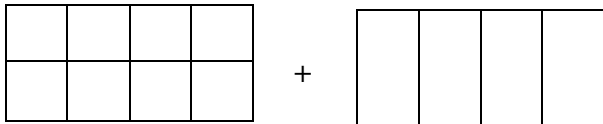
APPENDIX A: (2)

CODE: _____

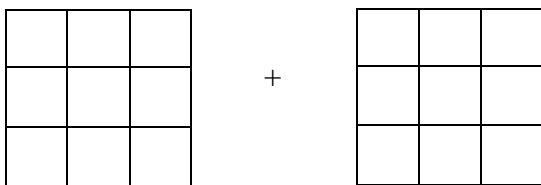
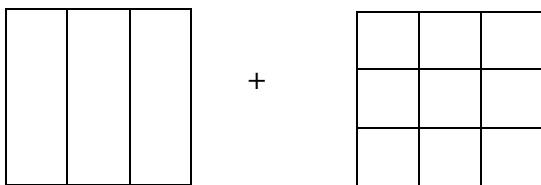
ACTIVITY 2

INSTRUCTIONS: ADD THE FOLLOWING FRACTIONS USING DIAGRAMS AND WRITE YOUR ANSWERS IN SPACES PROVIDED.

1. $\frac{1}{8} + \frac{1}{4} =$ _____



2. $\frac{1}{3} + \frac{1}{9} =$ _____



3. $\frac{1}{2} + \frac{1}{8} = \underline{\hspace{2cm}}$

4. $\frac{1}{3} + \frac{1}{6} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

5. $\frac{1}{5} + \frac{3}{10} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

6. $\frac{3}{8} + \frac{1}{2} = \underline{\hspace{2cm}}$

7. $\frac{4}{9} + \frac{1}{3} = \underline{\hspace{2cm}}$

8. $\frac{1}{12} + \frac{1}{4} = \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$

$$9. \frac{1}{12} + \frac{1}{3} = \underline{\hspace{2cm}}$$

$$10. \frac{1}{2} + \frac{2}{5} = \underline{\hspace{2cm}}$$

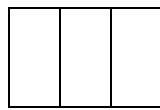
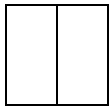
APPENDIX A (3)

CODE: _____

ACTIVITY 3

INSTRUCTIONS:

1. $\frac{1}{2} + \frac{1}{3} =$ _____



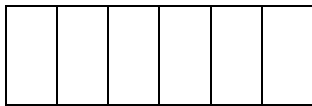
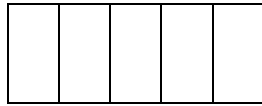
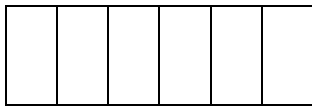
2. $\frac{1}{4} + \frac{1}{3} =$ _____

3. $\frac{3}{5} + \frac{1}{3} =$ _____

4. $\frac{1}{2} + \frac{1}{5} =$ _____

5. $\frac{1}{2} + \frac{1}{7} = \underline{\hspace{2cm}}$

6. $\frac{3}{6} + \frac{1}{5} = \underline{\hspace{2cm}}$

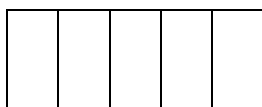
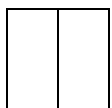
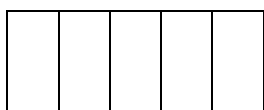
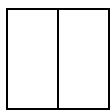


7. $\frac{1}{4} + \frac{1}{5} = \underline{\hspace{2cm}}$

8. $\frac{1}{6} + \frac{1}{9} = \underline{\hspace{2cm}}$

9. $\frac{1}{3} + \frac{2}{4} =$ _____

10. $\frac{1}{2} + \frac{2}{5} =$ _____



APPENDIX A (4)

CODE: _____

ACTIVITY 4

INSTRUCTIONS: FIND ANSWERS FOR THE FOLLOWING FRACTIONS, USE FRACTION CIRCLES OR DIAGRAMS.

1. $\frac{1}{10} + \frac{3}{10} =$ _____

2. $2\frac{1}{3} + \frac{1}{3} =$ _____

3. $1\frac{1}{5} + \frac{3}{5} =$ _____

4. $1\frac{1}{2} + 2\frac{1}{2} =$ _____

$$5. 3\frac{1}{4} + 2\frac{1}{4} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

$$6. 3\frac{1}{8} + \frac{1}{8} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

$$7. 1\frac{1}{4} + \frac{1}{4} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

$$8. 1\frac{1}{5} + \frac{1}{5} = \underline{\hspace{2cm}}$$

$$9. \frac{1}{2} + 1\frac{1}{2} = \underline{\quad\quad} = \underline{\quad\quad}$$

$$10. 1 + 2\frac{1}{2} + 3\frac{1}{2} = \underline{\quad\quad} = \underline{\quad\quad}$$

APPENDIX B (1)**OBSERVATION SCHEDULE**

Questions	Researcher's notes
7 Are all learners able to solve given problems?	
8 Are learners using the given fraction circles and diagrams ?	
9 Observing gestures for example facial expression. Are learners finding it interesting to manipulate concrete object.	

APPENDIX B (2)

INTERVIEW QUESTIONS BASED ON PRACTICAL WORK

I : What did you understand about doing practical work when learning fractions ?

L 1 :

I : Have you been engaged in practical when you learn addition of fractions? If yes, what did you use and how did you use that?

L 1 :

I : In the four lessons that we had, we used fraction circles and diagrams. Which one did you find easy to use? Explain for each one.

L 1 :

I : Did you enjoy learning addition of fractions using practical work? If so, why?

L 1 :

APPENDIX C

INTERVIEW QUESTIONS BASED ON PRACTICAL WORK

LEARNER 1

I : What did you understand about doing practical work when learning fractions ?

L 1 : In practical work we used fraction circles and drew diagrams to find answers to the questions.

I : Have you been engaged in practical when you learn addition of fractions? If yes, what did you use and how did you use that?

L 1 : No. Our teacher in grade 5 taught us to find the denominator of the two numbers.

I : In the four lessons that we had, we used fraction circles and diagrams. Which one did you find easy to use? Explain for each one.

L 1 : For me fractions circles were very easy. Mine was just to look for relevant pieces and add them. Drawing diagrams were a bit difficult, because I had to think of which fraction do I have to change to make it the same as the other. Another problem in other cases I had to find a different number to other than the denominators

I : Did you enjoy learning addition of fractions using practical work? If so, why?

L 1 : Yes, when we used fraction circles it was like we were playing a game. We were able to help one another in a group. No one was lazy to work. Diagrams were tricky, but they taught us equivalent fractions

LEARNER 2

I : What did you understand about doing practical work when learning fractions ?

L 2 : This was about playing like a game, where we used fraction circles and drawing diagrams.

I : Have you been engaged in doing practical when you learn addition of fractions? If yes, what did you use and how did you use that?

L 2 : We have not learnt addition of fractions in grade six.

I : In grade 5 didn't you use practical work?

L 2 : No, madam

I : In the four lessons that we had, we used fraction circles and diagrams. Which one did you find interesting to use? Explain for each one.

L 2 : I like working with fraction circles. Our sums were very easy to do.

I : What about diagrams?

L 2 : I also liked them.

I : Did you enjoy learning addition of fractions using practical work? If so, why?

L 2 : Yes, everything was very easy for us to do. I got all my sums right.

LEARNER 3

I : What did you understand about doing practical work when learning fractions ?

L 3 : It was when madam you asked us to use the pieces of fractions complete our activities.

I : Was that the only thing you used?

L 3 : You also asked us to make drawings of fractions.

I : Have you been engaged in doing practical when you learn addition of fractions? If yes, what did you use and how did you use that?

L 3 : Yes, last year in grade 5 we were asked to make drawing to shade and show the given fractions

I : In the four lessons that we had, we used fraction circles and diagrams. Which one did you find interesting to use? Explain for each one.

L 3 : I loved both of them, but I liked fraction circles more.

I : Did you enjoy learning addition of fractions using practical work? If so, why?

L 3 : I enjoyed because I don't like to find the lowest common denominator. I end up getting my sums wrong. When using diagrams we got a mark for the answer and for the diagram.

LEARNER 4

I : What did you understand about doing practical work when learning fractions ?

L 4 : It is about playing a game and win.

I : Why do think that?

L 4 : In our group we all loved it

I : Have you been engaged in doing practical when you learn addition of fractions? If yes, what did you use and how did you use that?

L 4 : No.

I : In the four lessons that we had, we used fraction circles and diagrams. Which one did you find interesting to use? Explain for each one.

L 4 : I liked using fraction circles

I : Why?

L 4 : They were easy to use and they are beautiful

I : Did you enjoy learning addition of fractions using practical work? If so, why?

L 4 : Yes madam. It is nice all other children in my group loved it

LEARNER 5

I : What did you understand about doing practical work when learning fractions ?

L 5 : It meant working together as a group.

I : Okay, didn't you used anything when you were doing your individual work?

L 5 : Yes, I used those pieces you gave us madam

I : Did they help you?

L 5 : Yes. In activity one I used fraction circles I got all my sums correct.

I : Have you been engaged in doing practical when you learn addition of fractions? If yes, what did you use and how did you use that?

L 5 : No, not like that day.

I : In the four lessons that we had, we used fraction circles and diagrams. Which one did you find interesting to use? Explain for each one.

L 5 : I loved fraction circles

I : Why?

L 5 : They were easy to use.

I : Did you enjoy learning addition of fractions using practical work? If so, why?

L 5 : Yes, it was easy.

APPENDIX: D

LETTER OF CONSENT

To: Participant(s) and Parent/ Guardian

Research Project: ‘Learners ‘views of practical work in addition of fractions’: A case study

Fortunate Gugulethu Mdluli is conducting a study through the School of Education, Mathematics Education at the University of KwaZulu Natal under the supervision of Dr. D. Brijlall contactable at 031-260 3491 (office hours). Proposed research looks towards a better understanding of “learning” fractional concepts at a primary school in KZN. It also investigate whether learners learn and understand better when they are taught addition of fractions using practical work.

Learners and a class educator are requested to assist through participating in this research project as it would be of benefit to the education practitioners and interested educationalists and/ or mathematics educators, However, participation is completely voluntary and has no impact or bearing on evaluation or assessment of the learner in any studies or course while at school. Participants will be observed during learning and will be asked to complete activity sheets and eventually be interviewed. Interviews will be recorded. Learners will be given codes for identification to make sure that their identities are kept confidential. All data will be kept in a secure place where authentication will be required to access such data.

Participants may revoke from the study at any time by advising the researcher of this intention. Participants may review and comment on any parts of the dissertation that represents this research before publication

Researcher’ signature

Date

DECLARATION

I _____ (Participant’s name) _____(signature)

_____(Parent’s/ Guardian’s name _____(Signature)

_____(Date)

Agree

Disagree

N.B. Tick ONE

APPENDIX: E

ISICELO SOKUSEBENZISANA NOMNTWANA

Mfundi noMzali

Ucwaningo kwizibalo: “Izinzwa zabafundi ngokusetshenziswa komsebezi wezandla uma kufundwa ukuhlanganiswa kwamaqhezu”

Ngingu Gugulethu Fortunate Mdluli ofunda eNyuvesi yaKwaZulu Natal, osefikelele kwizinga lokwenza ucwaningo ngezingane. Kulolu cwano ngizobe ngibhekelelwa u- Dr D. Brijlall otholakala kwizinombolo ezithi 031-260 3491.

Lolucwaningo luhlose ukubheka imizwa yezingane mayelana nokufundwa kwamaqhezu kusetshenziswa izinsiza kufunda ezenziwa ngezandla. Abafundi, uthisha wekilasi kanye nabazali bayacelwa ukuba basize ekubambeni iqhaza kulolucwaningo oluzosiza kakhulu othisha nababhekelele ezemfundo emabangeni aphansi.

Lokhu kuzokwenziwa ngaphandle kokuphoqa umfundi futhi akukho mibandela noma imiphumela emayelana nokuphumelela kwakhe esikoleni. Akukho kudalulwa kwamagama kulolucwaningo. Lokhu akuphoqi umfundi angacela ukuyeka noma inini ngokwazisa umcwaningi ngokuyeka kwakhe.

Umcwaningi

Usuku

ISIVUMELWANO

Mina _____ (Umfundi) _____ (Sayina)

_____ (Umzali/ Umbheki) _____ (Sayina)

_____ (Usuku)

Ngiyavuma

Ngiyaphika

Khetha okukodwa



PROVINCE OF KWAZULU-NATAL
ISIFUNDAZWE SAKWAZULU-NATALI

DEPARTMENT OF EDUCATION
UMNYANGO WEMFUNDO

Tel: 033 341 8610
Fax: 033 341 8612
Private Bag X9137
Pietermaritzburg
3200

228 Pietermaritz Street
PIETERMARITZBURG

INHLOKHOVISI **PIETERMARITZBURG** **HEAD OFFICE**

Imibuzo:
Enquiries: Sibusiso Alwar

Reference:
Inkomba: 0026/2009

Date:
Usuku: 08 May 2009

MS MDLULI G.F
P O BOX 1339
TONGAAT
4400

RESEARCH PROPOSAL: LEARNERS VIEWS OF PRACTICAL WORK IN ADDITION OF FRACTIONS : A CASE STUDY

Your application to conduct the above-mentioned research in schools in the attached list has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educator programmes are not to be interrupted.
5. The investigation is to be conducted from **08 May 2009 to 08 May 2010**.
6. Should you wish to extend the period of your survey at the school(s) please contact **Mr Sibusiso Alwar** at the contact numbers above.
7. A photocopy of this letter is submitted to the principal of the school where the intended research is to be conducted.
8. Your research will be limited to the schools submitted.
9. A brief summary of the content, findings and recommendations is provided to the Director: Resource Planning.

RESOURCES PLANNING DIRECTORATE: RESEARCH UNIT
Office No. G25, 188 Pietermaritz Street, PIETERMARITZBURG, 3201

APPENDIX:G



PROVINCE OF KWAZULU-NATAL
ISIFUNDAZWE SAKWAZULU-NATALI

DEPARTMENT OF EDUCATION
UMNYANGO WEMFUNDO

Tel: 033 341 8610
Fax: 033 341 8612
Private Bag X9137
Pietermaritzburg
3200

228 Pietermaritz Street
PIETERMARITZBURG

INHLOKHOVISI

Imibuzo:
Enquiries: Sibusiso Alwar

PIETERMARITZBURG

Reference:
Inkomba: 0026/2009

HEAD OFFICE

Date:
Usuku: 08 May 2009

MS MDLULI G.F
P O BOX 1339
TONGAAT
4400

PERMISSION TO INTERVIEW LEARNERS AND EDUCATORS

The above matter refers.

Permission is hereby granted to interview Departmental Officials, learners and educators in selected schools of the Province of KwaZulu-Natal subject to the following conditions:

1. You make all the arrangements concerning your interviews.
2. Educators' programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, educators and schools are not identifiable in any way from the results of the interviews.
5. Your interviews are limited only to targeted schools.
6. A brief summary of the interview content, findings and recommendations is provided to my office.
7. A copy of this letter is submitted to District Managers and principals of schools where the intended interviews are to be conducted.

The KZN Department of education fully supports your commitment to research: **Learners views of practical work in addition of fractions: a case study**

It is hoped that you will find the above in order.

Best Wishes

R Cassius Lubisi, (PhD)
Superintendent-General

RESOURCES PLANNING DIRECTORATE: RESEARCH UNIT
Office No. G25, 188 Pietermaritz Street, PIETERMARITZBURG, 3201

APPENDIX H

L. Gething, M.Phil. (Science & Technology Journalism) (*cum laude*)

WHIZZ@WORDS

PO Box 1155, Milnerton 7435 Cape Town, South Africa; cell 072 212 5417

leverne@eject.co.za

31 May 2013

DECLARATION OF EDITING OF MASTER'S DISSERTATION:

LEARNERS' VIEWS OF PRACTICAL WORK IN ADDITION OF FRACTIONS: A CASE STUDY

By Fortunate Gugulethu Mdluli

I hereby declare that I carried out language editing of the above dissertation by Fortunate Gugulethu Mdluli.

I am a professional writer and editor with many years of experience (e.g. 5 years on *SA Medical Journal*, 10 years heading the corporate communication division at the SA Medical Research Council), who specialises in Science and Technology editing - but am adept at editing in many different subject areas. I am a full member of the South African Freelancers' Association (Safrea) as well as of the Professional Editors' Group (PEG).

Yours sincerely

LEVERNE GETHING

leverne@eject.co.za