# THE EFFECT OF USING MODELS TO ENHANCE GRADE 7 LEARNERS' UNDERSTANDING OF FRACTIONS: A CASE OF A PRIMARY SCHOOL IN ONANKALI CIRCUIT, OSHIKOTO REGION

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## ABSTRACT

The study aimed to examine the effects of models have on enhancing Grade 7 learners' understanding of Mathematical fractions at a primary school in the Onankali Circuit, Oshikoto Region of Namibia. The study utilized a mixed-method approach, using a quasi-experimental design. The study was guided by the constructivism theory of Piaget (1964). To choose one of the primary schools in the Onankali Circuit, purposive sampling technique was employed. Two Grade 7 classes were selected as a sample, one chosen as the experimental group and the other as the control group. Thirty pupils were selected at random from each group. A pre-and post-test quasi-experimental design with two groups for the study sample was used to collect comparative quantitative data. On the other hand, over the same seven weeks, the control group received instruction using textbooks and algorithms, while the experimental group was taught fractions using models. The learners were given a variety of tests following seven weeks of fraction instruction utilizing models. Following that, the experimental and control groups received post-tests. Qualitative data were collected through focus group interviews with 10 randomly selected learners. The data were then subjected to thematic analysis. Results suggested that teaching fractions with models could improve learners' comprehension. The quantitative data results showed that the post-test performance of the experimental group outperformed that of the control group. The study concluded that learners in Grade 7 who were taught using models had a statistically significant difference in their understanding of fractions when compared to learners who were taught using presentations and textbooks, thus, the $H_0$ was not accepted. The study found that teachers used a range of representations, including area models, circular, rectangular, set models, and length models, to effectively teach fractions. The study recommends that Mathematics teachers refrain from using the algorithm method, as learners need to understand how they work to memorize rules. Learners end up forgetting in the end.

**Keywords:** Mathematics Instruction, Mathematical Fractions, Grade 7 Learners, Set Models, Fraction Instruction, Teaching Models

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## LIST OF ABBREVIATIONS AND ACRONYMS

**CAPS** – Curriculum and Assessment Policy Statement

**CPA** – Concrete Pictorial Abstract

**FKT** – Fractional Knowledge Test

**LCD** – Lowest Common Denominator

**MCU** – Mathematical Conceptual Understanding

**MKT** – Mathematical Knowledge for Teaching

**MoEAC** – Ministry of Education Arts and Culture

**MR** – Mathematical Representations

**PSLE** – Primary School Leaving Examination

**UNAM** – University of Namibia

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# DEDICATION

My mother, Helena Kandalindishiwo Petrus, supported me over my many years of education and gave me hope and strength when I felt like giving up. To her, I respectfully dedicate this thesis. In addition, I dedicate this thesis to my brothers and sisters for their unwavering financial, emotional, and moral support. In conclusion, I dedicate this thesis to all of Namibia's math professors.

## DECLARATION

I, Helena Simanekeni Shalonda, hereby declare that this study is my own work and is a true reflection of my research, and that this work, or any part thereof has not been submitted for a degree at any other institution.

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| Helena S Shalonda | H.Shalondah | October 2024 |
| **Name of Student** | **Signature** | **Date** |

# CHAPTER 1: INTRODUCTION

## 1.1 Introduction

The study investigated the effects of models on enhancing Grade 7 learners' understanding of fractions at a primary school in the Onankali Circuit, Oshikoto region of Namibia. Consequently, this chapter comprises the study's history, statement of the problem, the research questions, the significance of the study, its limitations, delimitations, and a glossary of words.

## 1.2 Background of the study

The Ministry of Education, Arts, and Culture (2016) states that one of the most important skills that must be included in the Mathematics curriculum is the ability to grasp fractions. The proficiency in the four fundamental fraction operations as well as the capacity to compare and arrange fractions are listed as the Grade 7 syllabus's objective outcomes (Ministry of Arts, Culture, and Education, 2016, p. 51). The knowledge of fractions is essential in learning other aspects of Mathematics, like algebra and geometry, to name a few (Lovemore et al., 2021, p.14). Furthermore, Aksoy (2019) stated that fractions could not be separated from daily life usage; hence, teachers should facilitate the development of the fraction concept effectively when presenting the learners. A study conducted in the Kunene region in Namibia also revealed that most teachers needed help to employ appropriate teaching methods when teaching Mathematical concepts, which include fractions (Kleopas, 2020).

The findings of Ugulu (2019) showed that poor performance in Mathematics has been recorded in Namibia for over a decade, and the contribution of fractions to this worrisome performance is evident. Numerous scholars (e.g., Van Dr Waller, 2016;

Sidney & Thompson, 2019) have proposed numerous methods for teaching fractions to alleviate this. However, throughout her teaching experience as an educator, the researcher observed that learners in Namibian schools continue to need help in grasping the idea. In Namibian classrooms, learners in Grade 7 struggle to grasp the concept of fractions. Furthermore, incorrectly teaching fractions can impair a learner's understanding of the topic for the rest of their life, potentially affecting their school, higher education, and career prospects. (Abdullah, 2018).

Albin and Brown (2019) suggest using fractional models in Namibian schools. Models are instructional strategies used in the classroom to highlight the teacher's manner of imparting knowledge through practical exercises in which the learners are thoroughly engaged and develop efficient learning strategies. The area model, linear/rectangular model, and circular model are the three main types of fraction models (Albin & Brown, 2019). Research by Albin and Brown (2019) indicates that giving learners the chance to interact with all three models is essential to helping them build a mental knowledge of fractions. Furthermore, Simon (2018) note that using fraction models helps learners solve problems involving fractions and create mental references that help them understand confusing concepts symbolically. Ugulu (2019) also suggested that teachers develop videos to augment their teaching skills in these conceptually demanding topics. Therefore, there is a need for teaching and learning models to the Mathematics contexts and teachers should provide learners with multiple models to help them understand the topic better.

In Namibian schools, learners in Grade 7 need help understanding the idea of fractions. Alternatively, Hamukwaya and Haser (2021), fractions are one of the mathematical learning challenges, and as such, teachers should apply their pedagogical strategies when teaching such ideas. This study will look at how employing models in fraction instruction affects learners' conceptual understanding of fractions in seventh grade.

### 1.3 Statement of the problem

Most learners all across the world, including Namibia, are forced to repeat grades due to poor performance (>40%) in the Mathematics fractions skills component of the curriculum (Mabena, 2021). Fractions are extremely hard for learners to comprehend and the topic continues to be a major obstacle for learners in South Africa (Baidoo, 2019). The study by Ndalichako (2013) in Tanzania found that, in the Primary School Leaving Examination (PSLE) conducted by learners to highlight fraction-related challenges, fractions were among the lowest performed topics in the examination, ranging from less than 10% to 75%. It was also noted that teachers appeared to struggle when teaching fractions, based on the researcher's own teaching experience as a primary school teacher. This is also consistent with Kleopas's (2020) findings of the study conducted in Kunene region of Namibia that teachers need help to employ appropriate teaching methods when teaching fractions. Albin and Brown (2019) who researched on the teaching of Mathematics in Namibia highlighted that many educators have a poor grasp of fractions and only use symbolic representations of abstract fraction concepts while teaching them. For instance, Naidoo and Hajaree (2021) noted that the reproductive teaching of Mathematics through the mechanical repetition of different rules found in a textbook is the reason for learners' weak conceptual comprehension of fractions. Research on using models to improve Grade 7 learners' conceptual comprehension of fractions in Namibian schools is still in its early stages. This study investigated the effect of using models to enhance Grade 7 learners' knowledge of fractions at a selected primary school in Onankali Circuit of Oshikoto Region in Namibia.

## 1.4 Research Question and Hypotheses

### 1.4.1 Main research question

The study used mixed methods with the quasi-experimental approach and answered this question:

What effect does teaching fractions using models have on learners' understanding and performance in Grade 7 at Onankali Circuit in the Oshikoto region of Namibia?

### 1.4.2 Sub-research questions

1. What challenges do learners experience on the learning of fractions at Grade 7?

2. What are the views of the learners in the experimental group on the use of teaching models to enhance their understanding of fractions?

### 1.4.3 Hypothesis

The following two hypotheses were investigated in this study:

**$H_0$:** There are no statistically significant differences in performance between learners in Grade 7 who are taught using models and those who are taught using alternative techniques like presentations and textbooks.

**$H_1$:** There are statistically significant differences in performance between learners in Grade 7 who are taught using models and those who are taught using alternative techniques like presentations and textbooks.

## 1.5 Significance of the Study

The significance of this study is that it will benefit learners, teachers, curriculum developers and will contribute to the limited literature of teaching fractions in Namibia. The study's findings have highlighted that Mathematics educators can teach fractions to the Grade 7 learners using models. In addition, it is expected that the learners' performance in fractions will increase, as they will be able to use models effectively to solve Mathematics problems within their context, which might as well encourage their teachers to employ models to teach fractions effectively. The findings will also assist educators in establishing what curriculum design is appropriate for their learners and learning goals, particularly when teaching fractions. It is also envisaged that the results would help curriculum developers create educational resources and activities that offer learners a variety of educational opportunities when learning fractions. Furthermore, the study may aid in the promotion of model-based Mathematics instruction in Namibian schools. This study adds to the understanding of the usage of teaching models in the Mathematics classroom for teaching fractions mainly in the Namibian context. Thus, the results of this study may add to the limited literature on Namibian Mathematics education, particularly regarding fractions.

## 1.6 Assumptions of the study

When conducting this study, the following assumptions were considered:

1. The researcher assumed that the use of models to teach fractions to the learners would be effective in making learners understand the concept fully.

2. Learners taught fractions using models will perform better in the posttests compared to those who are taught using alternative techniques like presentations and textbooks.
3. The results of the study will be valid and reliable given a mixed method approach used in the study.

### 1.7 Limitations of the Study

The scope of this study's design and geographic coverage are both constraints. The study only concentrated on Grade 7 learners at a single school in the Onankali Circuit in the Oshikoto region of Namibia. The effect of this limitation is that the findings might not be generalized to other regions. This target group was purposefully chosen, so the study sample might have been exposed to several other variables such as teaching and learning resources, as well as environmental effects, which could limit the learners' cognitive levels in answering pre and post tests and interview questions. Since the learners all attended the same school, they might share the materials across the two groups in the experimental design, the researcher gave the learners exposure to a range of models pertaining to fractions in order to address this. By collecting data through the administration of tests and through interviews to crosscheck the results, the problem of the sample being randomly chosen was resolved. Another limitation is that the study lasted only seven weeks, which might limit the findings. If more time could have been given, the results might have come out differently. Based on the amount of content covered and the depth of the concepts, this is insufficient time for learners to completely understand all of the skills required to attain advanced competency on the post-assessment. Slower pacing along with the use of additional materials with regards about the models, would have allowed learners to better retain the concepts. The researcher was the instructor for both groups; therefore, she might have been prejudiced toward one group which might affect the validity of the findings. Furthermore, the study's conclusions could have been constrained by the trainees' poor cultural and linguistic awareness. Exposing learners to a range of contexts improved their awareness of cultures, and for the sake of this study, the teacher code-switched into vernacular languages to overcome the language barrier.

### 1.8 Delimitations of the study

A chosen primary school in the Onankali Circuit in the Oshikoto area of northern Namibia served as the site for this study. Out of the potential 10 primary schools in the Circuit, only one school was selected for this study. The researcher is an educator at the rural primary school where the study was conducted, teaching Mathematics in Grade 7. This school was chosen because it had a higher enrollment of learners than the other primary schools in the Circuit. Besides that, there is persistent low learner performance in Mathematics at the selected primary school, which has piqued the researcher's interest in exploring what effect fractions have on learners' understanding of fractions and knowing how fractions are taught to learners. The school where the study was conducted is located in a rural area. There are few teaching resources, and teachers rely solely on textbooks and instructing learners to memorise rules with no supplementary learning materials. Overall, there are four qualified Mathematics teachers for Grades 4-7 at the selected primary school, but every teacher teaches one grade only grouped in two classes A and B. The average class size consists of 30-40 learners.

## 1.9 Definition of terms

The following terms were defined as follows in this study:

**Understanding fractions conceptually**: To do this, one must comprehend every idea that fractions might possibly express, including part-to-whole, ratio, measurement, and signify operations (Van de Walle et al., 2014). In the context of this study, this means learners should understand the concepts of fractions thoroughly and will be able to solve fractional problems effectively.

**Equivalent fractions**: Fractions that appear to look different but have the same value or represent a part of a whole.

**Fractional models**: Resources for teaching fraction concepts, such as number lines, area models, and rectangle models. (Albin et al, 2019).

**Improper fractions**: Fractions in which the number on top is greater than the number down, e.g. $\frac{9}{4}$ (Hambata et al., 2015).

**Lowest common multiple of denominators**: The lowest number that can be divided by each of the denominators of the given collection of fractions is known as the least common denominator, or LCD. Among the common multiples of the denominators, it is the smallest number (Methuseli, 2020).

**Proper fractions**: Fractions in which the number on top is less than the number down, e.g. $\frac{5}{10}$ (Hambata et al., 2015).

**Part-of-a-whole**: Splash-Learn (2022) defined part-of-a-whole as a ratio of fractions that represents a relationship between a part and its whole.

### 1.10 Summary

The researcher presented the study in this chapter, which looked at how models can improve Grade 7 learners' comprehension of fractions at a particular elementary school in the Onankali Circuit. The study's review of the literature is presented in the next chapter.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

This chapter begins by discussing the theoretical framework of constructivism, which informed this study. Secondly, the effects models have on enhancing Grade 7 learners' understanding of Mathematical fractions at a primary school in the Onankali Circuit were investigated by reviewing the relevant literature. The literature was under the following headings: (a) the concept of fractions and the use of models to teach, (b) common methods used to teach fractions, and (c) challenges faced when teaching fractions.

## 2.2 Theoretical framework

The constructivist learning theory, developed by Piaget (1964), informed this research study. The foundation of constructivist theory is the idea that learners create knowledge instead of merely absorbing it (Sasan & Rabillas, 2022). This theory fits this research since the researcher intends to find out how models may help learners in the learning of fractions. Through the model, learners must interact with the learning content, create experiences, and, in the process, construct concrete knowledge of fractions. This theory allows learners to recognize that there is more than one correct answer and that many points of view are valid in learning fractions. Fernado (2017) listed the tenets of constructivism theory are as follows:

1. Learners bring unique prior knowledge, experience, and beliefs to a learning situation.
2. Learning is both an active and reflective process.

3. Knowledge is constructed uniquely and individually in multiple ways, through a variety of authentic tools, resources, experiences, and contexts.

These tenets support this study in the sense that the researcher served as a facilitator, directing learners through instructional methods. Furthermore, these foundations underpin this study, since the teacher will establish an interactive learning environment in which learners will become active participants in their own learning. This will also result in improved performance for learners in the experimental group, who will have hands-on activities and apply learning models to better learn fractions. Similarly, these tenets are applicable to the study in the sense that learners will be able to apply the learning models to what they already know about fractions and real-world situations. In addition, learners will be able to apply models to solve problems based on fraction computation.

For instance, Piaget (1964a) showed that accommodation and assimilation, two cognitive processes, interplay continuously as the developing mind engages with novel situations or concepts.

When learners look at a new event and find that it does not fit into their preexisting schema, they modify their mental models to make room for the new concept (Jaleel & Verghis, 2015). On the other hand, assimilation happens when learners organize their thought processes to integrate the new concept into their preexisting schema and interpret the new concept by making links to what they already know (Jaleel, 2015). Upon analyzing a fresh experience and realizing that it deviates from their previous schema, learners modify their cognitive framework to incorporate the novel concept (Jaleel & Verghis, 2015). Nevertheless, assimilation will help learners to makes sense of learning models by applying what they already know about fractions. Besides that, the learners will fit reality of what they are learning into their current cognitive structure and this will influence how they interpret fractions.

Piaget (1964a) noted that learners will require information, concepts, ideas, or a network of related ideas in order to think using the knowledge they currently possess (in their cognitive schema). The thrill of making connections between ideas or concepts and the chance for varied and creative thought are taken away from learners by the monotony of rote learning, which involves memorizing facts without thinking about their meaning (Van De Walle et al., 2016). Learners are frequently instructed to manipulate symbols that have little or no related meaning because of rote-memorized rules (Simon, 2018). Moreover, rules are more complex to recall than integrated conceptual structures, which makes learning much more challenging (Sasan, 2022).

Instead, people create new knowledge by combining previous experiences, understandings, and beliefs. Piaget's proposal of cognitive constructivism (1964a) holds that learners sort through information, work through tasks, interact with concepts on their own, and either accommodate or integrate new information into their own mental schemata. As a result, learners influence concepts rather than simply absorbing them as teachers impart them.

Moreover, cooperative learning among learners and multimedia learning scenarios like research and decision-making applications are crucial elements of this teaching philosophy (Sasan et al., 2022). It is worth noting that constructivists acknowledge that both the learning setting and the attitudes of learners have an impact on the learning outcomes. However, constructivist theory, humans create knowledge and meaning by their experiences; as a result, mental construction leads to cognition

(Bada, 2015). In the context of this study, this literature means that learners' attitudes toward learning environment, such as their perception towards new teaching-learning models also play a crucial role in their academic performance. Learners' integration with the models for fractions and the teacher's support influenced their attitudes towards understanding fractions thus their performance improved very well in the posttest.

However, to provide learners with a distinctive learning environment, it is crucial to comprehend how teachers might implement constructivism in the classroom (WGU-Western Governors University, 2020). Nonetheless, most instructional materials in Namibia are not created for the learners; teachers are more facilitators of learning than actual instructors are. Furthermore, a hands-on approach is always preferred when dealing with new concepts with a firm foundation in everyday life competencies, especially with children of middle age. In addition, the researcher has seen that many learners need to learn the names of these concepts when they start classes, even though they are not solely ignorant of fraction notions.

The teacher is a facilitator and motivator in a constructivist classroom; the teacher helps learners find information and solve problems by thinking (Lamon, 2021). The topic Fractions is allegedly the most challenging concept for learners to master; henceforth, a constructivist approach concentrates on learners studying Mathematics and applying the findings collectively in the real world (Schunk, 2012). This theory fits this study of how models may help learn fractions. Through models, learners are supposed to interact with the learning content, create experiences and, in the process, construct concrete knowledge of fractions. This study looked into how employing models improved the fractional comprehension of learners in Grade 7 at a selected primary school in the Onankali Circuit.

## 2.3 Literature Review

### 2.3.1 The effects of using models to teach fractions.

At nearly every level, learners struggle with fraction issue-solving and problem-posing (Moloto, 2022). To ensure that learners have a conceptual understanding of fractions and operations involving fractions, teachers must provide exercises. With mathematical models, the development of such conceptual knowledge can be accelerated.

In one of the experimental studies that aimed to pinpoint the flaws in the fractions subtraction problems that primary school instructors pose and the models, they use to answer them (Tuba, 2017). Tuba's study findings show that teachers' pedagogical knowledge, teaching instructions, and mode of delivery contributed to the flaws in fractional concepts. The study further suggests that through workshops, in-service training, and other methods, the interviews with Mathematics teachers based on the teaching methods they use to teach the topic of fractions may help pinpoint the root reasons for the specific errors made by the teachers. Interestingly, the area model was the most often adopted by the study's participating teachers.

### 2.3.2. The concept of fractions.

In Namibian schools, the Grade 7 Mathematics textbook offers three forms of common fractions:

1. Proper fractions are fractions that have numerators that are smaller than the denominators, such as $\frac{3}{7}$

2. Improper fractions are fractions that have numerators that are bigger than the denominators, such as $\frac{3}{2}$ $a$nd

3. Mixed numbers have whole numbers and fractions, like $1\frac{1}{2}$ (Hambata et al., 2015, p. 49).

One of the main areas of Mathematics that both teachers and learners find challenging is fractions (Yazlik & Akyson, 2017). Additionally, Agbozo (2020) noted that in Mathematics, fractions have always been taken for granted since they appear to be a part of everyday life. However, they have never been analyzed on the same basis as whole numbers. The creation and comprehension of fractions are time-consuming, and teaching fractions is seen as problematic.

The concept "of fractions" has many definitions and representations; one can write them in symbols and the other in numbers or words (Chamane, 2016). Teachers use words like "numerator" and "denominator" and sometimes forget that learners may not have internalized those terms and most likely have never heard of them (Schoenfeld, 2022). This might have led to confusion. Using fraction models can help learners. By using fraction models, learners can create mental referents that help them complete fraction tasks in a meaningful way and clarify concepts that are misinterpreted frequently in a purely symbolic mode (Deringol, 2019). However, this inform this study that learners often become confused by the language that teachers use when describing fractions. Similarly, teachers from the chosen school for the study also present variety of different names to describe the numerator and denominator to learners in the hopes that they will make them easy to undertand. It is important that teachers are aware and develop a deep understand these interpretations so they can introduce them to learners in meaningful ways.In contrast, the use of teaching-learning- while models allows learners to visualise the concepts that are being discussed and enhance their understanding of a topic better.

Lazić et al., (2017), point that fractions are conceptually the most important component of the primary school Mathematics curriculum and naturally flow into the decimals and percentages domain. Fractions are crucial to the growth of mathematical reasoning, and formal mathematical knowledge among primary school teachers is insufficient to instruct learners in fundamental ideas (Kolar et al., 2018). Vida et al. (2018) believes that fractions are a difficult set of ideas in basic Mathematics that mostly depend on developing a solid grasp of other key ideas in the subject, such as algebra and probability. Numerous studies have revealed that a teacher's proficiency with fractions directly affects a learner's ability to learn fractions (Lovin et al., 2018). Nonetheless, teachers' lack of understanding of fractions and fractions operations affects the way learners learn. Mathematics teachers go into the teaching field with insufficient knowledge of fractions that is mainly about procedures and thereby pass on the same inadequate fractional understanding to the learners. Therefore, Mathematics teachers in the educational field should be supported in constructing conceptually content knowledge through the development of appropriate models of fraction concepts and concept operations.

Moyo and Machaba's (2021) study with Grade 9 learners at a school in Soweto, South Africa, established the fundamental fraction principles applied in learners' coursework. Their research showed that the learners' definitions of fractions were neither exact nor comprehensive. Particularly noteworthy were difficulties with the concept of equivalent fractions, which include fractional components such as the numerator and denominator in the rational number phase. However, Moyo's (2021) study opines that when learners first began to understand fractions in the latter stages of concrete learning, knowledge gaps may have originated in the early years of schooling.

### 2.3.3. Using models to teach fractions.

The area model, length model, and set model are the three primary categories of fraction models. It is recommended for teachers to use all three types (Albin, 2019). Van de Walle et al. (2016) indicated that wholes for area models are continuous, i.e., not isolated pieces. Diagrams and paper folding are frequently utilized in area models. The entire thing is "cut up" or divided into several pieces of various sizes (Van de Walle et al., 2016). The area models in the shapes below demonstrate that fractional parts are continuous rather than single (or broken) pieces. The figure below shows the types learning models designed the researcher.

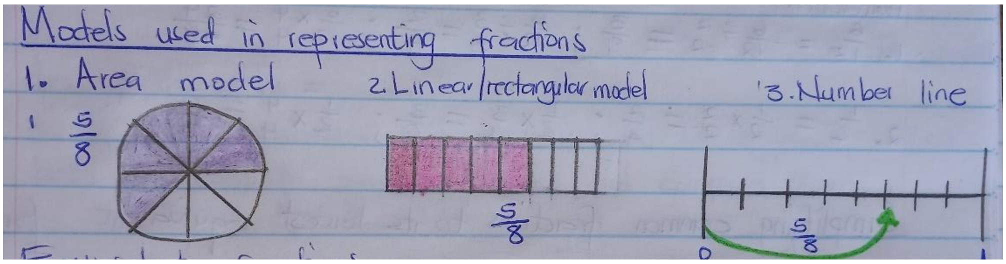


**Figure 1: Fraction models**

In order to improve learners' understanding of fractions and encourage abstract thought, Cramer et al. (2019) emphasized that educators should employ a variety of representations, including area models, length/linear models, and set models. Using number lines and visual aids while teaching fractions to children might help them build a good conceptual comprehension of the content (Siegler, 2010; Fazio and Siegler, 2010). Meanwhile, Humphreys and Parker (2023) point that educators ought to utilize an assortment of representations to cultivate a conceptual understanding that is based on a range of real-world scenarios.

Zhang (2020) states that learners using visual aids should illustrate fraction operations like fraction division. Sidney and Thompson (2019) have conducted an experimental study to determine which visual models are most successful in assisting learners to solve and conceptualize these processes. Sidney's et.al (2019) study suggests that area models are the most effective part-whole model for creating mental representations of fraction addition and relative sizes.  Yuan et al. (2013) emphasize that future research should look into the best way for instructors to offer diverse visual models to learners to improve their representational fluency across number lines.

Purwadi et al., (2019) conducted a study to see whether the Concrete-Pictorial-Abstract (CPA) technique increases learners' Mathematics, conceptual understanding (MCU), and mathematical representation (MR) of fractions. Their findings indicate that CPA strategies can improve learners' achievement and understanding of mathematical concepts and mathematical expressions of fractions. Samuel et al., (2021) evaluated the fractions-related Mathematical knowledge for Teaching (MKT) in Ghanaian primary schools. An assessment of problem-solving abilities showed that pre-service teachers required a more in-depth academic and pedagogical understanding of fractions. The study's findings of Samuel (2021) further recommends that teachers must acquire a considerably more significant and more profound comprehension of the Mathematics material than they did as learners.

### 2.3.4 Number line

Number lines, according to Van de Walle et al., (2013) are excellent for assisting learners in further developing fraction notions and understand that fractions are just numbers, not numbers that are stacked on top of other numbers. Learners should be instructed to find and contrast fractions on number lines, enabling them to compare the magnitudes of various fractions by plotting them on a number line and discovering that some fractions, like $\frac{3}{4}$ and $\frac{6}{8}$, are equivalent (Shongwe, 2021). Lenz (2020) points out that teachers can start by using number lines that already have the fractions marked, such as an eighths-marked number line, because by using this extra step, any issues the learners may have correctly segmenting the number line will be resolved. Both fractions with marked locations (such as $\frac{6}{8}$) and fractions with denominators that are factors or multiples of the unit fraction marked on the number line (such as $\frac{3}{4}$/$\frac{2}{3}$) should be asked to be placed by the learners. In addition, teachers should include fractions comparable to whole numbers, such as $\frac{8}{8}$, to ensure that children can comprehend that whole numbers can be expressed as fractions (Lovemore et al., 2021).

A number line can be marked with one unit above the line and another below it to aid learners in understanding and comparing fractions with various denominators. The teacher might divide the number line into fifths above the line and eighths below the line, for instance, if the learners are asked to compare $\frac{3}{5}$ and $\frac{1}{8}$. As children improve, these extra supports can be taken away, allowing learners to use number lines with fewer labels, such as simply the endpoints or the endpoints and the center of the line.

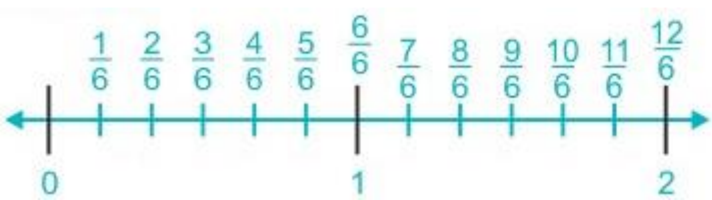


**Figure 2: Number Line Model (Rojo, 2024)**

A study conducted by Yuan and Chen (2022) in Taiwan investigated the association between fraction number line estimate tasks and whole number bias. As was the case with positive-integer number line estimate tasks, the results demonstrated that the learners' fraction learning pattern evolved from nonlinear to linear, and none of their guesses showed a logarithmic tendency.  Another study's findings, states that learners can significantly increase their conceptual understanding of fractions by using a number line. In another study conducted by Witherspoon (2019), fifth-grade learners' knowledge about fractions was examined and it was found that learners had difficulty calculating fractions of a line (fractions from 0 to 1).  A study by Barbieri et al., (2020) evaluated the effectiveness of testing high school subjects to teach the topic along with research-based teaching strategies.

Finding the value of a fraction on a number line is a challenging skill that every learner can master (Van de Walle et al., 2013). The same study for Van de Walle (2013) found four errors that learners frequently make, which are: calculating symbols beyond the intervals between symbols, changing units, using incorrect fractional symbols, and calculating symbols that appear without setting missing parts. Methuseli (2020), who seems to agree with Van de Walle et al., claims that numerous learners need help dividing units according to the number line (2013). It is important that teachers teach learners to count the length units and not the spaces bettwen numbers, so they will not end their counts between two numbers and will not know which number to use. Further, teachers should introduce number lines to learners when they already have an understanding on how to use area and circular model to solve fractions,because learners will just view it as spaces and lines and rather than a concrete model.

Finally, the idea of fraction density can be demonstrated using number lines (Avcu, 2019). Also, learners may find it challenging to grasp this idea; however, number lines can help for instance, learners can start with a number line that represents a total number (for instance, 0 to 1) and divide that line into half (Copur-Gencturk, 2021). Equally, Van de Walle et al. (2019), linear models are not frequently utilized in elementary and high schools, in contrast to area models. However, they are the most difficult and crucial resources that need to be highlighted more while teaching fractions to advance learners' conceptual comprehension.

### 2.3.5 Area model

Since the sum of the equal parts of the formula is the same and is related to the fraction variable, models are believed to be the most fundamental graphical representation of the part-whole, while the shaded areas are connected to the numerators (Moloto, 2021). As Van de Walle et al. (2013) stated, utilizing the area model to introduce fraction instruction is always a smart idea because it is closely related to equitable sharing and portioning. Learners can better visualize individual sections of an entire fraction by using length and area models. In these models, activities entail sharing items divided into equal pieces. On portions of an area, the fractions are based on the denominator of the fraction given. Circular models are frequently employed because they highlight the amount needed to complete the entire fraction (Van de Walle, 2014). An apple can be used as an example of a physical thing to represent a whole that will be divided into four equal pieces using a circular object. Four (4) divided by one (1) will be a quarter or fourth of the total. Models, according to Cramer (2019), can aid learners in making sense of concepts that are often twisted while learning in the symbolic form. Area models include the following as well.

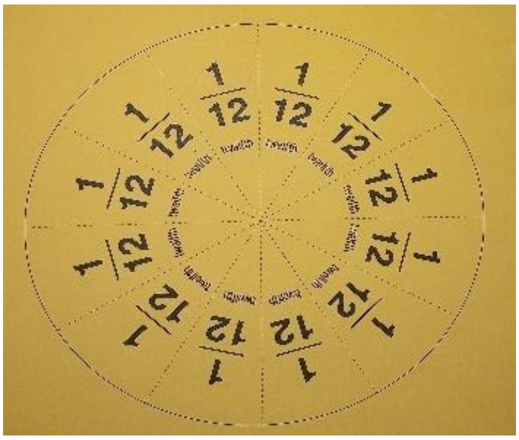

**Figure 3:** Area model by Rojo (2024)

### 2.3.6 Rectangular model

A rectangle divided into equal halves is called the rectangular fraction model. Depending on how many equal parts you divide the whole into; the equal parts may be divided into halves, thirds, fourths, and so on. Learners must remember that the numerator is the number at the top of any fraction, and the denominator is the number at the bottom.

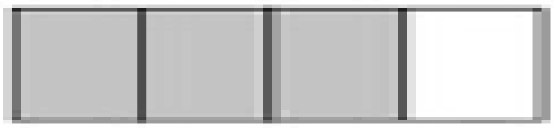

**Figure 4: Rectangular model** derived from *https://www.splashlearn.com/math*

### 2.3. 7 Common methods used to teach fractions.

It is commonly known in education that learners learn most effectively when they are able to understand the relevance and value of the material being taught (Albin, 2019). Therefore, educators need to foster an atmosphere where learners are motivated and engaged with the material. Using a range of instructional strategies that accommodate various learning preferences is one method to achieve this; for example, providing information through charts, graphs, and drawings can be useful for learners who are visual learners (Van de Walle, 2014).

However, certain learners might favour kinaesthetic or auditory learning methods. But regardless of their preferred method of learning, it's critical to create a stimulating and dynamic environment in the classroom (Kaminski & Sloutsky, 2020). This can include incorporating different teaching techniques, such as group discussions, interactive exercises, and hands-on activities, and by doing so, the ultimate aim of learning can be attained, ensuring that learners can retain and apply the knowledge gained (Deringol, 2019).

A study by Marieke et al., (2019) examined the fractions education in Grade 5 Dutch primary schools. The study discovered that effective fractional training requires a combination of carefully thought-out lectures, a consistent classroom environment, and a thorough comprehension of the subject. The authors recommended that educators better prepare their classes and gain a deeper comprehension of the subject matter they are teaching.

Ubah (2021) investigates the effects of three alternative methodologies employed by three teachers when teaching fractions to a sample of fifth Grade pupils in Johannesburg, South Africa. Ubah's findings revealed that the instructor improved learners' performance by a fraction more than the other two teachers using best practices and the suitable usage of different representations. As a result, the above study recommends that Mathematics teachers use suitable teaching tactics, such as a learner-centered approach, activity-based learning, and employing native languages, to assist learners in understanding fractions conceptually. The current research will test the effectiveness of using models in teaching fractions**.**

A study by Dodd et al. (2015) clarifies a critical component of education and the value of using extra resources. Based on the interviews, teachers employ materials primarily to get the attention of the learners. Their study's conclusions, which include both quantitative and qualitative data, are consistent with Ubah (2021) in that they emphasize the value of using these tools to improve learners' educational experiences. Research shows that teachers believe that learners can only learn and understand content when they are motivated.

Consequently, using auxiliary resources becomes imperative to maintain learners' interest and engagement with the content. Despite this, utilizing learning materials effectively assists learners in learning and grasping the fraction concepts better. In conclusion, the research study by Dodd et al. (2015) and Bernard et al., (2019) corroborate that materials play a vital role in enhancing the quality of education. It is essential to recognize the significance of utilizing auxiliary resources and ensure that they are employed effectively to facilitate the learning process of learners.

Moloto and Machaba (2021) investigated the mathematical expertise of two Grade six teachers to introduce the notion of fractions. Findings of the study suggests that a learner-centered approach should include a variety of insightful inquiries, improved learner interaction, social, verbal, concrete, physical, and experiential engagement with fraction concepts, as well as learners' active generation of ideas. Kaminski et al. (2020) appear to agree with Moloto and Machaba (2021) that in order to establish the notion of fractions appropriately, it is advised that teachers employ a variety of representations, including area models, circular models, rectangle models, set models, length models. Sidney et al. (2019) say that the efficient use of models is important in the study of fractions. When different models are utilized, learners appear to be more exploratory, which improves their knowledge of fractions (Fauzi & Suryadi, 2020). Cramer et al. (2019) recommend that in order to enhance fraction instruction, school procurement committees buy fractional charts, and schools need to have Internet connectivity in order to acquire fraction-related materials. This is study is benefiting from this study in a sense that the researcher and teachers will be able design up their own models and make use of the internet to download relevant fraction-related materials to be used in classrooms. By incorporating various teaching can enhance the learning experience for the learners and the teaching process more effective and enjoyable for both the teachers and learners.

Another study set by Abdul et al., (2021) intended to discover the common misunderstandings among Year 4 pupils regarding fractions. The study also examined the efficacy of cooperative learning in eradicating learners' misconceptions regarding fractions. The study's findings demonstrate that cooperative learning successfully eradicates learners' misconceptions regarding fractions. The study further recommends using cooperative learning as a teaching approach to overcome learners' misconceptions regarding fractions. Similarly, Bernhard et al. (2019) say that cooperative learning, where learners share their knowledge and ideas, peer encouragement is crucial.  Learners can become aware of these misconceptions and build a fresh knowledge of fractions. Zhang et.al., (2020) indicate that teachers should know the possibility and likelihood that learners will develop fractional misconceptions, and they need to work hard and implement interventions to identify and stop learners' misconceptions. This study is shaped by this literature, as the researcher will know that different types of models of teaching help to cater to the diverse needs and learning styles of learners. It appears to the researcher that each model has it is own strengths and limitations, and the choice of model depends on various factors, including the learner's level and the learning cont. Therefore, it is important that teachers resist rushing through the use of models to teach fractions and make sure all the learners really master the models before moving on to the next topic. Apart from that, teachers should use models they can build on later to avoid engendering the type of misconceptions learners are familiar with already.

### 2.3.8 Challenges faced when teaching fractions.

The data from the National Assessment of Educational Progress (NAEP) (2019), according to Namkung (2017), demonstrates that a large number of learners in Namibia struggle with fractions. Only 32% of fourth graders correctly identified which fractions were bigger than, less than, or equal to half, agreeing to the 2017 NAEP. Just 25% of fourth graders in 2009 correctly picked a fraction that was closest to half. The results of these two tests show that learners have consistently struggled with fractions for a long time.

Aksoy (2019), focusing on common mistakes that learners make when working through issues requiring fractional operations, contends that the majority of these mistakes are caused by the inconsistent teaching strategies that the mathematical content of fractions demands. However, Zhang et al. (2020) point out that creating this relationship is not the only strategy for effective training, even though it is crucial for fostering a conceptual knowledge of fractions. Zhang et al., (2020), for example, examine various approaches to connecting dissimilar fraction models in which the learning process aims to generate fractional representations. Evidently, Zhang's study recommended that the aforementioned didactic techniques be applied appropriately as a thorough and structurally sound approach to the learning process.

Maaike et al., (2019), in their study examined the teacher characteristics that influence learner proficiency development in the area of fractions, specifically in Grade 5 of Dutch primary education. The result shows that a teacher's experience, along with their pedagogical content knowledge, contributed positively towards learner performance. Avcu (2019) concurs with Maaike et al. (2019), stating that the degree of learners' participation in classroom activities was also found to have a significant impact on their understanding of fractions. They point out that it is essential to address these factors to improve learner learning and foster a positive classroom environment.

The results of a case study that examined how one early-career teacher taught similar fractions in Grade 4 classrooms are presented in an article (Shongwe, 2021). The research found and concluded that the most frequently cited problems in teaching equivalent fractions are five related fraction structures: whole part and whole part; ratio, operator, quotient, and measure and teachers' pedagogical approaches for teaching these ideas (Shongwe, 2021). The study suggested that larger, more extensive research may be required to clarify the scope of these findings and, if necessary, a substantial investment in beginning teacher education may be required in order to demonstrate the effectiveness of dialogic teaching in encouraging the meaningful acquisition of, at the very least, equal fractions.

Methusali (2021) conducted a study that examined a teacher's fractions instruction in a New Zealand Year 7 classroom using the Knowledge Quartet Framework and the five associated fractions notions. The results demonstrated that learners frequently took the initiative to employ fractions as a quotient and operator, relying on their knowledge of part-whole relationships to resolve fractional problems (Methusali, 2021). Consequently, the teacher's emphasis on making connections between the lesson's processes and concepts, as well as on directing the classroom conversation as it developed, helped learners grasp the concepts of fractions (Getenet & Callingham, 2019). Several researchers (Lazica, 2018; Van de Walle, 2012) have examined elementary teachers' struggles with procedural and conceptual fraction understanding. Furthermore, they indicate that a need for textbooks and learning tools, as well as learners' attitudes about fractions and an overcrowded classroom, all contribute to the ineffective teaching of fractions. It would be of interest if Mathematics teachers undergo ongoing professional development, particularly so they are abreast of innovative teaching techniques. Using real-life situations and concrete tools instead of teaching fraction rules will help accomplish effective fraction teaching to learners. In this regard, different teaching methods or computer programs may be beneficial to learners and help to structure their future learning correctly. It appears that learners' prior knowledge of learning natural numbers, for instance, negatively influenced their understanding of fractions and their operations, by using different teaching models will encourage critical thinking and keep learners engaged in the lesson.

Copur-Gencturk & Doleck (2021) in the USA suggest that the quality of education and learners' learning are impacted by teachers' comprehension of the subjects they instruct. In addition, the results show those teachers’ fraction calculation skills are limited, especially dividing fractions. However, there was a trend of consistency between teachers and competence in adding and dividing fractions (Copur-Genturk et al., 2021). Therefore, teachers who can develop and enhance learners’ mathematical understanding are those who have a sound knowledge base. In the context of this study, it means that teachers will be able to use learning models or diagrams to illustrate the concept and demonstrate how to apply it to a problem.

In a similar vein, the Curriculum and Assessment Policy Statement study by Chamane (2016) investigated teachers' experiences instructing Grade 6 learners in fractions. The study's findings demonstrated that a wide range of factors influenced the instructors' experiences, including motivation, aims and objectives, content, teaching activities, roles of the teachers, resources, grouping, time, location, and assessment. The most significant factor influencing instructors' experiences, according to Chamane (2016), was their personal, societal, and content-based teaching rationales. When teachers used their justifications for teaching, it was evident that they had a theoretical understanding of the subject (Chamane, 2016).

On the other hand, Fernando (2017) claims that educators whose decisions are impacted by the societal justification for teaching cannot contribute to the effective teaching of fractions. Lovin (2018) investigated how educators introduced the subject of fractions to learners. The study's findings indicate that educators who used the content-based approach to teaching believed that having a solid understanding of fractions would assist them in teaching fractions to learners. Furthermore, Lazica's (2017) research indicates that Mathematics teachers should continue their professional growth. As a result, they keep up with the most recent and innovative teaching methods, especially when it comes to teaching fractions.

## 2.4 Conclusion

Piaget's Constructivism theory (1964) serves as a framework for this research study. While most of the reviewed research has examined teaching fractions using models, only a few of them were carried out in a Namibian setting. They should have examined how effectively the models contribute to learners' understanding of fractions. Thus, there is a need to fill this gap. In addition, the literature has specifically reviewed these: the concept of fractions, using models to teach fractions, standard methods used to teach fractions, and challenges of learning fractions. However, research shows a positive correlation between learners' ability to use solutions and their mental understanding of fractions. Again, the reviewed research, using visual representations of fractions when teaching fraction arithmetic improves learners' computational skills. The next chapter describes the research and methods.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Introduction

The research paradigm, design, population, the sampling procedures, research instruments, the data collection procedures, data analysis and ethical considerations are all presented in this Chapter.

## 3.2 Research Paradigm

Given that this study is a mixed method, the study is guided by positivism and constructivism as research paradigms. According to positivists, the nature of social reality is that empirical facts exist apart from individual ideas and views and that they are governed by laws of cause and effect (Marczyk et al., 2005). The selection of positivism as a research paradigm is justified by establishing whether there is cause-effect correlation between learners in Grade 7 who are taught using models and those who are taught using alternative techniques like presentations and textbooks.

Constructivism paradigm on the other hand, views learning as an active process where individuals construct their knowledge and understanding through their interactions with the environment (Piaget, 2019). The choice of constructivism as the research paradigm is justified by its relevance to the study's focus on enhancing learners' understanding of mathematical fractions. Constructivism emphasizes the importance of learners actively engaging with the learning material and constructing their understanding through meaningful experiences. By employing models as a teaching approach, the study aims to provide a hands-on and interactive learning experience for Grade 7 learners, aligning with the principles of constructivism.

The constructivist paradigm acknowledges the significance of the social and cultural context in learning, recognizing that learners' prior knowledge, experiences, and interactions with others shape their understanding. In this study conducted in a specific primary school in the Onankali Circuit, Oshikoto region of Namibia, the local context and its influence on learners' understanding of fractions are considered. The constructivist paradigm aligns with the study's objectives, providing a theoretical framework that supports the use of models to enhance learners' understanding. It emphasizes learners' active role in constructing knowledge and highlights the importance of meaningful learning experiences.

## 3.3 Research design

The study used mixed research methods with the experimental approach where both quantitative and qualitative approaches were used to gather data through pre and post-tests and interviews. The reason for using the mixed research method is that mixing data sets can give a better understanding of the problem and yield more complete evidence. Qualitative data were obtained from interviews with the ten selected learners from the experimental group. A study design, as defined by Creswell & Creswell (2018), is an approach to inquiry that offers the researcher specific direction and can take multiple forms, including mixed, qualitative, and quantitative. The mixed-method research approach combines quantitative and qualitative research data to allow for a deeper understanding of the studied problem (Creswell & Creswell, 2018). An initial and follow-up quasi-experimental design including two groups for the research sample was used to collect comparative quantitative data. After the learners had been taught fractions for seven weeks with models, they were given two tests. Qualitative data were gathered by interviewing learners from the experimental group to explore their subjective perceptions of the use of models in teaching fractions. From the two data sets, conclusions were made on the effect of using models in teaching fractions to enhance learners' understanding of fractions in Grade 7. The quantitative data dominated the qualitative data because the focus is on the effects of models that have more weight than qualitative.

### 3.3 Population of the study

The population in research study, according to Shukla (2020), is a large group of individuals who are the subject of the study. As a result, the population is a collection or grouping of all the units that are employed to put the research findings into practice. The research took place at a rural primary school in Oshikoto Region. This school was selected because it has a high enrolment of learners compared to other primary schools within the Circuit. The selected school where the research was conducted had four Mathematics teachers for senior primary phases of which two of them hold diplomas in Mathematics and the other two teachers had Honours degrees in Mathematics. The average class size consists of 30-40 learners. The performance of learners in Mathematics at the selected school has been observed to be poor due to a lack of alternative teaching strategies to the 'chalk and talk' method used by the teachers. This study's population consisted of all the Mathematics teachers and learners at the selected primary school in Onankali Circuit of Oshikoto region of Namibia.

### 3.4 Sampling procedures

Vehovar et al., (2016, p.329) define a sample as 'a subset of a population'. To better understand the population, researchers survey the units from the sample. One primary school in the Circuit that has Grade 7 was chosen purposefully. Purposive sampling has the benefit of focusing on a portion of the research population conveniently close to the researcher, saving time and money on data collection procedures. Biographical data of the learners from the two classes that were chosen to be either the experimental and control groups were captured in terms of age and gender. In all, sixty Grade 7 learners from the chosen school took part in the research. A total of 30 learners participated in the control group, including 10 males and 20 females coded as L31 to L60. In the experimental group, a total of 30 learners comprises of 8 males and 22 females participated. Participants' ages for both groups ranged between 12-15 years. This shows that, in terms of gender composition, there were more female than male Grade 7 learners at the selected school who responded to the study. Additionally, the population of the chosen school included learners who are in comparable circumstances to everyone else because they are exposed to the same subject materials and are expected to learn the same competencies. Comparative quantitative data with two groups for the study sample were gathered using a pre-and post-test quasi-experimental approach. Each group received the same set of test questions covering the same curriculum content. On the other hand, over the same seven weeks, the experimental group was taught using area, rectangular, and number line models, while the control group was taught using textbooks and other resources. The learners were given a posttest following seven weeks of fraction instruction utilizing models. After seven weeks of the treatment (teaching using models) given to the experimental group, both groups received post-tests. Ten randomly chosen learners from the experimental group participated in the focus group interview to gather qualitative data. The qualitative data were then subjected to a thematic analysis.

**Table 1: Summary of the sample**

| Gender | Experimental group | Control group | Total | Percentages |
|---|---|---|---|---|
| **Male** | 8 | 10 | **18** | 30% |
| **Female** | 22 | 20 | **42** | 70% |
| **Total** | **30** | **30** | **60** | 100% |

### 3.5 Research instruments

The researcher developed the models (area, rectangular and number lines) as the treatment for the experimental group in this study. The researcher produced the models to use them in testing their efficacy for teaching fractions and the Mathematics textbooks available at the school do not cover all the relevant basic competencies in the Senior Primary Phase Mathematics syllabus. The models were produced based on the contents of the Mathematics syllabi, Grades 4 – 7, and were used as a treatment of the study. The instructional materials covered the faction content, focusing on equivalent fractions, comparing and ordering fractions, addition, and subtraction of fractions, and entering numbers into a numeric line. Based on the 15 lesson plans, the researcher developed area, rectangular, and number lines on fraction concepts. The treatment produced by the researcher in this study were the models made from colour papers, posters, and boxes. The researcher designed the models with permanent markers and colour pencils. Its features enabled the learners to read them and see the fractions represented, thus, models were designed with side notes, and symbols explaining the concepts. Lastly, these models were used by the learners in the experimental group and used as treatment in the study.

Using two groups for the study sample and a pre-and post-test quasi-experimental design, comparative quantitative data were collected. The learners were given a posttest following seven weeks of fraction instruction utilizing models. The experimental group's learners were taught 15 lessons throughout the whole intervention by the researcher. Each lesson took forty minutes and this was done during regular school hours by the researcher who is also a Mathematics teacher at the selected school. Each learner was assigned a number to anonymously identify their work and monitor progress data. Each learner was given a pretest that is the same to every learner in the study to measure his or her understanding of fractional concepts. The data was recorded on a spreadsheet. Following the pretest, the learners were taught fraction concepts, such as; equivalent fractions, comparing and ordering of fractions, addition and subtraction of fractions, and plotting mixed numbers on a number line. This lasted around seven weeks. Learners watched models being demonstrated by the teacher, interacted with each other using models, worked independently using manipulatives, and participated in class activities using manipulatives throughout the seven-week learning process. The teacher used manipulatives to teach the learners throughout the first week of class. She gave clear instructions while writing on the board, demonstrated the concepts with real models like area and rectangle models, and number lines, and let each learner utilize their own set of models. Throughout the whole intervention, learners in the experimental group wrote class activities, and topic tasks, completed worksheets, and practical investigations. Following the intervention, the learners were given a posttest of 30 marks that evaluated the entire topic of fractions.

Like the experimental group, the control group, was also taught same concepts and understanding of fractions including addition and subtraction, comparing and ordering fractions and number lines. The control group was also given a pretest prior to the instruction. A total of 15 lessons were also presented to the learners in this control group, however, they only watched the teacher model the skill using manipulatives. The learners did not directly use the hands-on manipulatives during the learning process. Learners were introduced to area, rectangular, and number lines, but were not taught how to use them to solve problems regarding fractions. In the control group, the teacher used direct instruction while writing on the board and used Mathematics textbooks to present lessons to the learners only. Further, learners in the control group wrote the same activities as the learners in the experimental group. At the end of the intervention, learners in the control group were also given a posttest to write about the whole topic of fractions. Ten learners from the experimental group were randomly selected in a focus group interview (Appendix H) to gather qualitative data on what effect models have on the learning of fractions of the learners. The data was thematically analyzed.

### 3.6 Data collection procedures

A primary school in the Onankali Circuit was selected through the application of a purposive sample technique. The researcher started by explaining the research purpose to the participants and informing them that they have the right to withdraw from the study if need be. The researcher also informed the participants that they would be writing two tests, the pre-test and the post-test; and it is only the experimental group that would be taking the interview. The researcher administered the pre-test to the 30 learners who were chosen to participate in the study before utilizing models to assess their comprehension of fractions. The researcher taught fractions to 30 learners (experimental group) for seven weeks using teaching models (area, rectangular, and number line) while observing how they solved issues involving fractions. The other learners of the control group received instruction for the same amount of time as experimental group using textbooks and algorithms, only. Fifteen lessons were presented to each group and each lesson was 40 minutes long. A post-test was then administered to see how learners' understanding of fractions changed after using the models. Following that, as a follow-up to the tests' results, interview sessions with the 10 Grade 7 from the experimental group were conducted. Participants were asked to give consent to the use of a voice recorder to record the sessions. Comparative quantitative data were gathered using a pre-and post-test quasi-experimental design with two groups for the study sample. Both groups were taught the same competencies and received the same notes and exercises on fraction concepts at the end of every lesson.

### 3.7 Data analysis

An SPSS for the paired t-test was used to test the effects of using models to enhance learners' conceptual understanding of fractions. An alpha value of .05 was used. If the p-values were less than that or equal to the alpha ($p \leq .05$) then the null hypothesis ($H_0$) would be rejected. If the p-values were greater than alpha ($p > .05$), then the researcher would accept the null hypothesis. The null hypothesis ($H_0$) suggested that there are no statistically significant differences in the performance of Grade 7 learners' understanding of fractions between those taught using models and the ones taught using other teaching methods such as presentations and textbooks, thus the null hypothesis is accepted.

Besides, qualitative data from the interview guide were analysed using a thematic approach. Thematic analysis is a method of identifying patterns, themes, and recurring ideas within qualitative data. Interviews were conducted to acquire qualitative data. The participants' responses to the interviews were audio recorded and analyzed subsequently. The researcher listened to the recorded audio of interview participants multiple times to gather what they said during the interviews and write down their responses. Furthermore, the researcher identified themes emerging from the data, as there were similarities in some of the responses. The following developed as themes and were sorted or classified as follows: (1) the concept of fractions, (2) challenges faced when learning fractions, (3) common methods used to teach fractions, and (4) the effects of using models on learners' understanding of fractions. The data provided by the interviewees was representative and adequate for answering the study's main question and sub-questions.

### 3.8 Ethical considerations

The committee for postgraduates at the University of Namibia granted the ethical clearance certificate (Appendix A). The research permission letter was granted from Postgraduate Research Support Services at the University of Namibia (Appendix B). The Ministry of Education, Arts and Culture (MoEAC), the Oshikoto Regional Office, the school administrator, and the learners were all contacted for permission letters (Appendix C, Appendix D). The permission to conduct data was then granted to the researcher by the director of Education for Oshikoto Region and from the school principal of the school where the study was carried out. Before the implementation of educational interventions, learners and their parents/guardians were asked to sign consent forms (Appendices E and F) and they signed. In addition, detailed information regarding the study's goal was provided to participants so they may decide whether or not to participate. The employment of fictitious identities in this study (L1, L2, and

L3) ensured the privacy and anonymity of the research participants. Participants were asked for consent before the researcher recorded their interview and they agreed. The ability to discontinue participation at any time was made known to the participants. Lastly, the researcher used a password to protect participant data on the researcher's computer. The data was kept secure for two years before being completely deleted from the computer.

### 3.9 Conclusion

This chapter detailed the data collection approach employed in the research on how employing models can improve grade 7 learners' understanding of fraction fractions. Pre- and post-tests, as well as interview schedules, served as the study's two research tools. The dependability or internal consistency of the data obtained from the pre-and post-tests and focus group interviews was evaluated by triangulating quantitative data with qualitative data and vice versa. In addition, this section also explained the population, sample, and methodology used in this study. Before a section on population sample and ethical considerations, the chapter also addressed the research context. The research findings based on quantitative and qualitative data are presented in the next chapter.

# CHAPTER 4: RESULTS PRESENTATION

## 4.1 Introduction

This chapter focuses on the inquiry's findings and the subsequent data analysis. The Grade 7 learner demographics from the selected school are presented, providing an overview of the participants in this study. Out of the initial 70 pupils considered for the sample, 60 learners were ultimately divided into two groups: 30 learners formed the experimental group, receiving instruction using models, while the remaining 30 learners constituted the control group, receiving no model-based instruction. Furthermore, ten learners were randomly selected from the total sample and interviewed to gather additional insights. To ensure clarity and facilitate comprehension, the demographic characteristics of the learner population are presented in both percentages and numerical values. This approach allows for a comprehensive understanding of the learner composition within the study.

## 4.2 Biographical information of participants

Figure 5 displays the biographical data of the individuals from the two classes that were chosen to create the experimental and control groups. In all, 70 seventh-grade learners from the chosen school 60 learners took part in the research. A total of 30 learners participated in the control group, including 10 males and 20 females. While a total of 30 participated in the experimental group, including 7 males and 23 females. The participants were coded as L1 up to L60. Participants' ages ranged between 12-15 years.

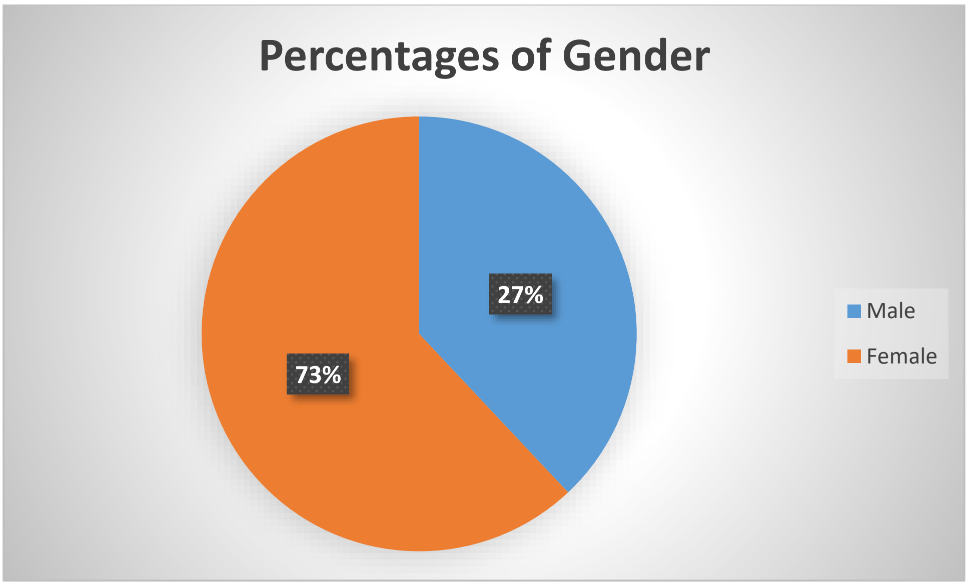


**Figure 5: The gender representation of Participants**

### 4.3 Presentation of quantitative data

This section displays the data analysis and study conclusions. The gathered data is displayed using tables, percentages, and frequencies in a way that draws attention to the variations between the experimental and the control groups' average scores.

#### 4.3.1 Experimental and control group pre-test scores

This section displays the pre-test results for the experimental and control groups. The findings of the pre-test are presented in the Tables below. In this study, there were 60 learners in total, and they were divided into two groups: an experimental group and a control group. Each group comprised 30 learners. The researcher administered a pre-test and post-test to both groups, with each test having a total of 30 marks. In the experimental group, the learners were assigned codes from L1-30 & for the control group learners were assigned codes from L31-L60.

**Table 2: Pre-test & Post-test results for Experimental Group**

| Learner's Code | Experimental group | |
|---|---|---|
| | **Pre-test** | **Post-test** |
| L1 | 8 | 26 |
| L2 | 13 | 29 |
| L3 | 8 | 28 |
| L4 | 6 | 26 |
| L5 | 8 | 21 |
| L6 | 14 | 23 |
| L7 | 10 | 22 |
| L8 | 6 | 17 |
| L9 | 7 | 25 |
| L10 | 12 | 27 |
| L11 | 10 | 18 |
| L12 | 8 | 19 |
| L13 | 13 | 30 |
| L14 | 6 | 20 |
| L15 | 8 | 24 |
| L16 | 8 | 17 |
| L17 | 7 | 23 |
| L18 | 5 | 26 |
| L19 | 20 | 30 |
| L20 | 7 | 15 |
| L21 | 10 | 29 |
| L22 | 6 | 25 |
| L23 | 6 | 20 |
| L24 | 12 | 28 |
| L25 | 14 | 30 |
| L26 | 7 | 20 |
| L27 | 12 | 29 |
| L28 | 22 | 30 |
| L29 | 6 | 21 |
| L30 | 10 | 29 |
| **Total** | **289** | **727** |

The pre-test average was calculated using the formula**: Mean =** $\frac{\boldsymbol{Sum\ of\ Values}}{\boldsymbol{Total\ number\ of\ Values}}$**.**

**Experimental Group Pre-test Mean =** $\frac{\mathbf{289}}{\mathbf{30}}$ **= 9.6**

**Experimental Group Post-test Mean =** $\frac{\mathbf{727}}{\mathbf{30}}$ **= 24.2**

**Table 3: Experimental Group Pre-test and Post-test Mean**

| Group | Mean on Pre-test /30 | Mean on Post-test /30 |
|---|---|---|
| Experimental Group | 9.6 | 24.2 |

Based on the information provided in Table 2, it is evident that the post-test scores (average of 24.3) were higher compared to the pre-test scores (average of 9.6). This suggests that there has been an improvement or increase in scores from the pre-test to the post-test.

**The Equation below calculates the Standard Deviation and Variance of the Experimental Group Pre-test**

Standard Deviation, σ: **4.0123420702738**

Count, N: 30
Sum, Σx: 289
Mean, μ: 9.6333333333333
Variance, $\sigma^2$: 16.098888888889

As mentioned above, a universal formula for computing the mean was used to arrive at this result. Table 3 below evaluates the following hypotheses using a t-test to see if there is a statistically significant difference:

**$H_0$** The experimental group's pre-test average performance does not differ statistically significantly from the control group.

**$H_1$** The experimental group's and the control group's pre-test average performance differs statistically significantly.

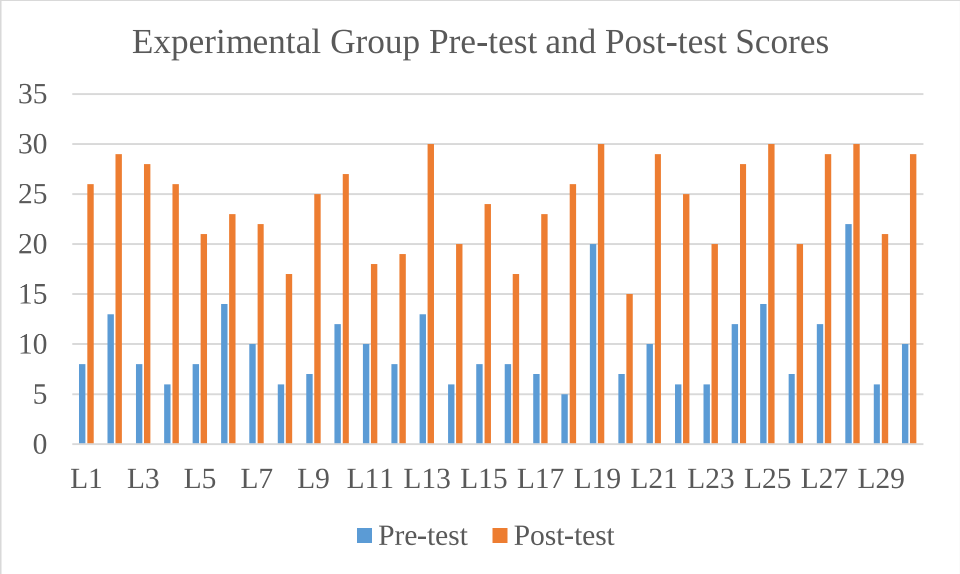


**Figure 6: Experimental Group Pre-test & Post-test Scores**

The analysis of Figure 6 reveals a significant difference between the pre-test and post-test scores of each learner, as evidenced by the consistently higher post-test scores depicted by the bars. This upward shift in scores indicates an improvement in learners' performance following the intervention, highlighting the intervention's effectiveness in enhancing learners' abilities and fostering their development and skill acquisition. The disparity between the pre-test and post-test scores demonstrates a noticeable transformation, with the post-test scores reflecting substantial progress compared to the initial baseline. Overall, the visual evidence strongly supports the conclusion of a statistically significant difference and underscores the positive impact of the educational or training program implemented.

The t-critical value depends on the desired significance level (alpha) and the degrees of freedom. Let us assume a significance level of 0.05 (5%) for this one-tailed test.

Using a t-distribution table, the researcher finds the t-critical value for a one-tailed test with a significance level of 0.05 and the degrees of freedom calculated in Step 3.

For a significance level of 0.05 and 29 degrees of freedom, the t-critical value is approximately 1.699 (rounded to three decimal places).

In this case, the t-critical value for a one-tailed test at a significance level of 0.05 is approximately 1.699, and the t-calculated value is approximately 13.678. The results are depicted in the table below.

**Table 4: Experimental Statistical Value**

| | **EXPERIMENTAL GROUP** | |
|---|---|---|
| **Statistical value** | **Pre-test** | **Post-test** |
| **Mean ($\mu$)** | 9.6 | 24.2 |
| **Standard Deviation ($\sigma$)** | 4.01 | 4.50 |
| **Variance ($\sigma^2$)** | 16.09 | 24.23 |
| **t-critical** | 1.699 | 1.699 |
| **t-calculated** | 13.678 | 13.678 |

Based on the provided information in Table 3 above, the researcher conducted a t-test comparing the mean scores of the experimental group and the control group. The t-calculated value obtained was 13.678, while the t-critical value was 1.699. Since the t-calculated value was greater than the t-critical value, the researcher rejected the null hypothesis ($H_0$) for the experimental group. This suggests that there is a significant difference between the mean scores of the experimental group and the control group. Rejecting the null hypothesis indicates strong evidence in support of the alternative hypothesis, which indicates a significant difference between the mean scores of the two groups.

The table below shows the control group pre-test and posttest for the group of 30 learners whereby every learner was assigned a code from L31-L60 to represent the learner in the control group. The two test scores were presented as follows.

**Table 5: Control Group Pre-test and Post-test Scores**

| **Learner's Code** | **Control group** | |
|---|---|---|
| | **Pre-test** | **Post-test** |
| L31 | 6 | 8 |
| L32 | 11 | 11 |
| L33 | 7 | 12 |
| L34 | 10 | 12 |
| L35 | 11 | 11 |
| L36 | 16 | 19 |
| L37 | 11 | 10 |
| L38 | 7 | 7 |
| L39 | 11 | 9 |
| L40 | 6 | 9 |
| L41 | 10 | 14 |
| L42 | 12 | 17 |
| L43 | 7 | 5 |
| L44 | 12 | 11 |
| L45 | 10 | 11 |
| L46 | 16 | 20 |
| L47 | 11 | 10 |
| L48 | 11 | 12 |
| L49 | 3 | 2 |
| L50 | 6 | 6 |
| L51 | 7 | 6 |
| L52 | 6 | 6 |
| L53 | 8 | 12 |
| L54 | 7 | 6 |
| L55 | 4 | 7 |
| L56 | 6 | 8 |
| L57 | 7 | 8 |
| L58 | 0 | 1 |
| L59 | 2 | 1 |
| L60 | 6 | 5 |
| **Total** | **247** | **276** |

The researcher determined the degrees of freedom for the given data by taking into account the number of observations in each group. There are two categories: pre-test scores and post-test scores. The formula used to calculate degrees of freedom is Number of observations – 1, n-1

For the pre-test scores group, which has 30 observations:

Degrees of freedom = 30 - 1 = 29

Similarly, for the post-test scores group, also consisting of 30 observations:

Degrees of freedom = 30 - 1 = 29

Consequently, both the pre-test scores and post-test scores groups have 29 degrees of freedom.

**Control Group Pre-test Mean =** $\mathbf{\frac{247}{30} = 8.2}$

**Control Group Post-test Mean =** $\mathbf{\frac{276}{30} = 9.2}$

**Table 2: Control Group Pre-test & Post-test Mean**

| Group | Pre-test /30 | Post-test /30 |
|---|---|---|
| Control Group | 8.2 | 9.2 |

Based on the information provided in Table 3, it is evident that the post-test scores (average of 9.2) were higher compared to the pre-test scores (average of 8.2). This suggests that there has been an improvement or increase in scores from the pre-test to the post-test.

**The Equation below calculates the Standard Deviation and Variance of Control Group Pre-test**

**Standard deviation = sqrt (sum((x - mean)^2) / (n - 1))**

Standard Deviation, σ: **3.630273941301**

Count, N: 30
Sum, Σx: 247
Mean, μ: 8.2333333333333
Variance, $\sigma^2$: 13.178888888889

**The Equation below calculates the Standard Deviation and Variance of the Control Group Post-test**

Standard Deviation, σ: **4.5416590214003**

Count, N: 30
Sum, Σx: 276
Mean, μ: 9.2
Variance, $\sigma^2$: 20.626666666667

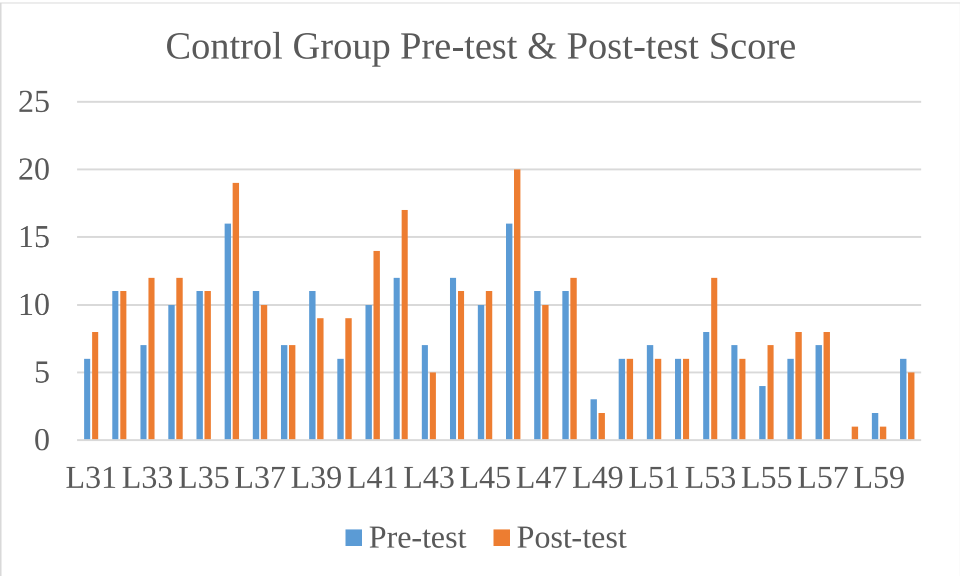


**Figure 7: Control Group Pre-test & Post-test Representation**

As depicted in Figure 7, a significant difference was observed between the pre-test scores and post-test scores for each learner. This finding suggests that there was a notable improvement or change in performance from the initial assessment to the subsequent evaluation for all participants.

The t-critical value depends on the desired significance level (alpha) and the degrees of freedom. Let us assume a significance level of 0.05 (5%) for this one-tailed test.

Using a t-distribution table, the researcher finds the t-critical value for a one-tailed test with a significance level of 0.05 and the degrees of freedom calculated in Step 3. For a significance level of 0.05 and 29 degrees of freedom, the t-critical value is approximately 1.699 (rounded to three decimal places).

In this case, the t-critical value for a one-tailed test at a significance level of 0.05 is approximately 1.699, and the t-calculated value is approximately 1.825 and the results are depicted in the table below.

**Table 6: Control Group Statistical Values**

| | **CONTROL GROUP** | |
|---|---|---|
| **Statistical value** | **Pre-test** | **Post-test** |
| **Mean ($\mu$)** | 8.2 | 9.2 |
| **Standard Deviation ($\sigma$)** | 3.63 | 4.54 |
| **Variance ($\sigma^2$)** | 13.17 | 20.62 |
| **t-critical** | 1.699 | 1.699 |
| **t-calculated** | 1.825 | 1.825. |

Based on the information provided, a one-tailed test with a significance level ($\alpha$) of 0.05 was employed for the control group. The t-critical value given for the control group is 1.699. For a one-tailed test, the absolute value of the calculated t-value is compared to the t-critical value. In this case, the t-calculated value is 1.825, and the t-critical value is 1.699. To determine whether there is or no statistically significant difference the t-tests presented in Table 3 and 6, test the following hypotheses:

**$H_0$** There are no statically significant differences in the mean score between the control group and the experimental group before the intervention.

**$H_1$** There are statically significant differences in the mean score between the control group and the experimental group before the intervention.

By consulting a t-distribution table for a 95% confidence level with 29 degrees of freedom, the researcher determined that the t-calculated value exceeds the t-critical value for both the pre-test and post-test in the control group. This implies that the difference in the average performance of the control group on both the pre-test and post-test is not statistically significant. Consequently, the null hypothesis cannot be rejected, indicating that there is no a statistically significant difference in the average performance of the control group between the pre-test and post-test. The observed differences above clearly showed that there is a need for learners to use models when learning the concept of fractions.

## 4.4 Presentation of qualitative data

This section presents the qualitative data obtained from interviews conducted with a group of 10 learners before the commencement of the experiments. The findings of qualitative data are presented thematically from the themes, which emerged from the study. These themes were (1) the concept of fractions, (2) challenges faced when learning fractions, (3) common methods used to teach fractions, and (4) the effects of using models on learners' understanding of fractions.

### 4.4.1 The concept of fractions

During the interview, learners were asked to define fractions. L2 defined fractions as *"a part of a whole whereby the number is expressed as a quotient, in which the denominator divides the numerator".*

However, L4 defined fractions *as a concept with three parts: proper fractions where the number on top is smaller than the number down, e.g.*$\frac{1}{2}$*, and an improper fraction with the number down bigger than the number on top, e.g.* $\frac{9}{2}$ *and mixed numbers where there is a whole number, and a proper fraction, e.g.* $7\frac{1}{3}$*".*

Nonetheless, L1 explained that, "*a fraction represents equal parts of a whole".*

The responses from the learners indicate a notable level of comprehension and a well-defined understanding of fractions among the majority of them. Based on these responses, it can be inferred that learners have varying definitions and understandings of fractions. While Learner 1 emphasizes the concept of fractions representing equal parts of a whole, Learner 2 focuses on fractions as quotients. Learner 4 demonstrates a more comprehensive understanding by recognizing different types of fractions. Addressing these different perspectives through clear explanations, examples, and practice opportunities can help learners develop a deeper understanding of fractions and their various representations.

In the interviews, learners were asked to describe how fraction names are taught to them. L9 specifically mentioned that

"*Sometimes teachers use terms like one out of two, the other teacher will say one half and another one would say one over 2, as you move from one Grade to another you will end up being confused about the concept of fractions.*"

L4 clarified that "*fraction names are also confusing, names like "thirds" (nobody knows that it means a whole divided into three parts) because they are not well explained to us when teachers first introduce the topic of fractions to learners".*

When learners from the focus group interview were asked to read the fraction, L7 read it as, "two *out of nine*". In contrast, L4 read it as "*two over nine*" and explained that, *"I read it as two out of nine because these are two different unrelated whole numbers".*

Based on the responses provided, it can be concluded that there is a lack of consistency and clarity in how fraction names are taught to the learners. Different teachers use various terms, such as "one out of two," "one half," or "one over 2," which can lead to confusion among learners as they progress from one grade to another. Learners 9 and 4 raised concerns about inconsistent terminology in fractions, leading to confusion and hindering understanding. Learner 4 highlighted the unclear explanation of "thirds," causing uncertainty. This lack of clarity makes it challenging to establish a strong foundation in fractions. In a focus group interview, learners disagreed on how to read a fraction, with Learner 4 perceiving the numerator and denominator as separate whole numbers, possibly indicating a limited understanding of their fractional relationship.

The conclusion drawn from these responses is that there is a need for consistent and clear instruction in teaching fraction names. The varied terminology used by different teachers, coupled with insufficient explanations, can contribute to confusion and hinder the learners' grasp of fractions. Addressing this issue through standardized and comprehensive instruction can help learners develop a solid understanding of fraction names and their corresponding meanings, enabling them to work with fractions more confidently and accurately.

### 4.4.2 Challenges faced when learning fractions.

All the ten learners who were interviewed for this study described the difficulties they had when learning fractions in Grade 7. The challenges mentioned were (a) confusing the denominator and numerator of the fractions, (b) finding equivalent fractions, (c) addition and subtraction of fractions, (d) placing fractions on a number line, and (e) comparing and ordering fractions. The following four sub-themes comprise these challenges:

#### 4.4.2.1 Mistaking the fractions' numerator and denominator

This challenge was supported by L6, who clarified that "*I always confuse the denominator and numerator of the fractions thinking that the equal parts a model is divided into represents the numerator instead of the denominator*."

Similarly, L3 said, "*Sometimes we only solve fractional problems given to us without a clear understanding of the key terms in the questions*".

On the contrary, L1 acknowledged, "*We are taught fractions as one number over another without being explicitly told which number is the denominator and which the numerator is".*

There are several challenges learners face in understanding fractions. Learner 6 struggled to differentiate between the numerator and denominator, mistakenly considering the equal parts as the numerator instead of the denominator. This confusion indicates a lack of clear understanding of the roles and relationships of these components in fractions. Learner 3 emphasizes the difficulty of solving fraction problems without a proper grasp of the key terms involved, indicating that learners may approach fraction-related questions without a solid vocabulary foundation. Learner 1 points out the lack of explicit explanation regarding the numerator and denominator, as fractions are taught as "one number over another" without clarifying their specific roles. This inconsistent instruction hinders learners' comprehension and proficiency in working with fractions.

Based on these responses, it can be inferred that learners face challenges in understanding the relationships between the numerator and denominator in fractions. There is a need for clearer and more explicit instruction, including consistent explanations of key terms, to enable learners to develop a solid understanding of fractions and confidently navigate fraction-related problems. By addressing these challenges through improved instruction, learners can enhance their comprehension and proficiency in working with fractions.

#### 4.4.2.2 Equivalent fractions

In the interview, learners were asked why they find it challenging to master equivalent fractions.

L6 responded, "*The most challenging component of fraction operations is equivalent fractions*".

This supports L2, who said, "*Due to the lack of a corresponding whole number, it is difficult to relate fractions to whole numbers since there is no whole number equal to* *a fraction. For example,* $\frac{1}{8}$ *is merely just one-eighth and not equal to any whole number".*

Likewise, L10 revealed that "*Before learning the use models to solve fraction problems, I thought that fractions with different numerators and denominators cannot be equal e.g.* $\frac{1}{2}$ *and* $\frac{3}{6,}$ *thus why I always think a fraction with the biggest denominator is always the biggest.*" Conversely, L8 explained, "*I always forget to multiply or divide the entire fraction by the common factor when finding same fractions, thus why she struggled with finding similar fractions".*

Learner 2 highlighted the difficulty learners' face in relating fractions to whole numbers, as fractions like 1/8 do not have an exact whole-number counterpart. Learner 10 reveals a misconception about fractions with different numerators and denominators, initially believing they cannot be equal, hindering their understanding of equivalent fractions. Learner 8 struggles with applying strategies to find equivalent fractions, often forgetting to multiply or divide the entire fraction by a common factor. These challenges in relating, understanding, and applying strategies for equivalent fractions can impede learners' proficiency in working with them.

Based on these responses, it can be inferred that learners face challenges in mastering equivalent fractions. These challenges stem from difficulties in relating fractions to whole numbers, misconceptions about fractions with different numerators and denominators, and struggles in applying the appropriate strategies for finding equivalent fractions. Addressing these challenges through targeted instruction, clarifying misconceptions, and providing practice opportunities can help learners develop a deeper understanding of equivalent fractions and enhance their proficiency in working with them.

#### 4.4.2.3 Fraction addition and subtraction

This challenge is in support of L5, who noted that*" the most challenging part of adding and subtracting fractions is converting fractions to common denominators; one needs to be sure that the denominators are the same before adding or subtracting fractions"*. Nevertheless, L8 further added, "*Teachers were supposed to teach us that if you multiply the top and bottom of a fraction by the same number, the value stays the same"*.

L4 agreed with this. He noted, "*It is hard to find the Lowest Common Multiple of the denominators of fractions too because one does not know whether to divide or multiply to make all the fractions the same.*"

L6 assumed that "*it is also hard to memorize the rules for adding and subtracting fractions"*.

Learner 5 identified converting fractions to common denominators as the most challenging aspect of adding and subtracting fractions, indicating a struggle with ensuring all fractions have the same denominator for accurate operations. Learners 8 and 4 mentioned a lack of understanding regarding fraction multiplication and its connection to equivalent fractions, an essential concept for finding common denominators. Learner 4 also expressed difficulty in finding the lowest common multiple (LCM) as part of the process. Learner 6 highlighted the challenge of memorizing the rules for adding and subtracting fractions, suggesting difficulty in internalizing the specific steps and procedures involved in these operations.

Based on these responses, it can be inferred that learners encounter challenges in adding and subtracting fractions. These challenges include converting fractions to common denominators, understanding fraction multiplication, finding the lowest common multiple, and memorizing the rules for these operations. Addressing these challenges through clear explanations, practice opportunities, and conceptual understanding of fraction operations can help learners overcome difficulties and develop proficiency in adding and subtracting fractions.

#### 4.4.2.4 Entering numbers into a numerical line

Learners were also asked to place fractions on a number line.

L10 perceived, "*Placing fractions on a number line confuses me because I always need clarification about whether to divide the number line into equal parts of denominators or numerators.*

L3 noted, *"Placing mixed numbers on a number line is very hard because you do not know where one whole number ends.*"

When L7 was asked to place $\frac{7}{3}$ on a number line, the learner responded, "*I could not do that because the top number was more than three, and the number line goes up to one only*."

L10 echoed the same sentiment when they said, "Fractions *are completely different from whole numbers, and thus why we struggle to represent them on a number line."*

Learner 10 expressed confusion about dividing the number line based on denominators or numerators when placing fractions, indicating a lack of clarity in the process. Learner 3 highlighted difficulties in placing mixed numbers on a number line, particularly in determining the division between whole numbers. Learners 7 and 10 both had misconceptions about the limits of the number line for representing fractions, with one struggling to place a fraction due to the numerator being greater than the denominator, and the other seeing fractions as entirely separate from whole numbers. These misconceptions and perceived differences between fractions and whole numbers can hinder learners' ability to accurately represent fractions on a number line.

Based on these responses, it can be inferred that learners face challenges in placing fractions on a number line. These challenges include confusion about dividing the number line, difficulty with placing mixed numbers, misconceptions about the limits of the number line for fractions, and perceptions of fractions as fundamentally different from whole numbers. Addressing these challenges through explicit instruction, visual representations, and conceptual understanding can help learners develop the skills to accurately place fractions on a number line and enhance their overall understanding of fractions on the number line.

#### 4.4.2.5 Comparing and arranging fractions

Additionally, learners were required to compare and sort fractions in both ascending and descending order.

When asked to explain his thinking and reasoning behind this challenge, L3 said, "*It is difficult to compare and arrange fractions with different denominators. I always guess because the rules for comparing and ordering fractions are too many and hard to memorize.*"

L3 further added, *"Sometimes I think the fraction with the smallest denominator is the smallest, which is always not correct."*

Similarly, L5 indicated, "*I organized the fractions according to the size of the numerators and filled in the gaps on the number line from left to right when they all* *have the same denominator*. L6 observed, *"placing mixed numbers on the number line is very tricky because you do not know at which point you will get the whole number and where to plot the remaining proper fraction."*

Learner 3 struggled with comparing fractions with different denominators, often guessing due to the challenging rules for comparing and ordering fractions. They also held a misconception that the fraction with the smallest denominator is always the smallest. Learner 5 mentioned sorting fractions based on numerators and using the number line for fractions with the same denominator, but this approach may not be effective for fractions with different denominators or placing mixed numbers on a number line. Learner 6 noted challenges in placing mixed numbers on a number line, unsure of where to plot the whole number and the remaining fraction. These difficulties in comparing, understanding denominators, and placing mixed numbers accurately on a number line can hinder learners' proficiency in working with fractions.

Based on these responses, it can be inferred that learners face challenges when comparing and sorting fractions. These challenges include difficulties with comparing fractions with different denominators, misconceptions about the relationship between denominator size and fraction magnitude, reliance on numerators and number line representations, and struggles with placing mixed numbers on a number line. Addressing these challenges through explicit instruction, practice with comparing fractions, and visual representations can help learners develop a better understanding of the rules for comparing and sorting fractions and enhance their overall proficiency in this skill.

### 4.4.3 Common methods used to teach fractions

When learners were asked how often their Mathematics teacher uses models to teach fractions, L1 responded, "*Teachers do not use models; they teach us to memorize rules*.**"**

L7 added, "My *Mathematics teacher never used models to present the topic of fractions. The only thing I can remember is us shading parts of circles in most lessons about fractions, but it was not clearly explained to us that they are models.*"

Despite this, L8 and L2 underscore that, in most cases, their teacher plays videos to them showing how the computation of fractions is carried out.

L10 said, "Our *teacher prefers writing problems on the chalkboard and explaining how she got the answers without any illustrations or pictures. This confuses me because it allows us to listen only and not to participate in the lesson; this is the reason why we still do not understand the concept of fractions*."

Learners, such as L1 and L7, reported limited use of models in their Mathematics classes for teaching fractions. L1 mentioned a focus on memorizing rules, while L7 described shading parts of circles without clear explanations that these were models. This suggests that visual models may not be extensively utilized or explicitly emphasized in the instruction of fractions in these cases. Instead, learners like L8 and L2 mentioned teachers relying on videos to demonstrate computational procedures for fractions. However, Learner 10 expressed confusion because their teacher predominantly used written problems on the chalkboard without illustrations or pictures, limiting active participation and hindering their understanding. These observations highlight the potential benefits of incorporating more interactive and visually oriented teaching methods that actively engage learners with visual models for a deeper comprehension of fractions.

Based on these responses, it can be inferred that the use of models to teach fractions varies among teachers. Some teachers may rely more on memorization, procedural explanations, or limited visual representations, while others may incorporate videos or visual models. However, the limited use of models and the lack of active participation through visual representations may hinder learners' understanding and comprehension of fractions. Encouraging teachers to utilize more visual models, engage learners actively, and provide clear explanations can enhance the learning experience and foster a deeper understanding of fractions.

### 4.4.4 Effects of using models to teach fractions

When learners were asked to explain which method they prefer when learning fractions, L4 said, "*I prefer being taught using models because it allows one to think out of the box and relate fractions to everyday life, rather than memorizing rules that I do not understand."* Learners found models effective in learning fractions.

L5 concurs with this in her interview when she said, "*I prefer being taught using models because it involves hands in activities whereby you can cut objects into equal parts to see how a whole is formed. It is also interesting as I pay attention and get involved when I see models displayed on the chalkboard.*"

In addition, L9 explained, "*Models have helped me understand fractions better. Since you introduced us to the area and linear models, my performance in fractions has improved. I am suggesting that teachers should make the use of area or linear model often.*"

Because models enable learners to be actively engaged in the lesson, the researcher observed that most learners were more interested in the concrete models the researcher brought to class. On the contrary, L1 supports L9 by saying, "*Yes, models made me understand what fractions are for the past seven weeks. I can add and subtract fractions properly, I can compare and arrange fractions both in ascending and descending order and I can find corresponding fractions using area and rectangular models*."

Learners, including L4, L5, L9, and L1, expressed a preference for learning fractions with the help of models. They found that models allowed for creative thinking, real-life connections, active participation, and a better understanding of fractions. L9 specifically noted that their performance improved after utilizing area and linear models. The researcher also observed increased interest and active engagement when concrete models were incorporated into the lessons. These findings highlight the effectiveness of models in enhancing learners' understanding, performance, and overall engagement with fractions.

Based on these responses, it can be inferred that learners have a positive perception of using models to learn fractions. They find models to be effective in improving their understanding, actively engaging them in the learning process, and facilitating their ability to apply fraction concepts in various mathematical operations. Incorporating models, such as area and linear models, into fraction instruction can foster deeper comprehension, learner engagement, and better performance in working with fractions.

The table provided below offers an overview of the main themes and subthemes that have been derived from the qualitative data analysis. These themes and subthemes serve as an organized framework for understanding and interpreting the rich information gathered through qualitative research methods.

**Table 7: Themes and Subthemes from Data**

| Themes | Sub-themes |
|---|---|
| 1. The concept of fractions | ______ |
| 2. Challenges faced when learning fractions | (a) Mistaking the fractions' numerator and denominator.<br>(b) Equivalent fractions.<br>(c) Fraction addition and subtraction.<br>(d) Entering numbers into a numeric line<br>(e) Comparing and arranging fractions |
| 3. Common methods used to teach fractions. | ______ |
| 4. Effects of using models to teach fractions. | ______ |

**4.5 Summary of Findings**

The study conducted on teaching fractions using models provides valuable insights into the effectiveness of this instructional approach for Grade 7 learners. By employing a mixed-method approach, the researcher collected both quantitative and qualitative data to gain a comprehensive understanding of the effect of teaching fractions with models.

The quantitative data analysis involved comparing the performance of the experimental group which consisted of 30 learners, who received instruction using models, with the control group also made up of 30 learners, which was taught using traditional textbooks and algorithms. The post-test results revealed that the experimental group outperformed the control group, indicating that teaching fractions with models had a positive effect on learners' comprehension. For example, the experimental group may have demonstrated a higher average score on the post-test or a greater improvement from the pre-test to the post-test compared to the control group. To complement the quantitative findings, the researcher conducted focus group interviews with 10 learners to gather qualitative data. These interviews allowed the learners to express their experiences and perceptions regarding the use of models in learning fractions. The qualitative data supported the quantitative findings by revealing that learners found the use of models beneficial for understanding fractions. Through the interviews, learners may have shared specific instances where the models helped them grasp concepts that were previously challenging or confusing.

# CHAPTER 5

# DISCUSSIONS OF FINDINGS

## 5.1 Introduction

The primary findings from Chapter 4 on the effects of using models to enhance Grade 7 learners' understanding of fractions are discussed in this Chapter. The discussion compares experimental, and control group test scores, and the qualitative themes that emerged from the interviews. This Chapter will also link these findings to the theory of constructivism theory as described by Piaget (1964), which informed this study. The discussion of the findings starts with quantitative data, followed by qualitative data.

## 5.2 Quantitative data

This section presents the qualitative data, under the following subsections:

### 5.2.1 The evaluation of the pretest results for the experimental and control groups

When the results were compared, it was seen that the average estimate of the control group was 0.4 points lower than the experimental group. In addition, the pretest score of the experimental group (9.68) was close to that of the control group (8.2). Based on the study findings, the researcher could not reject the null hypothesis, it can be concluded that there was no significant difference in the mean score between the control group and the experimental group before the intervention. This means that there were no significant differences in the pretest scores for both the experimental and control groups.

The t-test computation and the comparison of the pre-and post-test mean scores for the control group are displayed in Table 1. The test scores of the pretest for the experimental and control groups showed that most learners scored almost the same marks. Some learners learned what models were after being exposed to them, as evidenced by the fact that they did not apply them to approach the problems in the pre-test, but they applied the models in the post-test. Since the majority of learners were unsure of the correct answers, the researcher believed that they ended up attempting more guesses on the pre-test questions. The findings of this study are consistent with Piaget's (1964), which maintains that for pupils to think by the knowledge they already possess, they will need information, concepts, ideas, or a network of connected ideas (in their cognitive schema).

### 5.2.2 Comparison of the findings of control group pre-test and post-test scores

The control group's average pre-and post-test results showed that the post-test findings were better than the pre-test findings. When a t-test was used to determine whether there were statistically significant differences between these scores, the estimated t-value was found to be greater than the critical value. The t-critical value for the two-tailed test with a degree of freedom (df) of 29 and a significance level of 95%  at = 0.05 and t = 1.6 in the statistical table. The control group's pre-test and post-test findings showed no statistically significant differences, as seen by the t-calculated value being below the t-critical value. Therefore the findings showed that there was no improvement in the learners ‘performance in the post-test of the control group. Since these learners were not taught using models, their understanding of fractions was not enhanced. The topic of fractions must be presented to learners with different models to enable the learners to grasp the concept well. The outcomes corroborated

Vida et al. (2018) findings, which claimed that fractions are a complicated collection of ideas in basic Mathematics.

### 5.2.3 Comparisons of the experimental groups’ pre-test and post-test test scores

Pre-test average scores were lower than post-test averages for an experimental group, according to a study of the pre-and post-test data. The calculated value of t was greater than the critical value, which was a value of 11.98, with df = 29 and $\alpha = 0.05$. A t-test was used to see if the pre-and post-test findings for this group differed in a statistically significant way. Similarly, t-test values are shown in Table 3. There was therefore a statistically significant difference between the experimental group's pre-test and post-test mean scores, as indicated by the estimated t, which is greater than the t-critical and rejects the null hypothesis. The data showed that after learners were exposed to learning models their performance improved compared to their performance in the posttest. It can be concluded that models affect learners' understanding of fractions.

Based on the previously mentioned data, the experimental group's learners demonstrated exceptional performance on the post-test. The post-test results were better with a 14.6 mean score difference between the pre- and post-tests. This might occur because learners from the experimental group had received instruction through models. Furthermore, on the post-test given to the experimental group, every learner did better than average; four of them received 30 out of 30 points (see Appendix E). The findings from the study and posttest results of the experiment group showed that learners’ understanding of fractions was enhanced, as they performed exceptionally well in the post-test compared to the pretest. According to constructivism, learners are not only empty vessels that need to be filled with knowledge (Noureen et al., 2020). The work of Shongwe (2021) provides credence to the claim that learners instead generate new information from a variety of experiences, knowledge, and beliefs. Van De Walle (2016) agreed that the findings of Shongwe (2021) were correct. Further, the use of models allows learners to allow learners to visualize the concepts that are being presented and learners should be allowed to create and structure their thoughts towards the topic. Based on these findings, the use of models to teach fractions to the learners can affect their performance positively.

### 5.2.4 Post-test scores from the experimental and control groups' comparisons

When the post-test results of the experimental group and control group were examined, it was seen that the average score of the experimental group (24.2) was higher than the control group (9.2). T-test analysis was performed to show that there was a significant difference between the post-test scores of the groups. The results show that the calculated t-value is larger than the t-value. While the average score of the experimental group before and after the test increased by 14.6, the score of the control group increased by only 0.4. For df = 29 and $\alpha = 0.05$, the t-test value of 13.678, which is higher than 1.69, is the critical value. Therefore, the researcher discovered a noteworthy distinction in the post-test results between the experimental and control cohorts. This concludes that there was a statistically significant difference between the learners taught using models and learners taught using other representations and textbooks and the study rejected the null hypothesis.

## 5.3 Qualitative data

### 5.3.1 The concept of fractions

Learners find it challenging to learn fractions; however, using models to learn fractions plays a vital role as this helps learners learn fractional terms by visualizing the pictures

(Moloto, 2021). Participants for this study believed that fraction names are also confusing because they are not effectively explained to them when teachers initially introduce the idea of fractions to learners. This study's findings supported Chamane (2016) suggestion that the concept "of fractions" has many definitions and representations; one can write them in symbols and the other in numbers or words. The participants' understanding of fractions could have been clearer; instead of orally defining a fraction, the learners preferred providing an example which means that learners are only taught how to write fractions without an understanding of what really fractions are. A few of the participants of this study had their notions of fractions related to breaking something up into smaller parts that may not be equal to each other. On the contrary, some participants said that they thought fractions were different from whole numbers, and that is the reason why they read them separately.

Teaching terminology associated with the operations involving fractions is another technique to improve learners' comprehension of the notion of fractions. Furthermore, it is clear that most learners did not understand the notion of fractions at the beginning of the intervention, and teachers just explained fractions as a part of a whole without going into detail. The conclusions in this study concur with those of Van de Walle et al. (2016); mistakes may result from learners' scope being skewed toward continuous whole or area representations of fractions. Meg (2018) echoes the same sentiment with the findings that teachers throw around words like "numerator" and "denominator" and sometimes forget that learners may not have internalized those terms and most likely have never heard of them. Equally important, most learners probably needed help understanding the concept of fractions. The confusion appears to stem from the definition of fractions that is stated in many textbooks, which defines fractions as "part of a whole."

Additionally, the research showed that using models could improve learners' conceptual grasp of fractions. Therefore, at the end of the teaching intervention, the learners in the experimental group could use models to explain fractions to their control group counterparts.

After being instructed to learn fractions using models, the interviewees' comprehension of the concepts altered, as evidenced by their ability to read the proper names of the fractions. The results of Moyo and Machaba's (2021) investigation corroborate those of this one, which showed that they suggested a developmental intervention using concrete tools to increase knowledge of fractions before inductively leading learners to create algorithms and moving on to the more abstract uses of fractions necessary in lessons. As Getenet and Callingham (2019) have demonstrated, if the teacher uses language that is erroneous or unclear while describing fraction constructs, learners may continue to use that language to express fractions and may not fully comprehend the concepts.

### 5.3.2 Common methods used to teach fractions

This was evident during the interview that the researcher had with the ten selected learners from the experimental group. One learner revealed that their teacher did not use models to teach them fractions but taught them to memorize rules. Naidoo and Hajaree (2021) suggest that the reproductive teaching of Mathematics through the mechanistic repetition of different textbook rules is the reason for learners' inadequate mental comprehension of fractions further support. Ubah (2021) further underscores that Mathematics teachers should use suitable teaching tactics, such as a learner-centered approach, activity-based learning, and employing native languages, to assist learners in understanding fractions conceptually.

Moreover, learners indicated that in most of their lessons about fractions, they are only told by their teachers to shade parts of circles, with no justification that circles are models. The findings of this study also indicated that in most cases, their teachers play videos to them showing how the computation of fractions is done. The researcher agreed with Abdul et al. (2021) study findings that underscored that cooperative learning is successful in eradicating learners' misconceptions regarding fractions and sharing their knowledge and ideas. Peer encouragement is crucial. When different models are utilized, learners appear to be more exploratory, which improves their knowledge of fractions (Fauzi & Suryadi, 2020).

Participants in that this study mentioned, teachers prefer writing problems on the chalkboard and solving them without illustrations or pictures. Learners further pointed out that this confuses them because it allows them to listen only and not to participate in the lesson. Albin (2019) also concurs with this, that the introduction of rules be postponed until learners have achieved a comprehensive knowledge of the idea. Van de Walle (2016) noted that presenting the topic of fractions to learners with textbooks only without the use of teaching models limits their understanding of fractions. Knowing the fraction concept first is more powerful and generative than memorizing mathematical techniques (Moloto & Machaba, 2021).

### 5.3.3 Challenges Faced When Learning Fractions

This research found various and diverse challenges that prevent Grade 7 learners from understanding fractions better. One of the challenges identified was confusing the denominator and numerator of the fractions; learners assume that the equal parts into which a fraction is divided represent the numerator instead of the denominator. Similarly, some participants said they only knew the number on top and the number down but needed to be made aware of which one was the denominator and which one was the numerator. This is consistent with Abul et al. (2021) studies found that learners thought that a fraction's numerator was a whole number and that the denominator and numerator were independent integers, and could not identify a common denominator. These findings clearly showed that learners at every Grade level confuse the numerator and denominator.

However, a few participants stated that before learning how to use models to solve fractional problems; they believed that fractions with different denominators and numerators, such as 1-2, could not be equal. As a result, they believed that fractions with different denominators were distinct from one another. Finding analogous fractions can be difficult because, as one participant said, one must always remember to multiply or divide the whole fraction by the common factor. This makes it difficult to locate similar fractions. Van de Walle (2013) states that when practicing addition and subtraction with fractions, learners should utilize their understanding of fraction equivalency.

Another issue that this study revealed is the difficulty of adding and subtracting fractions; almost all the 10 participants confirmed that the most challenging part of adding and subtracting fractions is converting fractions to common denominators, where one needs to be sure that the denominators are the same before adding or subtracting. If you multiply the top and bottom of a fraction by the same number, the value stays the same. Another participant assumed that it is also hard to memorize the rules for adding and subtracting fractions. The fact that fractions are less natural than whole numbers is one reason why learners need help understanding fraction operations. The data analysis also revealed that some of the participants in this study used the lowest common denominator method erroneously to add fractions with diverse denominators before being exposed to models. This usage of incorrect fraction addition strategies corresponds with Simon (2018), who argues that many learners must fully comprehend the underlying ideas to adopt processes like the lowest standard denominator method. To minimize this constraint, Siegler (2014) proposes that fractions be taught with an emphasis on strengthening learners' conceptual grasp of fraction magnitudes.

Placing fractions on a numeric line was also discovered to be difficult for the participants to grasp fractions adequately. Participants in this study confirmed that arranging fractions on a number line is difficult since they were always stuck dividing the number line into equal parts of denominators or numerators. One of the participants stated that arranging mixed numbers on a number line is challenging since you need to know where one complete number ends. When asked to place $\frac{7}{3}$ on a number line, the participant pointed out that it could not be done because the top number was greater than 3, and the number line only goes up to one. The learners' experience with number lines is limited to whole numbers, according to the interview, and their prior understanding of fraction representation was primarily concerned with shading.

Most learners stated that they liked to color the sections of the circle partitions. This implies that they are often taught fractions through shapes instead of number lines. As revealed by Van de Walle et al. (2013), finding the value of a fraction on the number line is a difficult skill for learners to master. Shongwe (2021) further claims that some learners utilize the whole number line as a unit of measurement and fail to scale. Witherspoon (2019) looked at fifth graders' comprehension of fractions on the number line in a follow-up study. Plotting the numbers 1-4 on a number line starting at - 13 was one of the ideas that did not work well., recognizing a non-routine number line on a scale of 1-4, graphing a unit fraction beside an equal fraction, and graphing an improper fraction on a shared number line.

Lastly, it was shown that learners had difficulty organizing and comparing fractions. Learners should understand how fraction operators and fractions work and how they relate to each other, as they can compare and order fractions based on their exponents or equivalents. The replies from the participants revealed that, instead of viewing the fractions as pieces of a whole, they regarded them as a pair of two whole numbers. For example, Shongwe (2021) indicated that most learners who want to understand more about fractions and fractional operations see fractions as two whole numbers rather than a single entity. Furthermore, the results of the investigation showed that learners who arranged fractions according to the numerator neglected the denominators, which made the fraction, grow as the numerator.

Every participant acknowledged that ordering and comparing fractions with different denominators was difficult; one participant said they were always forced to guess because there were so many different rules to memorize. It is commonly wrong, according to many participants, to assume that the fraction with the smallest denominator is also the smallest. As suggested by L5, order the fractions according to the size of the numerators, and if all the fractions have the same denominators, fill in the gaps on the number line from left to right. Plotting mixed numbers on a number line can also be quite difficult since, in the opinion of one participant, it is still unclear at what point you would receive the entire number. The learner's encounters with numbers.

### 5.3.4 Effects of using models to teach fractions

The analysis showed that using models significantly influenced the learners' comprehension of fractions, which resulted in improved performance on the post-test. Participants said that rather than remembering rules they do not understand; they prefer to learn about fractions through models since it encourages creative problem-solving. Learners found fraction learning to be successful with models. L5 echoed this in the interview by saying, "I like being taught through models since it involves hands-on activities that allow you to break objects into equal sections to show how a whole is made. When I see models being exhibited on the chalkboard, it is also exciting because I pay attention and become an active participant in the lesson."

Based on the aforementioned, L9 stated, "Models have improved my understanding of fractions. My proficiency in fractions has considerably increased when you introduced us to the area and linear models. I advocate for teachers frequently using the area or linear model." Because models encourage active participation in the lesson, the researcher found that most learners showed a greater interest in the concrete models she brought to class. Contrarily, L1 concurs with this L9 when he says, “The use of rectangular, area and number line models have made us understand how to solve operations when it comes to fractions and made us understand what fractions are. I am proficient at adding and subtracting fractions correctly, comparing and organizing fractions in both ascending and descending order, and finding the same fractions using area and rectangular models”. Learners stressed the positive effects that models have on their comprehension of fractions and recommended that area and rectangle models be utilized frequently because they are simpler to use and comprehend than number lines. All the participants emphasized that models have a good impact on their understanding of fractions. They suggested that area and rectangular models should be used often because they are easy to use and understand, unlike using a number line.

### 5.4 Linking Constructivism theory to the findings of the study

With constructivism, learners rebuild themselves using their knowledge and their experiences. In this study, learners were provided with various models by their teachers and were educated on how to use them to demonstrate an understanding of fractions. generally, Lamon (2021) specified that a constructivist teacher serves as both a facilitator and a motivator in the classroom. The teacher encourages learners to think critically and locate information to solve problems. Piaget (1964) pointed out that learners are active participants in their education and that the instructor serves as a facilitator corroborating this. To form meaningful conclusions, learners looked at various examples and reiterated the topics they had learned.

At first, learners needed help understanding fractions since they could not distinguish fractions from integers. The findings of the study agree with Fernando and Faiz (2018), who stated that constructivism, is a learning theory that advocates for a participatory approach where learners are supposed to participate in the learning process actively. This means that learners were able to use models to solve problems based on the computation of fractions, which means they applied what they had learned into practice. They had their hands-on activities and used learning models to learn fractions better which made them active participants in the learning process. Displaying pictures of fractional models to enhance learners' understanding of fractions, learners got knowledge from the picture and could ask questions. Learners started having live discussions in each group as part of the learning group by putting forward models that assist in problem-solving.

Cognitive constructivism, as proposed by Lamon (2021), holds that learners sort through information, work through tasks, interact with concepts on their own, and either accommodate or integrate new information into their mental schemata. Constructivism maintains that learners are neither empty canisters nor blank slates waiting to be filled with information, according to Noureen et al. (2020). Rather, learners create new knowledge based on a wide range of prior experiences, understandings, and convictions. The results of the study demonstrated that when learners worked on fraction addition and subtraction computations, they could come up with ideas for equalizing the denominator. The strategies that learners employ to develop concepts differ; this is evident from learners from the experimental group as they were helping others solve problems by displaying visuals when performing calculations with fractions. Learners are capable of working through the stages and obtaining the desired outcomes, and learners can solve problems on their own. The teacher offered more questions regarding fractions and gave the learners time to reflect, displaying dynamic material that children could control, and learners could answer the questions thoroughly. To sum up, learners' understanding of fractions was enhanced, as they were able to solve fractional problems using models at the end of the experiment.

## 5.5 Conclusion

The results were discussed in this Chapter. The results were also examined in this Chapter in light of the constructivist theoretical framework that guided the investigation. The study's conclusion, recommendations arising from the investigation, and summary are presented in the next chapter.

# CHAPTER 6

# SUMMARY, RECOMMENDATIONS, AND CONCLUSION

## 6.1 Introduction

This chapter provides an overview of the research. It also offers the study's conclusion. Thirdly, it offers suggestions meant for both educators and learners. Finally, the Chapter offers suggestions for additional study.

## 6.2 Summary

This study sought to ascertain how the use of models improved seventh-grade learners' comprehension of fractions at a particular elementary school located in the Onankali Circuit in the Oshikoto Region. The research study was based on the constructivism theory of Piaget's (1964) framework. The study highlights the importance of learners playing a significant role in learning, and the responsibility of teachers to assist this process. The study's investigation was conducted using a mixed-methods methodology that is quantitative and qualitative approach. A purposive sample method was used to choose one of the Onankali Circuit's primary schools. Two Grade Seven classes were chosen as a sample; one was assigned as the experimental group and the other as the control group. Nevertheless, the experimental group outperformed the control group, with average scores of 24.2 against 9.2, when the post-test data were compared. The researcher rejected the null hypothesis, concluding that there was a significant difference between the post-test scores of the experimental and control groups. The findings of the quantitative data showed that learners in the experimental group performed better than learners in the control group, which clearly shows that models have an effect on the understanding of fractions to the learners.

The study's quantitative data results indicated that the use of models to teach fractions had a significant impact on the learners' conceptual comprehension of the idea, which is why the learners' performances improved after the use of models. These results corroborate the arguments made by Albin and Brown (2019), who suggested that the usage of fraction models could assist learners in making sense of concepts that are frequently unclear in a purely symbolic format and in creating mental referents that help them complete fraction tasks.

The findings from qualitative data indicate that learners faced many challenges when attempting to learn the various aspects of fractions. This is in line with Hamukwaya and Haser (2021), who indicated that fractions are one of the mathematical learning challenges, as such; teachers should apply their pedagogical strategies when teaching such concepts. The findings further pointed out that establishing good fraction models right after teachers start teaching fractions would enhance learners' understanding of fractions. The survey also identified difficulties that learners in Grade 7 encountered when studying fractions, including (fractional concepts, addition and subtraction of fractions, comparing and ordering fractions, and placing fractions on a number line).

## 6.3 Conclusions

The goal of the study was to find out how employing models improved the fractional understanding of learners in Grade 7. The study concluded that learners who used models to learn were generally more successful, as the results showed. The data analysis from this study shed light on the difficulties that learners in Grade 7 had when studying fractions. Additionally, it emphasized the potential advantages that models offer in strengthening learners' conceptual understanding, particularly concerning the addition of fractions, comparing and of fractions, and plotting fractions on the number line. Consequently, this study concludes that employing models can significantly enhance learners' performance in comprehending the concept of fractions. Hence, it is imperative to move beyond traditional teaching methods and incorporate a diverse range of learning approaches when teaching the concept of fractions, as it allows learners to have a solid and comprehensive understanding of fractions. This can be achieved by integrating proven teaching aids that effectively captivate learners and engage their curiosity in this subject. In addition, the study stressed the importance of teachers constructing the fraction concept before implementing the procedures. Teaching models, on the other hand, assist learners in constructing conceptual fluency, and they achieve this by fostering heightened engagement through the utilization of tangible materials to tackle fractional problems.

Conversely, this study found that learners need to make an effort to understand the logic underlying fractional operations. Rather, they depend on learning the terminology, formulas, algorithms, and regulations by heart. The results of this study also showed that learners who actively participate in the learning process by doing things like connecting ideas, generating generalizations, and solving problems get better learning outcomes. The study's findings indicate that using models to teach fractions greatly enhances learners' comprehension of the concepts, and that using models can spark learners' curiosity, creativity, and motivation in learning.

## 6.4 Recommendations

Based on the study findings, the following were recommended:

### 6.4.1 Recommendations for Teachers

- To prevent learners from viewing fractions as two distinct numbers, Mathematics teachers should help them get a mental comprehension of fraction notions by introducing the issue to them using appropriate fractional words.
- When teaching the concept of fractions, teachers should employ a variety of representations, including set models, length models, circular, rectangular, and area models.
- Teachers should emphasize how learners should represent models and use them to carry out calculations instead of relying on the explanations of fractions from textbooks; hence, many textbooks make fraction visual models more confusing than they have to be.

### 6.4.2 Recommendations for Learners

- Mathematics teachers should give learners ample time to experiment with manipulatives and models. For some learners, visualizing parts of a whole can be difficult, but when teachers use manipulatives, they make the concept more concrete.
- Learners should comprehend that fractions are portions of a whole and that, particularly when comparing fractions, parts of a whole must be equal.
- When learning fractions, learners can utilize real-world examples like splitting an apple among themselves. This will help them apply what they have learned in the real world to solve fractional problems and use their existing knowledge to solve problems.

### 6.4.3 Recommendations for further research

- Future studies should examine how models can be used to teach other Mathematical concepts.
- Since the scope of this study is limited to Grade 7, research on other grades might yield valuable insights that can be utilized to guide the development of the fraction-learning curriculum in Namibia.

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# APPENDICES

## Appendix A: Ethical Clearance Certificate

UNAM
UNIVERSITY OF NAMIBIA

**ETHICAL CLEARANCE CERTIFICATE**

**Ethical Clearance Reference Number: DEC: HPC00016** **Date: 24 May 2023**

This Ethical Clearance Certificate is issued by the University of Namibia Ethics Committee (REC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the ethics committee.

**Title of Project: THE EFFECTS OF USING MODELS TO ENHANCE GRADE 7 LEARNERS' UNDERSTANDING OF FRACTIONS: A CASE OF A PRIMARY SCHOOL IN ONANKALI CIRCUIT, OSHIKOTO REGION.**

**Investigator:** HELENA SIMANEKENI SHALONDA

**Student Number:** 201404948

**Centre for Research Services**

Take note of the following:

1. Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the ethics committee. An application to make amendments may be necessary.
2. Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the ethics committee
3. The Principal Researcher must report issues of ethical compliance to the ethics committee (through the Chairperson) at the end of the Project or as may be requested by the ethics committee
4. The ethics committee retains the right to:

i) Withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,

ii) Request for an ethical compliance report at any point during the course of the research.

The ethics committee wishes you the best in your research.

Dr Angelina Popyeni Amushigamo (Chairperson DEC HPC)

Prof. Davis Mumbengegwi (Head, Multidisciplinary Research)

**Appendix B: Research Permission Letter**


**CENTRE FOR RESEARCH SERVICES**
*Office of the Pro-Vice Chancellor: Research, Innovation & Development*
University of Namibia, Private Bag 13301, Windhoek, Namibia
340 Mandume Ndemufayo Avenue, Pioneers Park, Office F223 - Fblock, Second Floor
☎ +264 61 206 4673; E-mail:kmbulu@unam.na: URL.: http//www.unam.edu.na


UNAM
UNIVERSITY OF NAMIBIA

**RESEARCH PERMISSION LETTER**

**Date: 28/11/2023**

**Student Name:** HELENA SIMANEKENI SHALONDA

**Student Number:** 201404948

**Programme:** MASTERS OF EDUCATION (MATHEMATICS)

**Approved Research Title:** THE EFFECTS OF USING MODELS TO ENHANCE GRADE 7 LEARNERS' UNDERSTANDING OF FRACTIONS: A CASE OF A PRIMARY SCHOOL IN ONANKALI CIRCUIT, OSHIKOTO REGION.

**TO WHOM IT MAY CONCERN:**

I hereby confirm that the above-mentioned student is registered at the University of Namibia for the programme indicated. The proposed study met all the requirements as stipulated in the University guidelines and has been approved by the relevant committees.

The proposal adheres to ethical principles as per attached Ethical Clearance Certificate. Permission is hereby granted to carry out the research as described in the approved proposal.

Best Regards

**Dr. AEE Shikongo**
**Head: Postgraduate Research Support Services**
**Tel: +264 61 206 3129**
**E-mail: aeshikongo@unam.na**

CENTRE FOR RESEARCH SERVICES
Office of the Director
2023 -11- 28
University of Namibia
UNAM

**Appendix C: Request for permission to conduct the study**

Enq: Ms. H. S. Shalonda | P O Box 3522

Cell: +26481 6740832 | Ondangwa

Email: hsimanekashalonda@gmailcom | 24 May 2023

The Director of Education
Oshikoto Education Directorate
Private Bag 2028
Ondangwa

Dear: Ms. Eises

REQUEST FOR PERMISSION TO CONDUCT RESEARCH STUDY

I am Helena Shalonda, a Master's learner at the Univesity of Namibia, and a teacher at Omuntele Primary School. To fulfill the requirements for a master's degree in education, I am currently researching "Exploring the Effectiveness of Using Models to Improve Grade 7 Teachers' Conceptual Understanding of Fractions: The Case of Primary School in Onankali Circuit of Oshikoto". Learning is just an educational intervention. I would like to implement the program at a local elementary school and evaluate its impact on 7th-grade learners. The study will take place from May 29 to July 30, 2023.

The researcher will give the pre-test to the 60 learners who have been chosen to participate in the study before utilizing models to assess their comprehension of fractions. The researcher will teach fractions to 30 learners (experimental group) for seven weeks using teaching models while observing how they solve issues involving fractions. The other 30 learners of the control group will be taught using presentations and textbooks. A post-test will then be administered to see how their conceptual grasp of fractions has changed after using the models. Following that, as a follow-up to the tests' results, interview sessions with the 10 Grade 7 in the experimental group will be conducted. Participants will be asked to give consent to the use of a voice recorder to record the sessions.

Please find a copy of the letter of recommendation from my supervisor, Professor Ipinge Sacky. The contact person is 081 1296939. and smiipinge@unam.na

It is intended that this study would yield important data for various stakeholders in Mathematics education. Furthermore, individuals' participation in this study is considered a learning opportunity. I am committed to promoting the autonomy of all participants and their right to withdraw from the study at any moment without repercussions. In light of this, Participants and their parents/guardians will be asked to sign a consent form. In this regard, I would like to request your permission to allow me to survey one of the educational centers within your region.

Yours sincerely

Helena S. Shalonda

Med Learner

University of Namibia

**Appendix D: Director's permission letter**

REPUBLIC OF NAMIBIA

OSHIKOTO REGIONAL COUNCIL

Tel: (065) 242500 **DIRECTORATE: EDUCATION, ARTS & CULTURE** Private Bag 2028
Fax: (065) 241660 ONDANGWA
Enquiries: Ms Tende 06 June 2023

**Ref: 13/2/9/1**

Ms Helena Shalonda
PO Box 3522
Ondangwa
Cell: 0816740832
hsimanekashalonda@gmail.com

Dear Ms Shalonda

**RE: PERMISSION TO CONDUCT A RESEARCH STUDY IN OSHIKOTO REGION**

The Office of the Director acknowledges receipt of your letter seeking for permission to conduct a research study focusing on "*Investigating the effects of using models to enhance grade 7 learners' conceptual understanding of fractions*" a case study of selected schools in Onankali Circuit.

Kindly be informed that permission has been granted to carry out the research in Oshikoto Region, please be guided by the following:

- You have to consult the school principal well in advance to ensure a proper co-ordination of other school activities
- The research should not interfere with the normal teaching and learning process at the school.
- Participation in the research should be on a voluntary basis.
- The information to be collected should be treated as confidential and only for research purposes.

Thank you for showing interest to do the research in the Oshikoto Region. It is our sincere hope that the information you would gather will be useful towards the completion of your qualification.

Sincerely yours

REGIONAL COUNCIL Director 2023 -06- 09 PRIVATE BAG 2028 ONDANGWA EDUCATION, ARTS, CULTURE

..................................
**MS ALETTA A. EISES**
**DIRECTOR OF EDUCATION, ARTS AND CULTURE**
**OSHIKOTO REGION**

## Appendix E: Permission letter from the Principal

**MINISTRY OF EDUCATION, ARTS & CULTURE**
**ONANKALI CIRCUIT,**
**OSHIKOTO REGION**

OMUNTELE PRIMARY SCHOOL

Tel: +26465 – 289221
Inquiries: Ms. T. O. Hangula
Email: omunteleps@gmail.com
24 May 2023

The School principal
Omuntele Primary School
P.O.Box 70049
Omuntele

Ms. H. S. Shalonda
P O Box 3522
Cell: +26481 6740832
Email: hsimanekashalonda@gmailcom

Dear Ms. Shalonda

**SUBJECT: PERMISSION TO CONDUCT AN EDUCATIONAL RESEARCH AT OMUNTELE PRIMARY SCHOOL.**

Kindly be informed that the permission to conduct a research study entitled "*Investigating the effects of using models to enhance grade 7 learners' conceptual understanding of fractions*" a case of one selected primary school in the Onankali Circuit is granted.

I wish you all the best in conducting your research and I am looking forward to hearing from you.

Yours sincerely

Ms. Teopolina. O. Hangula
**The school principal**
Omuntele Primary school

OSHIKOTO REGIONAL COUNCIL
DIRECTORATE OF EDUCATION
THE PRINCIPAL
2023 -05- 2 4
OMUNTELE PRIMARY SCHOOL
P.O. BOX 70049 OMUNTELE
TEL/FAX: 065-289 221

**Appendix F: Informed consent for parents**

Enquiries: Ms. Helena Shalonda Education Department

Cell: +26481 6740832

Email: hsimanekashalonda@gmailcom

University of Namibia

04 February 2023

Dear parent

INVITATION TO PARTICIPATE IN A STUDY

This information is a request for your child's consent to participate in this study. I am a learner pursuing a Master of Education in (Mathematics Education) at the University of Namibia, Windhoek. I am currently working on a research project to fulfill the requirements for my Master's degree in Education. The researcher will use models to teach fractions to 30 learners over seven weeks, looking to solve problems related to fractions. The remaining 30 learners in the control group will be taught through presentations and textbooks. A post-test will be given to see how your theoretical understanding of fractions changes after using the formula. Therefore, we ask that you allow your child to participate in this life-changing learning experience. Also, remember that participation in this study is voluntary and that anonymity is guaranteed through the use of a pseudonym. Additionally, you have the right to withdraw from this study without penalty. Research results are published and presented in academic and professional circles. If you have any questions about this survey, please contact us at any time.

**Yours Sincerely**

____________________________

**Helena S Shalonda**

**M.Ed. learner**

**University of Namibia**

**Declaration form**

I________________________________________________________________ (full names of a parent/guardian) therefore confirm that I understand the content of this article and the nature of the educational intervention. That's why I let my child ____________________________________ to participate in this research study.

_____________________________

_______________________

Signature (parent/guardian) Date

**Appendix G: Informed consent for learners**

**Consent letter for learners**

**Topic**: The effects of using models to enhance grade 7 learners' understanding of fractions: a case of a primary school in Onankali Circuit, Oshikoto region.

I, ______________________________________________ (name and surname) a grade 7 learner from Omuntele Primary School ______________________________________________ I officially grant permission to participate in the aforementioned research project. I am aware that my participation in this study is entirely voluntary, and that I may withdraw at any time without penalty. I also understand that the researcher will treat all personal information as confidential and that data will be securely stored and discarded after 5 years. Name and signature

_______________________

Date

Contact information:

Research supervisor: Prof. S. Iipinge (081 1296939)

Researcher: Ms. Shalonda (081 6740832)

**Appendix H: Pre and Post-Tests**

Pre-test. ____

30 Marks

**Learner's name: ..................................** **Date:**

**.................................**

**Mathematics Post-test:** **Common Fractions** **Duration: 45 minutes**

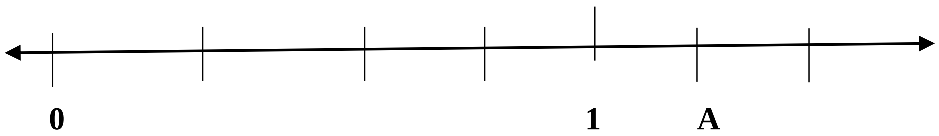
________________________________________________________________________________

**Instructions to learners:**

________________________________________________________________________________

**1. Identifying fractions**

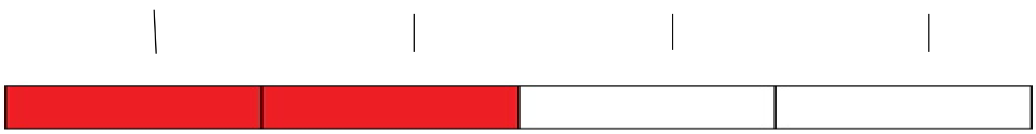
1.1. What fraction of the number line is shown by the letter A?



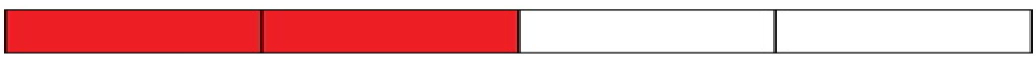

Answer: ______________________ [1]

1.2.What shaded areas represent $\frac{4}{7}$

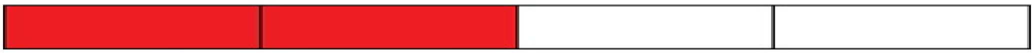
(a)



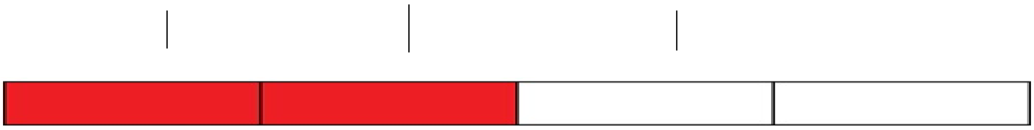
(b)



(c)



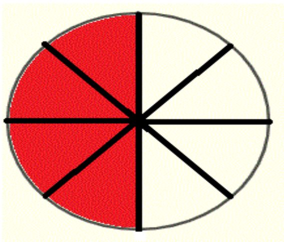
(d)



Answer:

_____________________ [1]

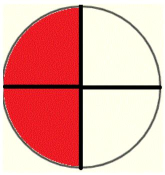
1.3.What portion of the circle is shaded??



Answer:

_______________________ [1]

1.4.Which letter represents the actual shaded area of all the images below?



(a) Four quarters

(b) Two halves

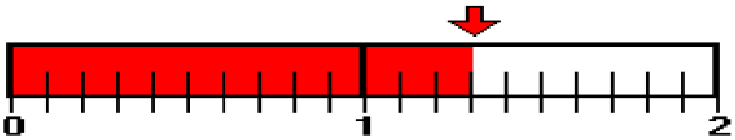
(c) Two-quarters of four

(d) Four quarters

Answer:

_____________ [1]

1.5. 1.1. Write the fraction represented by the shaded area on the number axis below.

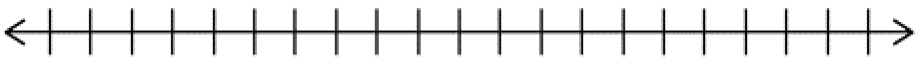



Answer: __________ [1]

1.6. $\frac{5}{3}$ reads as ‘five thirds’

Write $\frac{3}{10}$ in words Answer: ______________________________ [1]

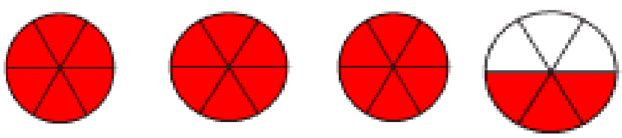
1.7. Mark fraction $\frac{2}{5}$ with the letter **B o**n the number line below.



[1]

**0** **1** **2** **3**

1.8. The models shown here are only a sample of fractions. One circle equals one whole number.



(i) Which fractions are represented collectively by all of the shaded areas? Put your response in mixed fractional form. Answer: ______________________ [1]

(ii) Give your answer as an improper fraction

Answer:

__________________ [1]

(iii) Represent this fraction on a number line.

[1]

## 2. Addition and subtraction of fractions

2.1. Calculate. You can use a model to demonstrate the process of calculating the sum or difference of fractions.

(a) $\frac{1}{5} + \frac{1}{5}$

(b) $\frac{2}{3} + \frac{3}{4}$

(c) $\frac{5}{12} - \frac{3}{12}$

(d) $\frac{1}{2} + \frac{1}{6}$

[8]

2.2. **Comparing and ordering fractions**

2.2.1. Compare the fractions and fill in the blanks with one of the symbols <, >, or = to make each expression true. Use the model to show how you arrived at your answer.

**(a)** $\frac{1}{2}$ $\frac{1}{5}$

[2]

**(b)** $\frac{1}{8}$ $\frac{1}{8}$

[2]

2.2.2. Arrange the following fractions in ascending order and use **circle models** to show how you get your answers.

(a) $\frac{2}{5}$ $\frac{1}{5}$ $\frac{5}{5}$ [2]

(b) $\frac{1}{6}$ $\frac{2}{3}$ $\frac{1}{4}$

[2]

2.2.3. Arrange the following fractions in descending order and use **rectangular models** to show how you get your answers.

**(a)** $\frac{1}{4}$ $\frac{3}{4}$ $\frac{2}{4}$

[2]

**(b)** $\frac{1}{2}$ $\frac{2}{3}$ $\frac{1}{3}$

[2]

POST-TEST

_____ 30 Marks

**Learner's name: ...................................** **Date:**

**..................................**

**Mathematics Post-test:** **Common Fractions** **Duration: 45**

**minutes**

---

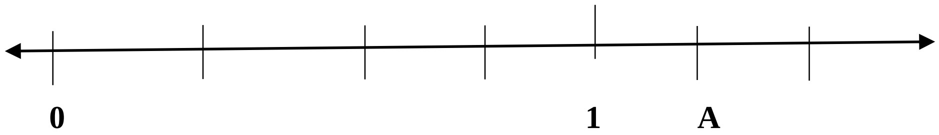
**Instructions to learners:**

- Write your name and date in the space provided.
- Answer all questions.
- Show all your workings.
- The use of calculators is not allowed for this test.

---

**3. Identifying fractions**

3.1. What fraction of the number line is shown by letter A?

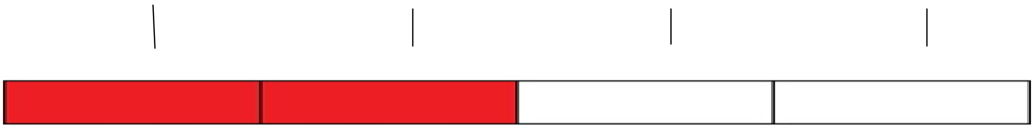


Answer:

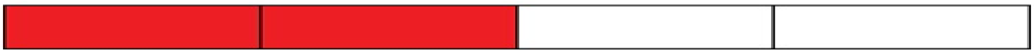
______________________ [1]

3.2.What shaded areas represent $\frac{4}{7}$

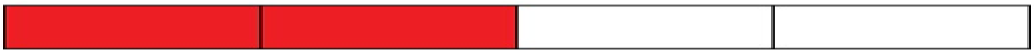
(e)



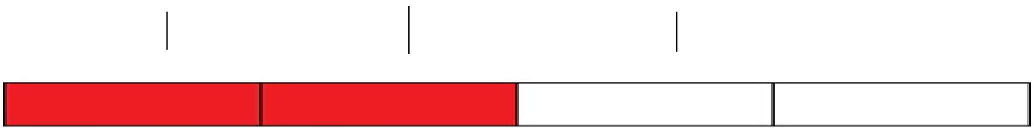
(f)



(g)



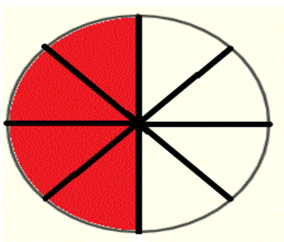
(h)



Answer:

_______________________ [1]

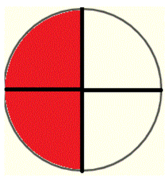
3.3. What fraction of the circle is shaded?



Answer: _________________________

[1]

3.4.Which letter shows the correct shaded parts of the full below?



(e) Four quarters

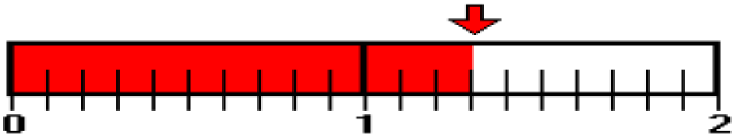
(f) Two halves

(g) Two-quarters of four

(h) Four quarters

Answer: _____________ [1]

3.5. Below, on the number line, write down the fraction represented by the shaded area.

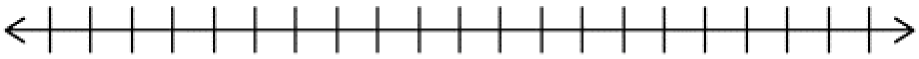



Answer: _____________ [1]

3.6. $\frac{5}{3}$ reads as 'five thirds'

Write $\frac{3}{10}$ in words Answer: _________________________________ [1]

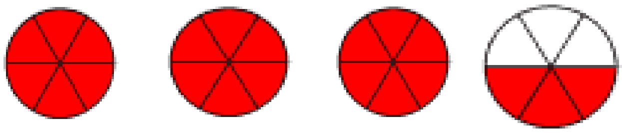
3.7. Mark this fraction $\frac{2}{5}$ with the letter **B** on the number below.



[1]

**0** **1** **2** **3**

3.8. The models shown here are only a sample of fractions. One circle equals one whole number.



(ii) Which fractions are represented collectively by all of the shaded areas? Put your response in mixed fractional form. Answer:

______________________ [1]

(ii) Give your answer as an improper fraction

Answer:

_________________ [1]

(iii) Represent this fraction on a number line.

[1]

**4. Addition and subtraction of fractions**

4.1. Calculate. You can use a model to demonstrate the process of calculating the sum or difference of fractions.

(e) $\frac{1}{5} + \frac{1}{5}$

(f) $\frac{2}{3} + \frac{3}{4}$

(g) $\frac{5}{12} - \frac{3}{12}$

(h) $\frac{1}{2} + \frac{1}{6}$

[8]

4.2. **Comparing and ordering fractions**

4.2.1. Compare the fractions and fill in the space with one of the symbols <, > or =to make each statement true. Use **models** to show how you get your answers.

**(c)** $\frac{1}{2}$ $\frac{1}{5}$

[2]

**(d)** $\frac{1}{8}$ $\frac{1}{8}$

[2]

4.2.2. Arrange the following fractions in ascending order and use **circle models** to show how you get your answers.

(c) $\frac{2}{5}$ $\frac{1}{5}$ $\frac{5}{5}$ [2]

(d) $\frac{1}{6}$ $\frac{2}{3}$ $\frac{1}{4}$

[2]

4.2.3. Arrange the following fractions in descending order and use **rectangular models** to show how you get your answers.

**(c)** $\frac{1}{4}$ $\frac{3}{4}$ $\frac{2}{4}$

[2]

**(d)** $\frac{1}{2}$ $\frac{2}{3}$ $\frac{1}{3}$

[2]

## Appendix I: Interview Guide Questions

Thank the interviewer and greet them throughout the interview. Make sure the interviewer is confidential and consistent.

1. How can we define the term fractions?
2. What is the difference between the denominator and numerator?
3. Do you find fractions difficult to learn? If yes, what exactly makes it difficult to learn?
4. How often does your Mathematics teacher use models to teach fractions? If yes, what types of models does he/she use?
5. Name any model that you have learned on the topic of fractions.
6. Do you prefer being taught fractions using teaching models or using the algorithm method (whereby learners are taught how to use rules to learn fractions)? Explain why.
7. Do you think models can help learners understand fractions better? If, yes what type of models do you suggest should be used often?
8. After being taught using area, rectangle, and number line models, do you think your understanding of fractions has changed? If yes, what is the difference in your understanding of fractions before and after the use of models?
9. After being taught to use models, will you be able to use models to carry the four basic operations in fractions and represent fractions using different models? If yes, solve the two problems on the chalkboard in front of you.

**Appendix J: Test Scores**

**Grade: ……………………………….** **Marks: 30**

**Date: ……………………………….. Method of delivery: ……………………………..**

| **Learner's Code** | **Experimental group** | | **Control group** | |
|---|---|---|---|---|
| | **Pre-test** | **Post-test** | **Pre-test** | **Post-test** |
| L1 | 8 | 26 | 6 | 8 |
| L2 | 13 | 29 | 11 | 11 |
| L3 | 8 | 28 | 7 | 12 |
| L4 | 6 | 26 | 10 | 12 |
| L5 | 8 | 21 | 11 | 11 |
| L6 | 14 | 23 | 16 | 19 |
| L7 | 10 | 22 | 11 | 10 |
| L8 | 6 | 17 | 7 | 7 |
| L9 | 7 | 25 | 11 | 9 |
| L10 | 12 | 27 | 6 | 9 |
| L11 | 10 | 18 | 10 | 14 |
| L12 | 8 | 19 | 12 | 17 |
| L13 | 13 | 30 | 7 | 5 |
| L14 | 6 | 20 | 12 | 11 |
| L15 | 8 | 24 | 10 | 11 |

| | | | | |
|---|---|---|---|---|
| L16 | 8 | 17 | 16 | 20 |
| L17 | 7 | 23 | 11 | 10 |
| L18 | 5 | 26 | 11 | 12 |
| L19 | 20 | 30 | 3 | 2 |
| L20 | 7 | 15 | 6 | 6 |
| L21 | 10 | 29 | 7 | 6 |
| L22 | 6 | 25 | 6 | 6 |
| L23 | 6 | 20 | 8 | 12 |
| L24 | 12 | 28 | 7 | 6 |
| L25 | 14 | 30 | 4 | 7 |
| L26 | 7 | 20 | 6 | 8 |
| L27 | 12 | 29 | 7 | 8 |
| L28 | 22 | 30 | 0 | 1 |
| L29 | 6 | 21 | 2 | 1 |
| L30 | 10 | 29 | 6 | 5 |

**General comments: ……………………………………………………………**