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THE EFFECT OF THREE-TIER TEACHING MODEL FOR TEACHING MATHEMATICS IN CONTEXT ON PRIMARY SCHOOL PUPILS' PERFORMANCE IN FRACTIONS: CASES OF CAPE COAST METROPOLIS AND MFANTSIMAN MUNICIPALITY

BY

DANIEL GBORMITTAH

Thesis submitted to the Department of mathematics and ICT Education, Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Doctor of Philosophy degree in mathematics Education

SEPTEMBER 2022

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my original research and that no part of it has been presented for another degree in this University or elsewhere.

Candidate's Signature..... Date..13/10/2022

Name: Daniel Gbormittah

Supervisors' Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

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ABSTRACT

Teaching in context in this study is an innovative way of teaching mathematics that relates the abstract mathematical concepts that teachers teach in schools to the learners' everyday realities. The three-tier teaching model for teaching mathematics in context is an innovative way of teaching mathematics in context. This study investigated the effect of the three-tier teaching model for teaching mathematics in context on primary one pupils' performance in fractions in two selected districts in the Central Region of Ghana. The study drew on socio-cultural theory and ethnomathematics as its main theories. This study's research design was sequential explanatory mixed methods including quasi-experimental pretest-posttest design. A multistage sampling technique was used. Pupils' Identification of Fraction Worksheet; pretest and posttest were used to collect quantitative data from 860 primary one pupils from the 24 selected public schools, with 12 primary schools from each district. Twenty-four primary one mathematics teachers with each teacher from each school participated in the study. The semi-structured 'Interview Guide for Teachers' perception about the use of the model for teaching mathematics in context' was used to collect the qualitative data. The quantitative data was analyzed using both descriptive and inferential statistics. The qualitative data was analyzed using content analysis followed by narrative discussion. The analysis of results indicated that the model's approach was more effective in improving pupils' performance in the identification of fractions. The model should be used as an innovative teaching approach for teaching fractions in context by all primary one mathematics teachers.

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KEYWORDS

Basic School

Primary School

Formal Approach to Mathematics

Informal Approach to Mathematics

In-school Mathematics

Out of School/Everyday Mathematical Practices

Performance

Context of Schools

Sex

Everyday Mathematical Concepts

Scientific Concepts

Teaching in Context

Conventional Group

Experimental Group

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DEDICATION

To my wife, Rebecca Osei, and my children.

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CHAPTER ONE

INTRODUCTION

The focus of this study is to examine the impact of the three-tier teaching model for teaching mathematics in context on the performance of primary one pupils in identification of fractions. It also aimed to ascertain and extend understanding of teaching in context in order to improve pupils' fractional knowledge through the use of the three-tier teaching model for teaching mathematics in context. The importance of fractions in acquiring mathematical knowledge cannot be overstated in mathematics teaching and learning because it serves as a foundation for the acquisition of advanced mathematical knowledge (Mack, 2001; Clarke & Roche, 2009; Davis, 2010, 2013, 2016, 2017a, 2017b). Most (if not all) advanced mathematical concepts require the use of fractions in their learning. As a result, there is a need for the teaching and learning of mathematical concepts like fractions to be done in context at the basic school level and beyond because it affects learners' foundations for advanced learning of mathematics either positively (i.e., if appropriate concepts of fractions are formed) or negatively (i.e., if inappropriate concepts of fractions are formed). Sex is noted in literature as one of the variables that influences pupils' achievement in mathematics at the primary school level (Wilmot, 2001; Frempong & Ayia, 2005; Asare-Nkoom, 2007).

Background to the Study

Primary school forms the basis of all advanced levels of schooling in Ghana. It therefore prepares pupils to enter into advanced levels of schooling in Ghana. Pupils with a sound foundation in mathematics at the primary school

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levels have the advantage of outperforming their counterparts with a weak foundation from primary school at their advanced levels of schooling. This means that teachers at the primary schools play key roles in helping learners to form secure foundations in their various fields of study, especially in mathematics. Due to the significant nature of mathematics teachers' role in ensuring that primary one pupils have strong foundations for advanced levels of schooling in mathematics, there is the need for the teaching of mathematics at the primary school level to be done in context (See for instance; Davis, 2010, 2017b) the need for primary school mathematics teachers to teach mathematical concepts in context should not be underestimated. Teachers' ability to teach in context would greatly improve pupils' performance and influence their ability to form a secure basis in learning mathematics for the future (Davis, 2010, 2016).

When thinking about mathematics, few people consider the role of culture, context, history, or diversity in teaching and learning, all of which are important in the development of mathematical concepts (D'Ambrosio, 2015; Presmeg, 1998, 2006b, 2007; Hedegaard & Chaiklin, 2006; Bergsten & Greyholm, 2008; Davis & Chaiklin, 2015; Davis, 2010, 2016, 2017a, 2017b). Many teachers believe that constructs such as culture, context, history or diversity do not play a key role in teaching and learning mathematics (Presmeg, 1998, 2006b, 2007; Hedegaard & Chaiklin, 2006; Bergsten & Greyholm, 2008; Davis & Chaiklin, 2015; Davis, 2010, 2016, 2017a, 2017b). Meanwhile, these constructs have the potential of improving pupils understanding of

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mathematical concepts since children take part in cultural activities carried out at their local settings (Bishop, 1985; Davis, 2010, 2017b).

The performance of primary school pupils in fractions and its related concepts over the years has been low. This affects their mathematical performance as a whole since fractions form the basis of learning most mathematical concepts. Pupils' performance in fractions is largely worrying (Davis & Hisashi, 2007; WAEC, 2006, 2008, 2013, 2015, 2016, 2018; Lewis & Blunk, 2012; Sleep & Eskelson, 2012; Duedu, Atakpa, Dzinyela, Sokpe & Davis, 2005; Ministry of Education Youth and Sports, 2004; Davis, 2010, 2016, 2017b). Fraction is of main importance in learning mathematics since it serves as a prerequisite for the acquisition of advanced mathematical knowledge (Davis, 2010, 2016, 2017b). This is because fractions are applied in almost all the other concepts in mathematics. Because of this, there is the need for the teaching of mathematical concepts like a fraction to be done in context at the primary school level (Davis, 2010, 2017b). It must be of keen interest to stakeholders of mathematics education since it affects learners either positively or negatively the foundation learners build for the future.

It was also evident from literature that fraction is as one of the most difficult mathematical concepts encountered in primary school years (Schneider & Seigler, 2010; Charles & Nason, 2000; Mack, 2001; Barnett-Clarke, Fisher, Marks, & Ross, 2010; NCTM, 2007; Davis, 2010, 2016, 2017a, 2017b; Cramer & Whitney, 2010; Clarke & Roche, 2009; Yoshida & Sawano, 2002; Ball, Thames & Phelps, 2008). At this age, children are acquainted with whole numbers that are countable and the principles of addition and subtraction.

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However, the fraction is a composite concept with a numerator and denominator and is more related to the division principle. This requires pupils to make a qualitative leap of comprehension and hence makes it difficult for them to assimilate the idea of fractions.

A set of five interrelated constructs; part-whole, ratio, operator, quotient and measure, can be considered as fractional constructs depending on the context in which these constructs are used. One could start teaching fractions based on any of these constructs. But it has been shown that pupils perform best when they are taught fractions using the part-whole sub-construct of division where an object is divided into parts (Cramer & Whitney, 2010; Clarke & Roche, 2009). The limitation in using this sub-construct would be the fact that one can teach only proper fractions where the numerator is lesser than the denominator. However, once pupils grasp this fundamental idea of what fractions are, teachers can expand their schema to learn more complex ideas of fractions. The three-tier teaching model for teaching mathematics in context uses the learners' everyday concepts of fractions to scaffold the learning of the scientific concepts of fractions (Davis, 2010, 2017b).

According to the reports of the chief examiners for the Basic Education Certificate Examination (2006, 2008, 2013, 2015, 2016), a large number of Junior High Students have low knowledge in fractions and related concepts in their final mathematics examination. To address this, there is a need for the teaching of mathematics to be done in context. Everyday concepts are culturally oriented and entail the cultural practices of the children in their local settings. This mathematics is usually practiced at home and is not formally taught as done

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in the case of scientific concepts. The everyday concept helps the learners to learn in context (Davis & Chaiklin, 2015; Davis, 2010, 2017a, 2017b). Everyday mathematics is vital because of its real-world context. However, without context, it is very difficult for learners to appreciate the beauty and significance of mathematics (Davis, 2010, 2017b).

This idea is critical to make when we want our learners to think mathematically and become problem solvers. Learners can apply their mathematical knowledge when teaching is done in context. Despite all efforts that have been put in place to ensure that pupils learn mathematics with ease, children still perceived mathematics as one of the subjects that they find challenging to study at school. This was ascribed to the fact that mathematics is taught as an abstract set of symbols and rules (Davis, 2010). Pupils have a good procedural knowledge to perform the operations on fractions but lack the corresponding conceptual understanding in doing it. This calls for the use of more innovative methods of teaching so that pupils appreciate the learning of mathematics more and relate it to real-life situations. One of such approaches is the three-tier teaching model for teaching mathematics in context pedagogy (Davis, 2010, 2017b).

A three-tier teaching model for teaching mathematics in context is an innovative approach developed by Davis in 2010 and validated in 2017 in teaching mathematical concepts such as fractions and measurements by engaging learners in three interrelated levels - enculturation, transition and acculturation (Davis, 2010, 2017b). This model is an innovative approach in teaching mathematical concepts in context. The use of a three-tier teaching

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model for teaching mathematics in context in teaching mathematics in primary schools has been motivated by the fact that pupils' social and cultural context must have consequences for the teaching and learning of mathematics in the classroom. Hence, a context-based teaching approach to mathematics education is pedagogically beneficial (Davis, 2010, 2013, 2017a, 2017b).

A teaching that is done in context would actively engage learners in the learning process (Davis, 2010, 2017b). They will share ideas with their group members, classmates and teachers. They learn by making meaning of their social interaction and cultural context but not following mere algorithms. They ask questions among themselves in the group to shape and deepen their understanding of the concepts been learnt. The teacher only comes in to provide hints when necessary. Pupils' proficiency with fractions will serve as an important foundation for learning more advanced mathematics (Davis, 2010; Misquitta, 2011). Fractions are pupil's first introduction to abstraction in mathematics and, as such, provide the best introduction to other mathematical contents such as algebra and measurement in the primary and higher school years. Context is necessary for pupils to develop the conceptual links among fractional concepts and use it in solving real-life problems (NCTM, 2003; Davis, 2010, 2017b).

Linking school mathematics to the exciting realm of everyday mathematics is the way to go now (Bishop, 1988; Hedegaard & Chaiklin, 2006; Davis & Chaiklin, 2015; Davis, 2010, 2017b). Children should be allowed to think and connect their everyday knowledge of mathematics experienced at home to that of the mathematical knowledge acquired in school. Children

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should be allowed to use their everyday mathematical knowledge as a prerequisite knowledge in learning In-school mathematics (Bishop, 1988; Davis, 2010, 2016, 2017a, 2017b). In so doing the children would see the practical use of their everyday mathematics and take pride in their learning. Children would approach the learning of mathematics with joy if they are made to realize that the school mathematics emerged out of the home mathematics which they always experience around them.

Teaching and learning mathematics in context at the primary school level is particularly critical because that is where they form the foundation for the advanced mathematical concepts (Davis, 2010, 2016, 2017a, 2017b). A weaker foundation would adversely affect their mathematical achievement as they climb the academic ladder. If we take out the context from the teaching and learning of mathematics, mathematics is reduced to the mere abstract subject with algorithmic rules. If mathematics is taught as fact drills and limitless word problems, mathematics learning becomes ineffective and meaningless to pupils (Davis, 2010, 2017b). Contexts in learning mathematics provides carefully planned content that is intended to foster deep understanding in mathematics learning (Gonzalez, Moll & Amanti, 2005; Davis, 2010, 2016, 2017a, 2017b).

The learning philosophy of the new primary school mathematics curriculum brings to bear that an effective mathematics education that is needed for sustainable development should be inquiry-based (NaCCA, 2019). It added that the primary school mathematics curriculum must equip learners with the opportunity to expand, change, enhance and modify how they perceived the world around them. Teachers are to employ a teaching approach that will make

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learners play active roles in their knowledge creation. Teachers must design pupil-centred lessons that will engage learners physically and cognitively in the knowledge acquisition process in an inquiry-based environment (NaCCA, 2019). Similarly, NaCCA also stated in its learning philosophy of the primary school mathematics curriculum that mathematics learning must be perceived as an active process where learners construct their knowledge based on experience rather than acquiring it.

To achieve this, there is the need for teaching to be done in a context where teachers will act as actual facilitators through the creation of enabling environment that fosters the creation of learners' knowledge based on their prior experience from the participation in cultural activities in the local settings. Teachers are to teach pupils in a way that will help learners to develop critical thinking skills (Davis, 2010, 2017b). Furthermore, in order to achieve the primary school new mathematics curriculum's teaching and learning philosophies, teachers must critically examine how they introduce pupils to mathematical concepts such as fractions at the primary school level, because the traditional method of teaching mathematics would not allow for the effective realization of these philosophies.

This study is hence based on the assumption that the manner in which teachers introduce students to fractional concepts has a significant impact on their performance, and thus there is a need for teaching to be done in context. The current practices in our schools in introducing pupils to mathematical concepts are largely done out of context (Davis, 2010, 2017b). Teachers usually teach without linking the pupil's conception of home mathematics to that of the

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mathematics they learn at school. A large number of Ghanaian primary school children perceived school mathematics to be completely different from home mathematics and therefore failed to draw a relation between home mathematics and school mathematics (Davis, 2010, 2017b). Most of the children from poor socioeconomic backgrounds and rural areas have the negative perception that the two are completely disjoint (Davis, 2010, 2017b). The three-tier teaching model for teaching mathematics in context is developed to be used in teaching mathematics in context (i.e., teaching that involves the use of the out-of-school knowledge acquired by pupils through their cultural practices as a prerequisite for the learning of the In-school concepts of mathematics).

Statement of the Problem

Teachers, pupils, parents, educators, government, and general public are increasingly concerned about pupils' persistent low achievement in mathematics, particularly at the primary school level, where the various fundamental concepts in mathematics are formed. This condition is deplorably high, to the extent that Ghanaian pupils start competing for the last position instead of first in mathematics in the TIMSS 2003 competition. The results from the Trends in International mathematics and Science Study (TIMSS), carried out by the International Association for the Valuation of Educational Achievement (IEA) of the USA in 2003 indicated that Ghanaian grade 8 children performed abysmally poor in the mathematics achievement test (TIMSS, 2003) where Ghana's eighth-graders were ranked 45th among 46 participating countries.

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Also, in the international study conducted in 2007 by Trends in International mathematics and Science Study (TIMSS, 2007), Ghana's eighth-graders were ranked 47th among 48 countries that participated in the study. This was worst when in 2011 the TIMSS report showed that Ghana was ranked 76th among the 76 nations that participated in the Trends in International Mathematics and Science Study (TIMSS, 2011). After the first three appearance in TIMSS, Ghana has stayed out from the subsequent ones. This points to the fact that Ghanaian learners have limited subject knowledge, application and reasoning skills that they needed for problem solving (Davis, 2010; MOEYS, 2012). TIMSS (2011) emphasized that teaching methods in countries where pupils were not able to exhibit maximum application and reasoning skills were mainly teaching by telling approach which mainly results in procedural knowledge and instrumental understanding.

Although fractional awareness is essential for the potential success of pupils in mathematics, science, and everyday life, pupils still experience difficulties in learning fractions as highlighted in the background to the study (Kilpatrick, Swafford & Findell, 2001; Kloosterman, 2010; Lamon, 2006; NCTM, 2007; Siegler, Givvin & Thompson, 2010; Siegler, Thompson & Schneider, 2011; Van de Walle, 2010; Bulgar, 2003; Hecht, Close & Santisi, 2003; Newton, 2008). Literature suggests that the problem still persist in many countries (NCTM, 2011; TIMSS 2007, 2011). In Ghana, pupils have challenge learning the mathematical concepts of fractions, measurements, geometry/shape, algebra and word problem solving (Davis & Hisashi, 2007;

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WAEC, 2006, 2008, 2013, 2015, 2016; Davis, 2010; Duedu, *et al.*, 2005; MOEYS, 2004, 2008, 2012, 2018, 2019; MOE, 2018, 2019).

In 2013, when JHS pupils in Ghana were asked to subtract a mixed fraction from another mixed fraction, most candidates could not do the simplification well and hence failed to answer the question well (WAEC, 2013). Also, in 2015, JHS pupils were given a fractional word problem which required them to find the product of 2/5 and 2/3. Most of the candidates added instead of multiplying the two fractions (WAEC, 2015). This became worst in 2016 BECE where more than half of the candidates could not recognize decimal fractions and common fraction equivalences for halves (WAEC, 2016).

The literature also supports the fact that these low achievement and retention rates were caused by inappropriate teaching approaches in mathematics teaching and learning (Davis, 2010, 2016, 2017b; Davis & Chaiklin, 2015). The way teachers introduce pupils at the early grade to mathematical concepts, especially fractions were usually done out of context (Davis, 2010, 2017b). Because of this, there is a need for the teaching of mathematical concepts like a fraction to be done in context at the primary school level. Teaching fractions in context must be of keen interest to stakeholders of mathematics Education since it affects pupils negatively the foundation they build for their future learning of mathematics.

The importance of understanding fractional concepts in mathematics, combined with pupils' poor performance on fractional items in both internal and external assessments, has drawn the attention of several researchers (D'Ambrosio & Mewborn, 1994; Misquitta, 2011; Davis, 2010, 2017b). A comprehensive

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examination of the majority of important works on fractions dating back to the early 1980s, including one of the most important studies on rational numbers. The Rational Number Project (RNP) was launched in 1979 and concluded in August 2000. Since 1980, the RNP has been supplementing the research literature with reports on studies on the teaching and learning of fractions in mathematics among fourth and fifth graders (Bezuk & Cramer, 1989; Behr, Wachsmuth, Post & Lesh, 1984; Mitchell & Horne, 2010; Misquitta, 2011). Little attention is given to how fractional concepts were introduced in the earlier grades like grades one since it is in this grade that learners first experience the concepts of fractions. Little or no attention is given to the building blocks of mathematical concepts like fractions on how teachers introduced learners to fractions at the early grade in Ghana.

A review of studies on fractions to date revealed an effort by various researchers (Ni & Zhou, 2005; Charles & Nason, 2000; Siegler, *et al.*, 2011; Bailey, Hoard, Nugent & Gerary, 2012; Moseley, Okamoto & Ishida, 2007; Newton, 2008; Davis, 2010, 2016) to focus their study on where fraction use/instruction begins, whether formally or informally, that is, in fifth grade or lower, with sparse research on how primary school children are introduced to fractions. Because of the complexities of the various sub-constructs that can be assigned to a fraction (i.e., part-whole relationship, measure, operator, quotient, and ratio), more in-depth and ongoing research is required to improve conceptual and functional understanding of these fundamental school concepts. Boulet (1998) discussed the significance of pupils' understanding of mathematical concepts and the consequences of a lack of understanding. She went on to say

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that understanding is, without a doubt, the goal of learning, and that teachers generally make sure their pupils understand what they learn. She emphasized this by saying that:

> Without the understanding of the mathematical concepts, the learning of mathematics is reduced to the mere memorization of formulae and the rules prevailing them. Mathematical concepts that are learned through mere memorization of algorithms cannot be meaningful and will become much less useful (p. 19).

Fractional concepts are very difficult for pupils to understand when the conceptual links are not established among its related concepts (Misquitta, 2011). This makes the learning of fractional concepts in the early grade very difficult and may transcend in learning other mathematical concepts. Misquitta reechoed that "Historically, fractions have been one of the most difficult mathematical skills to master" (Misquitta, 2011, p. 109). According to Davis, Bishop, and Seah (2009), and Davis (2016, 2017b), fractional concepts like identification of fractions, order, and equivalence receive little attention and are frequently taught out of context. Davis (2010) asserted that, rather than assuming that pupils already understand these topics, pupils in the early grades should thoroughly be introduced to fractional concepts in order to strengthen their understanding before moving on to operations on fractions.

A common error in teaching fractions, according to Aksu (2012), is having pupils begin computation before they have had enough experience to develop the necessary conceptualization. She advised teachers to: (a)

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use manipulatives/physical referents and meaningful engaging activities to promote higher-level thinking skills and conceptual understanding of pupils' fractional ideas; and (b) assist pupils in creating the 'correct' constructs among fractions required to successfully pursue the tasks of performing and understanding operations on fractions if pupils are to make meaning of their learning. Pupils' fractional concepts can be improved by allowing them to work with different physical models (i.e., continuous and discrete) before performing operations on fractions (Behr & Post, 1992; D'Ambrosio & Mewborn, 1994).

One of the primary goals of mathematics education is to help pupils develop their reasoning skills in fractions so that they can apply their content knowledge and skills to solve real-world problems (NCTM, 2003). This is only possible if teachers use appropriate methods to introduce pupils to mathematical concepts like fractions in a way that allows pupils to transfer the content knowledge they have learned in context. Given the numerous challenges that pupils face when learning fractions, it is not surprising that a number of studies on this topic have been considered (Cramer, Post, & Delmas, 2002; Keijzer & Terwel, 2003; Stafylidou & Vosniadou, 2004; Siegler, *et al.*, 2011).

National Council for Curriculum and Assessment (NaCCA) (2019), indicates clearly that the old curriculum does not have what it takes to help learners in Ghana to demonstrate deeper understanding and mastery of knowledge (metacognition) and skills that they need to develop as they progress through their education and hence the need for the introduction of the standard-based oriented curriculum at the primary school level. As a result, the new (standard-based) curriculum for primary schools, which was implemented in

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September 2019, stated that the old (objective-based) curriculum was too mechanistic in nature and did not allow learners to expand, change, enhance, and modify their worldview. According to NaCCA's learning philosophy, "Mathematics learning is an active contextualized process of constructing knowledge based on learners' experience rather than acquiring it" (NaCCA, 2019, p. v). To achieve the 2019 primary school mathematics curriculum's main learning philosophy, teaching and learning must take place in context. It was also evidence from literature that these poor achievements and retention in the learning of mathematics was a result of non-use of appropriate teaching approaches in teaching and learning mathematics (Hedegaard & Chaiklin, 2006; Davis, & Chaiklin, 2015; Davis, & Seah, 2016; Davis, 2010, 2016, 2017a, 2017b). Davis' work in 2010 emphasized that the way teachers introduce pupils at the early grade to mathematical concepts, especially fractions are usually done out of context (Davis, 2010, 2017b).

Literature also suggests that social and cultural contexts have a positive influence on how children learn mathematics as highlighted in the background to the study (Kaleva, 2004; Presmeg, 2007; Davis, *et al.*, 2009; Davis, Seah & Bishop, 2009; Bishop, 1988, 2016; Davis, 2010, 2017b). Some researchers have developed models that attempt to bridge the gap between home and school mathematics (Presmeg, 2006b; Hedegaard & Chaiklin, 2006; Davis & Chaiklin, 2015; Davis, 2017b). Davis' Three-tier teaching model for teaching mathematics in context is an innovative way of teaching and learning mathematics in context. However, Davis' three-tier teaching model for teaching mathematics in context appeared to have been tried on a small sample. Despite the number of

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interventions by the stakeholders in education in improving the teaching of fractions in the primary school, little is known about introducing pupils to fractions in context at the primary school level in Ghana (Davis, 2010, 2016, 2017a, 2017b). As a result, it is essential to understand how pupils are introduced to fractions at a young age, because fractions serve as the foundation for learning other concepts in mathematics (Verschaffel, Janssens, & Janssen, 2005). This present study investigated the effect of an innovative way of introducing primary one pupils in identification of fractions through the use of the three-tier teaching model for teaching mathematics in context. It also aimed at ascertaining and extending the understanding of teaching identification of fractions in context to improve primary one pupils' performance in fractions through the use of the three-tier teaching model for teaching mathematics in context.

Purpose of the Study

This study sought to investigate the effect of the three-tier teaching model for teaching mathematics in context on primary one pupils' performance in identification of fractions. It also aimed at ascertaining and extending the understanding of teaching in context to improve primary one pupils' performance in identification of fractions through the use of the three-tier teaching model for teaching mathematics in context.

Research Questions

The following research questions were formulated to guide the study:

1. What is the performance of primary one pupils in the identification of fractions in the pretest?

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a. What is the performance of primary one pupils in the identification of fractions in the pretest by districts?

b. What is the performance of primary one pupils in the identification of fractions in the pretest by control and experimental groups?

c. What is the performance of primary one pupils in the identification of fractions in the pretest by Below Average, Average and Above Average achieving schools?

d. What is the performance of primary one pupils in the identification of fractions in the pretest by sex?

2. What is the performance of primary one pupils in the identification of fractions in the posttest?

a. What is the performance of primary one pupils in the identification of fractions in the posttest by districts?

b. What is the performance of primary one pupils in the identification of fractions in the posttest by control and experimental groups?

c. What is the performance of primary one pupils in the identification of fractions in the posttest by Below Average, Average and Above Average achieving schools?

d. What is the performance of primary one pupils in the identification of fractions in the posttest by sex?

3. What is the effect of the three-tier teaching model for teaching mathematics in context on primary one pupils' performance in the identification of fractions?

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H_01g: There is no significant difference between the performance of male and female pupils in primary one in the pretest from the experimental group.

H_01h: There is no significant difference in the performance of male and female pupils in primary one in the pretest from the experimental group.

The next set of hypotheses investigate the effect after the intervention across different context of schools and are listed below:

H_02a: There is no significant difference between the performance of primary one pupils in the control and experimental groups in the posttest.

H_02b: There is no significant difference between the performance of primary one pupils in identification of fractions by context of schools in the posttest.

H_02c: There is no significant difference between the performance of primary one pupils in the identification of fractions from CCM and MFM in the posttest from the control group.

H_02d: There is no significant difference between the performance of the male and female pupils in primary one in the identification of fractions in the posttest from the control group.

H_02e: There is no significant difference in the performance primary one pupils in the identification of fractions in the context of schools in the posttest from the control group.

H_02f: There is no significant difference between the performance of primary one pupils from CCM and MFM in the posttest from the experimental group.

H_02g: There is no significant difference in the performance of primary one pupils in the identification of fractions in the context of schools in the posttest from the experimental group.

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$H_0$2h: There is no significant difference between the performance of male and female pupils in primary one in the identification of fractions in the posttest from the experimental group.

$H_0$2i: There is no significant difference in primary one pupils' control group's pretest scores and that of its posttest scores.

$H_0$2j: There is no significant difference in primary one pupil's experimental group's pretest score and that of its posttest scores.

Significance of the Study

The findings of this study have the potential to stir up the current school of thought that guides mathematics education in Ghana and inform policy and pedagogical practices accordingly in mathematics education. Such information will be crucial at this present time especially when Ghana is trying to re-orient her mathematics and science education to meet international standards with the introduction of the standard-based curriculum. Therefore, teacher training institutions and other stakeholders will put teaching in context at the center of their education in order to provide prospective teachers with the required abilities, knowledge and value in extending the understanding of teaching in a context in using a more innovative approach of teaching mathematics like the three-tier teaching model for teaching mathematics in context pedagogy in teaching fractions.

Teachers in Ghana particularly will use the three-tier teaching model for teaching mathematics in context as a pedagogical tool to improve the performance of their pupils in identification of fractions by identifying some of the elements of Ghanaian cultural practices that influence pupils' learning and

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tailoring their lessons in such a way that will support pupils understanding of mathematics rather than promoting mere memorizations of algorithms.

The findings in this study will also help pupils to learn mathematics in context since context-based teaching will trigger learning to be done in context as well. This will enable pupils to easily make connections between school mathematics and the mathematics they encounter in their daily lives. This will go a long way in improving pupils understanding of fractions and hence their achievement in mathematics.

The study has found the three-tier teaching model for teaching mathematics in context to be effective in improving pupils' performance in identification of fractions. Hence this will serve as an example of an innovative teaching model for teaching mathematics in context for teachers to use in teaching fractions and its related concepts in context.

To the research community in Ghana, this study is useful in the sense that literature on the influence of the three-tier teaching model for teaching mathematics in context to the knowledge of the researcher, is very rare. This study, therefore, contributed to literature about the effect of the three-tier teaching model for teaching mathematics in context on the learning outcomes of learners in Ghana. This will inform future researchers to take a keen interest in teaching in context.

Through literature, the study has enhanced the researcher's understanding of teaching in context in mathematics education. Hence, the researcher now has a deeper understanding of teaching in context and its role in the teaching and learning of mathematics.

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Delimitations

This study was designed to ascertain and extend understanding of teaching in context to improve primary one pupils' performance in identification of fractions through the use of the three-tier teaching model for teaching mathematics in context. Since this study was designed to find out the effect of the three-tier teaching model for teaching mathematics in context on primary one pupils' performance in identification of fractions, the study was restricted to only the introduction to fractional concepts in mathematics.

The study used primary one mathematics teachers and their pupils from CCM and MFM. The study was restricted to only primary one (1) pupil and their teachers since it is now the level where the introduction to fractional concepts begins in the primary schools. This means that all other groups of teachers and pupils were not included. The study was carried out in two districts in the Central Region due to convenience, financial and time constraints. Again, although there were 96 and 84 public primary schools in the CCM and MFM respectively as at the time of conducting this study, the study was confined to 24 public primary schools from these two districts. Finally, the domain of content to be covered in this study was the identification of fractions. This implies that all the other areas of mathematics were not included.

Limitations

The study was carried out in the CCM and MFM in the Central Region of Ghana, thus a large section of the population of primary one pupils and teachers were not included. However, this did not affect the authenticity and generalizability of the findings. Also, the study did not explore the other

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approaches in introducing pupils to fractional concepts but was limited to the use of the conventional approach and a three-tier teaching model for teaching mathematics in context approach as sole pedagogical tools for the control and experimental schools respectively.

Definition of Terms

Basic school is made up of pupils from grades 1-9 (i.e., pupils in primary and junior high schools). (My explanation for this study).

Primary school is made of pupils from age 5 to 13 (My explanation for this study).

Culture refers to the shared values, norms, knowledge and understanding which serves as a mode through which individual human minds interact in communication with one another (Bishop, 1988).

Curriculum, as used in this study is not limited to the syllabus for teaching but includes the aims, content, methods and assessment procedures (Howson, Keitel & Kilpatrick, 1981).

Formal approach to mathematics refers to approaches that are related to learners' scientific concepts, often gotten in textbooks. (Bishop, 1988).

Informal approach to mathematics refers to mathematical approaches that connect learners' out-of-school/home practices to that of In-school mathematics (Davis, 2010).

In-school mathematics refers to international/western mathematics which the learners normally acquire through formal schooling (Davis, 2010).

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Out of school/everyday mathematical practices refer to mathematical practices experienced in everyday life which may not be the same as school/western mathematics. This knowledge constitutes knowledge acquired by the child through cultures as he/she grows (Davis, 2010).

Performance, as used in this study, refers to grade/score obtained by pupils in any examination(s) conducted by any organization /group of experts recognized by the Ghanaian system as credible enough to assess the attained curriculum. These, therefore, include pupils' scores/grades in performance monitoring test (PMT), Ghana Education Service (GES), Basic Education Certificate Examinations (BECE) conducted by the West African Examinations Council, Trends in International mathematics and Science Study (TIMSS) conducted by IEA and other examinations conducted by teams of experts for research purposes (Davis, 2010).

Context of schools as used in this study refer to Below Average (BA), Average (A) and Above Average (AA) achieving schools as categorized by performance monitoring test (PMT). (My explanation for this study).

Sex as used in this study, refers to strictly male and female pupils/teachers. (My explanation for this study).

Everyday mathematical concepts as used in this study refer to the learners' everyday concepts which they form as a result of their participation in social and cultural activities which are mathematical in nature and not formally taught and learned in school. (My explanation for this study).

Scientific concepts as used in this study refer to international mathematics which is formally taught and learned in school. (My explanation for this study).

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researcher for the study is presented in Chapter three, namely the research methods, including the research design, research participants, various data sources and their relationship with the research questions and hypotheses presented in Chapter one, data analysis procedure, and their relationship with the research instruments. The research methodology's implementation was also discussed. Chapter four presents the findings and discussion of the research questions and hypotheses that guided this study, as well as how the entire research procedure described in Chapter three was carried out. The key findings, conclusions, and recommendations for future research were drawn from the discussion of the findings in Chapter four and in relation to the research problem outlined in Chapter one.

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CHAPTER TWO

LITERATURE REVIEW

This chapter reviews literature related to the study. Major thematic areas include theoretical perspectives, socio-cultural theory of learning, Vygotsky's zone of proximal development in the teaching and learning of mathematics, mediation, ethnomathematics, mathematics and culture, three-tier teaching model for teaching mathematics in context, the roles of context in teaching and learning fractions, formation of fractional concepts in mathematics, fractional constructs, challenges faced by pupils in learning fractions and the roles of learners' sex in the teaching and learning of mathematics.

Theoretical Perspectives

Some theories have been proposed in an attempt at explaining the process of teaching in context. Notable among these theories are Socio-cultural theory and Ethnomathematics. These theories are discussed below.

Socio-cultural Theory of Learning

The cultural and social contexts of learners play vital roles in shaping a learner's cognitive capacity (Vygotsky, 1978; Bronfenbrenner, 2005; Lave & Wenger, 1991; Allman, 2018). Society, culture and history have contributed to the cognitive development of most (if not all) individuals. As a result, the role of social processes in knowledge acquisition cannot be underestimated (Phan 2008, 2008a, 2008b, 2009a, 2009b, Vygotsky 1978). A learner shapes his or her experience through interaction with the environment or through participation in cultural activities. Learners learn in multiple ways from their siblings, friends,

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parents or elders at home (Allman, 2018). This means that social interaction and learner culture can impact the creation of the child's knowledge. According to Vygotskian's theory, social interaction and culture play a key role in the development of high-level thinking among learners (Vygotsky, 1978), mentioned in (Allman, 2018). Thus, the adoption of this perspective in mathematics education will help learners attain high-level thinking skills. According to him, learning is carried out in a context and these contexts are of a social and cultural nature. This is supporting the present study that intended to allow teachers and learners to teach and learn in context through the use of the three-tier teaching model for teaching mathematics in context (Davis, 2010, 2017b). Teaching and learning mathematics should take place in context. The origins of the socio-cultural theory of learning are presented below.

The Origin of Socio-cultural Theory

The socio-cultural theory of learning was pioneered by Russian psychologist Lev Vygotsky (1896 - 1934). He was a gifted scholar with diverse interests, as well as a successful scholar and creative author in educational psychology. Vygotsky's goal was to develop a new comprehensive approach to human psychological development (Miller, 2011), which was cited in (Allman, 2018). He also looked into the work of some researchers, including Pavlov, Binet, Piaget, and Freud. He frequently mentioned their philosophies in his presentations on human psychology. Hegel's, Marx's, and Engels' ideas also help to clarify his point of view. He died of TB when he was 37 years old. His untimely death occurred ten years after he had completed a career in psychology and education (Miller, 2011; Kirshner & Meng, 2011; Allman, 2018).

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Immediately after Vygotsky's death, his ideas were generally not allowed to be used for political reasons, and no one could even talk about it until the late 1960s, when his ideas were revisited and allowed to be reused following the Soviet Union's demise. Vygotskian thought became more popular in the Western world in 1962. His works and ideas have since been translated into languages that everyone can read and understand (Allman, 2018). Thanks to the efforts of some scholars, his ideas are still being spread around the world (Wertsch, 1985; Engestrom, 1987; Miller, 2011; Phan, 2009b, 2010). Vygotsky's ideas influenced educational psychology and learning theories significantly (Driscoll, 2000). It is also used to inform the vast majority of current educational practices (Miller, 2011; Allman, 2018).

Vygotsky's viewpoints of teaching and learning were often associated with Piaget's theories of teaching and learning largely because both psychologists in education rivetted their theories on understanding the cognitive processes and the development of the learner in teaching and learning (Allman, 2018). On the other hand, Bruner describes their theories as inadequate because Piaget and Vygotsky have focused on two ways that learners can make sense of their world. Piaget proposed that this can occur through thought, whereas Vygotsky proposed that it occur through interpretive reconstruction of circumstances, and both of these are insufficient indicators of meaningful learning (Driscoll, 2000, p. 240). Vygotsky's viewpoints were regarded as complementary to Piagetian viewpoints and other Western approaches because his all-encompassing socio-cultural viewpoint balances the emphasis on the individual, as a position by Piagetian theory of teaching and learning (Miller,

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2011; Bruner, 1990; Burling, Armstrong, Blount, Callaghan, Foster, King,..., & Wynn, 1993; Forman, 2003; Allman, 2018). The fundamental principles of Socio-cultural theory are discussed further below.

Dominant Tenets of the Socio-cultural Theory

The socio-cultural theory is influenced by three fundamental ideas: a) the social interaction of learners, b) language and c) the zone of proximal development (Vygotsky, 1978) cited in (Allman, 2018). These three concepts focus on the socio-cultural perspective of learning. Each of these primary concepts, as well as related ideas and their implications for teaching and learning, will be introduced. The social interaction between learners is one of the most important factors influencing effective learning initiation. The socio-cultural learning perspective holds that the learner's thinking process has social consequences for how the learner learns. Social and cultural theorists believe that intellectual development cannot be understood without reference to the social and cultural contexts in which the learner conveyed this knowledge (Allman, 2018). He hypothesized that social and cultural contexts play an important role in the cognitive growth process of the learner in advancing higher-level intellectual skills.

The knowledge gained by the child through participation in social and cultural activities must serve as the foundation for how and what the child will think and do in new situations with which the child will be confronted with (Driscoll,2000). Vygotsky, for example, emphasized that an individual's learning takes place on two levels: the social level and the individual level. He believes that learning at the social level should serve as a foundation for learning

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at the intrapersonal level. That is, first among so-called inter-psychological people, and then within the child, which is known as intra-psychological (Vygotsky, 1978). The learner's active participation in the development of new intellectual and problem-solving skills through a contextualized collaborative activity with an experienced peer distinguishes this stage. The experienced peer does not necessarily have to be the teacher, but can be anyone in the learner's immediate environment who is knowledgeable than the learner (Rogoff, 1990). Cooperative learning allows a learner to internalize or participate in shared social experiences and the learning outcomes that come with them. This helps the learner develop problem-solving abilities for dealing with social issues (John-Steiner & Mahn, 1996; Scott & Palincsar, 2013; Allman, 2018). The Vygotskian view of cognitive development is demonstrated by the social context and individual interiorization processes. The social and cultural context considers learning to be the transformation of socially shared activities or experiences into internalized processes or an act of socialization, emphasizing the importance of social contexts in learning (John-Steiner & Mahn, 1996).

Vygotsky's perspective on the social context of learning contrasted with more popular views of Piaget's theory of cognitive development, which proposed that growth through certain stages is biological and determines and leads the individual in acquiring cognitive complexity (kristinsdottir, 2001; Allman, 2018). This difference in Vygotsky and Piaget's assumptions is critical because of the practical implications for teaching and learning. Piaget stated that developmental stages are required for learning. According to Driscoll, from a Piagetian standpoint, some concepts will not be taught until students reach a

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certain age (Driscoll, 2000). This was not the case in Vygotsky's opinion. He believed that meaningful learning is initiated by sound social and cultural contexts of the learner. If teachers believe that age progression drives learning, then learners must progress in order to acquire the universal ideas and values required to solve new tasks or problems. Teachers can design lessons to promote intellectual growth among students in a variety of social and cultural contexts (Vygotsky,1978; Scott & Palincsar, 2013). This will help students develop high-level thinking skills needed to solve new problems (Miller, 2011). According to Vygotsky, the learner's internal developmental processes can only be effective if the learner is allowed to interact with his environment and peers in a way that promotes meaningful learning in the child. Learning becomes shared knowledge in this context, and it can be applied to resolving new societal problems (Vygotsky, 1978). Learning becomes shared knowledge in this context, and it can be applied to resolving new societal problems (Vygotsky, 1978). Teachers teach math to students so that they can become problem solvers in their society. As a result, if the method of instruction does not encourage this, the proper theoretical foundation for teaching and learning is not used.

Another conclusion based on the Vygotsky learning point of view from historical and cultural contexts is that the socio-cultural perspective recognizes individual and intercultural differences in the development of intellectual growth in learners (Allman, 2018). Although diversity is necessary for the development of higher-level thinking skills, most research from this perspective focuses on white middle-class children with a western tradition and the assumption of universality (Miller, 2011). It is important to note that different

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cultures may have different historical and cultural contexts that promote different developmental paths and experiences, making it difficult for teachers to assume universality (Miller, 2011). As a result, when planning lessons, teachers must consider cultural diversity and apply the appropriate theoretical foundation that is functional to the development of the learner.

Language, according to (Vygotsky, 1978), plays an important role in learning. Vygotsky believed that language communicates advanced reasoning and that language shapes cognition, beliefs, attitudes, values, and perceptual realities (Miller, 2011). He emphasized that tools and signs, or semiotics, such as language, counting systems, conventional signs, works of art, and so on, mediate both the social context and an individual's innate ability. Vygotsky refers to these tools as semiotic mediation, and they promote the co-construction of insight as well as the individual's social and individual functioning (Allman, 2018). This semiotics is important in the creation of knowledge through appropriation. Appropriation is the process by which a person adopts these socially available psychological tools in order to become an independent problem solver (John-Steiner & Mahn, 1996). This means that learners will not have to re-create existing tools before using them to learn. The learners only need to be shown how to use a specific tool effectively before applying it in a variety of situations, including solving novel societal problems (Cole, 1967, 1996; Scott & Palincsar, 2013; Brow, Collins & Duguid, 1989; Allman, 2018).

Language, according to Vygotsky, is the direct result of cultural symbols and tools. It is a type of symbolic mediation that serves two critical functions: communicating with others and creating meaning (Kirschner & Martin, 2010;

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McLeod, 2014). To begin, language is used to give social interactions meaning. It occurs when a child interacts with his or her environment and learns the language of his or her immediate surroundings through a variety of social events and processes. In general, the child's family and friends play an important role in his or her cognitive development (Mitchell & Myles, 2004; McLeod, 2014; Allman, 2018). For example, when a child realizes that words have meaning and that this meaning is shared within the language community, he or she begins to use these words to communicate with others in order to form meaningful thoughts. During this stage of cognitive development, a child reinforces the tone of voice and the manner in which ideas are addressed. Signs and symbols are used to assign value to objects and events, which shapes an individual's value set (Miller, 2011; Tharp, 2001; Phan, Maebuta & Doroyolomo, 2010; Allman, 2018). At the start of childhood cognitive development, Vygotsky's language and thought are two distinct systems (Vygotsky, 1986). Language is also helpful in understanding. When children are three years old, they start to develop what we call private discourse. There, the language is either external or open. This is similar to social discourse but directed toward the individual. In addition, private speech is used for mental and self-regulatory functions rather than for communication (McLeod, 2014; Vygotsky, 1986; Allman, 2018). It may be seen when a child expresses his thoughts aloud. This is generally the case when he or she solves difficult problems and tasks. They communicate their thinking through language. They use language to plan based on collaborative modelling strategies. They can do this generally with somebody with advanced experience. As a result, private speech becomes a tool used by the child to aid his or her

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cognitive processes and development, rather than simply a component of a child's social activity (Miller, 2011; Allman, 2018). Language and thought, according to Vygotsky, begin to consolidate into two separate systems at the age of three and eventually become interconnected. This implies that thoughts become verbal, and discourse assumes a representative role (McLeod, 2014).

The transition from private to public discourse occurs gradually. Around the age of seven, private discourse becomes less visible. As a result, a child's monologue internalizes private speech as self-talk as they grow older. A child might 'think in words. Vygotsky defined external discourse as the verbal embodiment of thought. Interior discourse becomes more personal, abridged, and disjointed, and it is "largely thought into pure meanings" (Vygotsky, 1986, p. 249). Like the private speech, the inner word remains directed toward oneself and maintains self-regulated and intellectual functions. Language internalization is important because it promotes cognitive growth.

Vygotsky estimated that an individual's social context has a strong influence on private discourse. The high correlations observed in children between social interaction and private speech support this (McLeod, 2014; Allman, 2018). Children from more affluent families are frequently raised in more stimulating cognitive and linguistic environments. As a result, they can begin using and internalizing private discourse earlier than their less advantaged peers (McLeod, 2014). It has a unique educational impact. Appropriate educational environments, particularly in the early years of primary school, can provide additional cognitive and linguistic support as well as serve as a model for academic monologue. These can have a positive impact on the development

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of private and inner speech in children of all backgrounds. This, in turn, may benefit their cognitive development and educational achievement (Robbins, 2005; Ladson-Billings, 1995; Thunissen, 2005; Allman, 2018). This necessitates teaching and learning of mathematics in a way that allows students to make sense of their social and cultural contexts.

Meaningful learning takes place within the zone of proximal development. The concept of Zone of Proximal Development (ZPD) is perhaps the most widely accepted concept in socio-cultural theory. It is "the distance between the actual developmental level of the learner as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). That is where learning takes place. According to Vygotsky (1978), effective learning should be matched to a child's developmental level. He believes that there is a need to distinguish between the learner's actual level of development and the learner's potential level of development. He contends that the ZPD is a better and more self-motivated indicator of cognitive development than simply a measure of what children can do on their own.

Vygotsky defined ZPD application broadly as "any situation in which a specific activity leads children beyond their current level of functioning." This means that the area can be used for recreation, work, school, and other purposes (Miller, 2011). He contended that productive interactions "start teaching toward the ZPD; otherwise, teaching lags behind the child's development" (Scott & Palincsar, 2013, p. 8). Within the ZPD, interactive instruction and guidance

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allow a learner to develop skills and strategies that they will eventually apply on their own in other related situations. This will encourage the development of higher cognitive abilities (Vygotsky, 1978; Allman, 2018).

It is impossible to overestimate the importance of a learner's social partner. The type of social interactions, tools used, and skills practiced all influence the outcome of the collaborative experience. This could result in both normal and accelerated cognitive progression for the individual, as well as developmental delays and abnormal development (Driscoll, 2000; Allman, 2018). As a result, an ideal co-learner, whether a teacher or an experienced peer, should possess sufficient advanced knowledge or skill to facilitate learning. The experienced peer should also be able to interact with the learners within the zone at a level that the learners can achieve. In addition, when working on an effective collaborative activity, learners may have shared knowledge and understanding of the task. They would also be bound by a common goal, which is referred to as inter-subjectivity. Learners working together must co-create knowledge by solving a problem through a collaborative effort, which implies shared influence and experience over the process (Driscoll, 2000). Scaffolding is the next concept to be discussed in socio-cultural theory.

In the 1970s, Bruner, Wood, and Ross introduced scaffolding to socio-cultural theory (Puntambekar & Hübscher, 2005). What is it exactly? Scaffolding is the ongoing assistance provided by an experienced peer to a learner in the process of learning and completing a task that the learner cannot complete on their own. As the learner achieves optimal learning, the support is gradually reduced. Scaffolding is thus a support mechanism that helps a learner

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complete a specific task within the ZPD. As a result, it is an excellent tool for guided discovery. It entails a mutual and one-of-a-kind interaction. Working together, the learner and the experienced peer influence and adjust each other's knowledge (Miller, 2011; Allman, 2018). Scaffolding in a socio-cultural context, like physical scaffolding, provides both movable and transitional assistance to building sites. It refers to a more experienced peer who, rather than the learner, provides them with the necessary support as their emerging skills progress. So, what is the basis for this assistance? These supports are dependent on the learner's rate of intellectual growth and are reduced considerably as the learner gains competence, promoting independence in the ZPD region (Miller, 2011). Scaffolding becomes more effective when an experienced peer who knows both content and pedagogy can tailor the task to the learner in a manner in which the learner can make sense of it. The experienced peer motivates and guides the learner by providing just enough help, modelling and explaining the essential characteristics of the task. The experienced peer can do the same thing by constantly evaluating and trying to adjust the support as needed. Furthermore, the experienced peer facilitates reflection by making suggestions and asking questions. These encourage more complex, useful, and long-term experiential learning (Puntambekar & Hübscher, 2005).

Furthermore, ZPD and scaffolding concepts have far-reaching implications for assessment, teaching, and education in general (Allman, 2018). Assessment has traditionally been used to assess what learners know and understand spontaneously at a given time. Vygotsky, on the other hand, held a different viewpoint. He believed that assessing what a learner knows

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independently as well as what they can do or fully comprehend with assistance provides a more accurate estimate of that individual's personal learning (Allman, 2018). In socio-cultural theory, assessment methods seek to measure a learner's performance holistically (Miller, 2011). Knowing how a pupil can accomplish without and with the assistance of a more knowledgeable peer will have a positive impact on teaching and learning.

Furthermore, the socio-cultural perspective suggests a different approach in viewing the relationship between the learner and the teacher compared to what is presently happening in a socio-cultural learning context. The learner assumes more responsibilities. These may include identifying the learning objectives, becoming a resource base for their peers, and being a collaborator in the learning. This makes learning a more shared enterprise. Teachers are referred to as guides, assistants, and facilitators rather than knowledge communicators or delivery agents and these distinguish it from the Piagetian perspective which focuses solely on the innate ability of the individual learner (Allman, 2018). This shift in roles promotes individualized, differentiated, and learner-centred types of instruction. When such appropriate educational practices are followed, they provide an influential alternative method for reshaping modern education systems (Watson, Lee, & Reigeluth, 2007).

Merits and Weaknesses of Socio-cultural Perspective to Learning

The socio-cultural perspective has numerous widely acknowledged benefits. It encompasses the larger social, cultural, and historical context of all human activity (Davis, 2010; Allman, 2018). People are not regarded as remote

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entities in the socio-cultural perspective, which provides a more affluent perspective by emphasizing the interaction between oneself and others. The socio-cultural viewpoint describes a child's powerful nature, which develops societal knowledge and skills and, as a result, shapes their worldview (Miller, 2011; Allman, 2018). Second, the socio-cultural perspective takes into account individual and multicultural diversity among learners. In contrast to other developmental perspectives that emphasize collective aspects of intellectual growth, the socio-cultural perspective acknowledges disparities within a culture as well as disparities across cultures (Allman, 2018). In relation to a specific societal situation, the socio-cultural perspective recognizes that "different historical and cultural circumstances may encourage different developmental routes to any given developmental endpoint" (Miller, 2011, p. 198). Furthermore, the socio-cultural perspective connects the concepts of learning and growth, which significantly contributes to the theoretical understanding of cognitive growth. The concept of learning is socially motivated rather than determined by the learner's developmental level (Miller, 2011; Allman, 2018).

The socio-cultural approach is also noted in the literature to have some constraints (Allman, 2018; Rogff, 1990). The first constraint is associated with the early death of Vygotsky's which could not allow him to elaborate more on his theory (Allman, 2018). Furthermore, due to political constraints and translation issues, little was known about his philosophies. Furthermore, the significant constraint is associated with the ZPD's ambiguity. Individuals may have large or small areas that are suitable or unsuitable depending on the learning context. Increasing the size of the zone "does not provide an accurate

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picture of their learning, ability, learning style, and current level of development in comparison to other children of the same age and level of motivation" (Miller, 2011, p. 198). Furthermore, little is known about whether a child's zone is comparable across different learning domains, with different learners, or whether the length and width of a specific learner's zone change over time. There is also no universal metrical scale for assessing the learners' ZPD (Miller, 2011). Finally, Rogoff emphasizes that Vygotsky's theories may not be as universal as Vygotsky initially assumed. Vygotskian theory provides scaffolding for a system that is heavily reliant on oral instruction. As a result, this may not apply to everyone from all cultures (Allman, 2018). Because of its numerous strengths that outweigh its few weaknesses, my study capitalized on the strengths of the socio-cultural theory to underpin this current study.

Concept of Mediation

Vygotsky's conceptualization of mediation as a representation tool in solving a problem is key in social-cultural learning theory (Vygotsky, 1978). This tool was used by the child in solving a societal problem. One of the major tools used by the child in learning mathematics is language and language is a social-cultural tool (Davis, 2010, 2017b). So maximum learning is attained when the teacher consciously integrates the diverse cultural tools of the learners during the teaching and learning process. In Davis' works in 2010 and 2017, the child's everyday concepts are key in learning school mathematics.

Language familiar to the child is therefore instrumental in learning all mathematical concepts. He described this process as enculturation. In this case, the child relatively appreciates concepts being learned if it is communicated in

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a language that is suitable in the domain of the child to understand. So, in mediation the social context is key. Turuk (2008) described mediation as a process in the development of the child which is initiated by more experienced ones in the child's life in the society. Davis (2010, 2017b) saw the need to use language familiar to learners by using Ghanaian language (Fante) to introduce learners to fractions and concluded that indeed language familiar to learners play a key role in concept formations in learning mathematics. Vygotsky (1987) also emphasized that social, cultural and historical contexts contribute significantly towards the child's cognitive development and potential development in learning.

Ethnomathematics

D'Ambrosio (1985) coined the term ethnomathematics to describe the mathematical practices of identifiable cultural groups. It can be defined as the study of mathematical practices from any culture. D'Ambrosio (1990) decided to modify the definition of ethnomathematics as follows:

> The prefix ethno is today accepted as a very broad term that refers to the social-cultural context and therefore includes language, jargon, and codes of behaviour, myths, and symbols. The derivation of mathema is difficult but tends to mean to explain, to know, to understand, and to do activities such as ciphering, measuring, classifying, inferring, and modelling. The suffix tics is derived from techné, and has the same root as technique (p. 81).

Rosa and Orey (2007) define ethnomathematics as members of a group within a cultural setting who are identified with their cultural traditions, codes,

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symbols, myths, and specific ways of making meaning to each other. According to Rosa and Orey, the low achievement of pupils in mathematics can be attributed to the absence of cultural harmony in the curriculum in most countries. So, integrating cultural aspects in the curriculum will promote mathematics learning among pupils (Eglash, 1997; Rosa & Orey, 2007, 2008; Zaslavsky, 1973, 1997). In other words, cultural aspects of mathematics emphasized mathematics from our everyday lives, improving our ability to make meaningful connections and deepening our understanding of mathematics. In this perspective, Davis (2010, 2017b) asserted the need for building connecting home mathematics to school mathematics. He emphasized that though home and school mathematics are independent of each other, however, the two are mutually influential in the learning of mathematics.

According to Ascher (1991), ethnomathematics is the mathematical ideas of traditional people. Some ethnomathematics researchers found the tone of Ascher's definition of ethnomathematics offensive (Pompeu, 1994; Presmeg, 1998). Pompeu (1994) extended Ascher's definition of ethnomathematics, stating that ethnomathematics is any form of cultural knowledge or social activity that can be recognized by other cultural groups, such as Western anthropologists, but is not necessarily identified as mathematical by the original group. This definition also implies that while some cultures may not recognize their activities as mathematical, others outside of that culture may see them as such. Presmeg (1998) also gave a simpler definition of ethnomathematics. She defines ethnomathematics as the mathematics of cultural practices of a group of people.

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This definition is more generic and straight to what ethnomathematics is all about. So, drawing on Presmeg's conception of ethnomathematics ideas which was generally about the cultural practices of a group that are mathematical in nature. This re-echoes the cultural, social and historical nature of mathematics which must be situated in the context of practices of an individual or a group of people. Meaning mathematics emanated out of contexts and these contexts are history, social and culture. This implies that in ethnomathematics literature, the perception that mathematics is value-free or culturally neutral is no longer conceivable (D'Ambrosio, 1985; Bishop, 1988; Presmeg, 2007; Davis, 2010, Davis, *et al*, 2019). Therefore, teachers' knowledge of pupils' culture influences learning outcomes in mathematics (Ladson-Billings, 1995; Charboneau & John-Steiner, 1988, Davis, 2010). It follows that teachers' knowledge of learners' culture forms the support base for the learning of mathematic in context. Ethnomathematics was developed to bridge the gap between school mathematics and home mathematics.

Ethnomathematics restores the cultural respect for the recognition of one's cultural activities that are mathematical in nature thereby creating the awareness of valuing one's own culture. Ethnomathematics programmes give local people the leverage to take pride in their own culture. Ethnomathematics reinforces culture, self-respect, and offers a broad view of human beings. Ethnic mathematics is not synonymous the same as ethnomathematics (Rosa & Orey, 2010). Ethnomathematics in its natural state is devoid of ethnicity. The concept of ethnomathematics is not selective but embraces the cultural nature of all cultural groups and the need to integrate culture into mathematics learning.

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There is a need for mathematics instruction that will take into consideration the cultural background of the learners in the mathematics classroom and used their prior experiences in scaffolding the learning of the school concepts of mathematics (Davis, 2017b).

The conception that mathematics is culture and value-free is no more plausible (Zaslavsky, 1973; Abreu & Duveen, 1995; Barton, 2008; Bishop, 1988; D'Ambriosio, 1999, 1985, 1997, 2001, 2006; Gee, 2009; Gerdes, 1994, 1988; Owens, 2001, 1999; Presmeg, 1998; Abreu & Cline, 2003; Goos, 2008; Davis, Seah & Bishop, 2009; Rosa, 2000; Rosa & Orey, 2008, 2011; Abreu, 1995; Gay, 2000; Torres-Velasquez & Lobo, 2004). In recent times, Mathematical facts which used to be considered absolute and unquestionable have now been considered not to be so (Bishop, 1988; Pinxten & Francois, 2007). This makes Mathematical knowledge to be seen as a great social element that can be objectified and subjected to mathematical proofs as well as criticisms (Bishop, 1988; Presmeg, 2007; Davis, 2010). Mathematics has been considered as a product of cultural activities (Bishop, 1988, 1993; Presmeg, 1998; Gay, 2000). Bishop (1988) added that "mathematics as a cultural product which needs to be acknowledged as such in the classroom both for effective teaching and meaningful learning of the subject in developing countries" (p.320). He therefore, advocates that the culture of both pupils and the teacher could be used as a great tool for teaching and learning mathematics. Charborneau and John-Steiner (1988) added that there is the need to take into account the numerous and varied experiences with which children come to school.

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Bishop (1988) emphasized that "mathematics must be understood as a kind of cultural knowledge, which all cultures generate but which need not necessarily 'look' the same from one cultural group to another" (p.180). Bishop added six postulates which are fundamental activities practiced by all cultural groups that have been studied to be necessary and sufficient for the development of mathematical knowledge. These activities include:

Counting: this is the process of systematically comparing and ordering discrete phenomena in one's cultural settings. This includes tally or recording with objects or strings, as well as special number words or names.

Locating: this entails exploring one's spatial environment and symbolizing it with models, diagrams, drawings, words, or other means.

Measuring: quantifying qualities for comparison and ordering by using objects or tokens as measuring devices with associated units or 'measure-words' in one's society.

Designing: making a shape or design for an object or any part of one's spatial environment. This could include making the object a "mental template" or symbolizing it in some culturally acceptable way.

Playing: process of creating and participating in games and pastimes with more or less formalized rules that all players must follow in order to play the game.

Explaining: finding ways to justify the existence of phenomena, whether religious, animistic, or scientific in nature, is a process. According to Bishop, mathematics as cultural knowledge is the result of humans engaging in these six universal activities on a consistent and conscious basis (Bishop, 1988, p. 182 -

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183). When teaching mathematics, it is critical to consider the diverse experiences that children bring to school.

The premise of mathematics as a cultural subject influenced the relationship between home and school mathematics in terms of concrete and abstract reasoning (D'Ambrosio, 1985; Presmeg, 1998; Nunes, 1992). Individuals' involvement in cultural activities in their local communities generates concrete reasoning among members of the society. Ethnomathematics seeks to raise awareness of mathematics' cultural nature. Cross-cultural research in both Western and non-Western societies revealed the cultural nature of mathematics (Cole, 1967; Greenfield & lave, 1982; Bishop, 1988; Davis, 2010; Davis & Chaiklin, 2015; Davis 2017a, 2017b). Different mathematics coexist in Western and non-Western societies, according to ethnomathematics literature (Nunes, 1992; D'Ambrosio, 1985; Bishop, 1988; Davis, 2010). To differentiate between the concepts of home and school mathematics, symbolic technology such as counting systems (Saxe, 1994) and measuring (Abreu, 1995) were used. Bishop (1988) broadened the use of symbolic technology to include counting, measuring, designing, explaining, playing, and locating to distinguish between home and school mathematics in terms of socio-cultural activities carried out by both western and non-western societies. Although all cultures produce mathematics that is not necessarily the same across all cultures, there are some cross-cultural activities that are cross-cutting in both western and non-western cultures (Bishop 1988). Bishop emphasized that counting, measuring, designing, explaining, playing, and locating are mathematically based cross-cultural activities. This prompted (Goodnow, 1990) to define mathematical cognition as

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a set of skills and strategies, or "situated processes" (D'Ambrosio, 1990), that are linked to the societal cultural context.

The literature argues for culturally relevant pedagogy that reflects the relationship between learners' cultures and the subject being taught at school (D'Ambrosio, 1990; Gay, 2000; Ladson-Billings, 1995; Rosa & Orey, 2003, 2006; Davis, *et al.*, 2009; Davis, 2010, 2017b). This is critical for bridging the gap between the mathematics learners do in their everyday settings (which is not formally taught) and the mathematics they do at school (which is formally taught). In this way, it is critical to integrate culturally relevant curriculum into school curricula. This will assist teachers in contextualizing whatever concept is being taught and connecting it to the learners' culture and reality (Davis, 2017b).

According to the National Council of Teachers of mathematics, every country's mathematics curriculum must connect mathematics learned in school to students' personal lives and cultures (NCTM, 1991). Rosa and Orey exemplified this by saying "When practical or culturally-based problems are examined in a proper social context, the practical mathematics of social groups is not trivial because it reflects themes that are profoundly linked to pupils' daily lives," (Rosa & Orey, 2006, p.34). This reflects the social and cultural aspects of mathematics that are often overlooked in math education.

The cultural relevance of mathematics emphasizes the role of mathematics in a socio-cultural context, which includes the ideas and concepts associated with ethnomathematics, as well as the application of an ethnomathematical perspective to real-world problems (Rosa & Orey, 2008).

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Bishop (1988) emphasized that, while different cultures produced different mathematics, some cross-cultural activities, such as counting, measuring, locating, playing, designing, and explaining, are present in all cultures. The focus of highlighting these cross-cutting activities is to promote cultural congruence. For teachers to promote cultural congruence in learning mathematics, there is the need for teachers to appreciate the cultures and languages of every learner (Zeichner, 1996).

Bishop (1988) classified the mathematics curriculum into enculturation and acculturation curriculum. To Bishop, enculturation curriculum entails inducing learners into their culture while acculturation curriculum involves inducting learners into practices that are alien to them. Davis (2017b) emphasized the need for teachers to pay conscious effort in transiting learners from their everyday cultural activities to international mathematics. Davis (2010, 2017b) attributes the low pupil's achievement in mathematics to lack of proper transition of learners from their everyday practices to that of the In-school concept of mathematics. Ethnomathematics was considered as one of the appropriate theories for this study because it alludes to the cultural and social nature of mathematics.

Three-tier Teaching Model for Teaching Mathematics in Context

Teaching in context in mathematics education has significantly become a central issue in education not only in developed countries but in developing countries as well (Freudenthal, 1983; Gay, 2000; Hedegaard & Chaiklin, 2006; Davis & Chaiklin, 2015; Davis, 2010, 2017b). The three-tier teaching model for teaching mathematics in context was developed in Davis (2010) and

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validated in Davis (2017b) using primary two pupils and their mathematics teachers in one school in Cape Coast Metropolis. The three-tier teaching model for teaching mathematics in context was developed using fractions and measurement at the primary school level (Davis, 2010). The model's approach to teaching mathematics in context gives credence to flexibility in the use of language that is familiar to the learner. This teaching model is an innovative approach in teaching mathematics in context. The use of the three-tier teaching model for teaching mathematics in context to teach mathematics at the primary schools was motivated by the belief that pupils' social and cultural context must have consequence for the teaching and learning of mathematics in the classroom in order to make the subject relevant (Davis, 2010, 2017b). The stages of Davis' Three-tier teaching model for teaching in contexts are presented below.

Stage one: at this stage, the pupils would be introduced to their own mathematical culture. At this stage pupils would be allowed to show how they experience mathematics at their own social and cultural contexts. At the enculturation stage, learners would be taken through their everyday mathematics in the classroom. Before starting school, children learned primary mathematical concepts such as plenty and few, greater than (a quantity greater than), less than (a quantity less than), size (the quantity is either big or small), shape (either regular, irregular, plane, curved, or circular), area, volume, capacity (more, less, and measurement), distance (far, near, magnitude, broadness, height, depth, perimeter), and time from their daily activities. Their

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experiences from their day-to-day practices could be harnessed in teaching them In-school mathematics (Bishop, 1991, 1988; Davis, 2010, 2017b).

The idea of enculturation is very instrumental in the field of mathematics education (Bishop, 1988, 2002; Davis, 2010, 2017b). In this stage, no international/In-school mathematics would be introduced during the enculturation stage (Davis, 2010, 2017b). The pupils would rather be allowed to show the way they experience mathematics in their everyday realities. In this stage, the teacher should give practical activities as well as paper and pencil activities using solely the pupils' out-of-school mathematics which forms the majority (if not all) of the pupils' schema (see Hogan,1995) cited in Davis (2010). This stage would reinforce the pupils' out-of-school concepts of mathematics (Davis, 2010).

Stage two: the transition stage serves as the interface between enculturating pupils into their everyday mathematics (i.e., out-of-school mathematics) and acculturating pupils into international mathematics (which is mainly In-school mathematics) (Davis, 2010). The transition stage is therefore the stage after which the child or the learner is consciously made aware of their out-of-school mathematics and is then moved from their everyday (familiar mathematical concepts that they go through at their cultural settings) to the scientific concepts (unfamiliar mathematical concepts to be learnt at school). In other words, the transitional stage is conceptualized as the vehicle through which the teacher consciously moves the learner from their everyday concepts (not formal in nature) to the scientific concepts (formal in nature). During the transition period, the teacher should direct the pupil's attention to the local aspects of

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mathematics that comprise their out-of-school mathematics. At this stage, the teacher should allow the learners to communicate their everyday experiences using the language that they (if not all) are mostly familiar with (Davis, 2010, 2017b). As a result, the teacher would consciously prepare the pupils to accommodate an expansion in their schema to include how mathematics is done elsewhere in the world (i.e., in-school concepts of mathematics) at this stage (Davis, 2010, 2017b).

Stage three: acculturation stage introduces pupils to the in-school concepts of mathematics after the learners have demonstrated appropriate transitional experiences necessary to help them accommodate the school concepts of mathematics. This stage comes after the first two stages (i.e., enculturation and transition stages). In this stage, the teacher should discuss practical activities with the pupils using the in-school concepts of mathematics (Davis, 2010). He emphasized that "stages two and three address the situation whereby pupils used out-of-school logic for the practical activities and In-school approaches for paper and pencil activities" (Davis, 2010, p. 363). In the acculturating curriculum, emphasis is on the scientific concepts (Bishop, 2002; Rudmin, 2003; Davis, 2010, 2017b). Davis (2010, 2017b) and Bishop (2016) asserted that the scientific concepts must not be taught in isolation but must be linked to the everyday practices of the learners. If the learner is the one that is supposed to do the learning, then learners' everyday concepts from his/her social and cultural practices are key in scaffolding the new learning experiences. Hence, the third stage of Davis' three-tier teaching model for teaching mathematics in context must be informed by the first stage with good transitional experiences

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(stage two). These three constructs (i.e., enculturation, transition and acculturation) must not be seen in isolation but rather as interrelated concepts that are necessary and sufficient for teaching mathematics in context. Learners must be taken through these three stages of Davis' three-tier teaching model for teaching mathematics in context in an intellectually honest manner.

Formation of Fractional Concepts in Mathematics

According to the literature, teaching and learning of fractions remains a major issue in mathematics education, particularly from grade 1 to grade 8. (Clarke, Roche & Mitchell, 2008; Lerman, 2006; Clarke, Sukenik, Roche & Mitchell, 2006; Clarke & Roche, 2009; Driscoll, 1984; Theunissen, 2005; Tzur, 1999; Siegler, *et al.*, 2010; Davis, 2010, 2017b). As a result, mathematics teachers, educational researchers, and other stakeholders around the world continue to pay attention to this (Misquitta, 2011; Davis, 2010, 2017b). Issues concerning the concept of fractions, the order in which fractions should be presented, and how the concept should be presented continue to pique the interest of researchers all over the world (Hill & Charalambous, 2012a, 2012b; Wu, 2008; NCTM, 2007, 2011; Charalambous & Pitta-Pantazi, 2007; Olive & Vomyoridi, 2006; Yang, Reys & Wu, 2010; Alajmi, 2012; Mack, 2001; Tzur, 1999). Mack (1998, 2001) and Davis (2010, 2017b), for example, emphasized the importance of considering pupils' prior knowledge when teaching fractions in the early grades because this is where the development of various mathematical concepts began.

The cultural nature of mathematical concepts such as fractions is also supported by literature (Freudental, 1983; Bishop, 1991, 2002; Davis, 2010,

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2016, 2017a, 2017b). Teaching fractions more practically includes not only dividing a given whole into parts, but also comparing objects that are separated from each other or experienced separately (Freudenthal, 1983; Davis, 2010, 2017b). Freudenthal (1983) refers to this as "fraction as comparer" and provides examples such as "in a room, there are half as many women as men," "the bench is half the height of the table," and so on (p.145). In relation to this term of fraction as a comparer, there is the issue of fractions in everyday language such as "half as many," "half as much," which by analogy imply "equally as," "twice as" when comparing quantities and magnitude values (Freudenthal, 1983, p. 134 -135).

The cultural significance of the concept of fractions was demonstrated by all of these everyday languages. Is the idea of this concept's universal application conveyed by these everyday languages? Different cultures may interpret the western view of halves in everyday language differently in different contexts. Davis asserted, for example, that "in the Ghanaian context, for example, it is common for people to describe an auditorium three-fifths full of the audience as half ("fa") and two-fifths full also as ("fa")," which could mean true halves or just part of any quantity (Davis, 2010, p. 38). He went on to say that halves have different meanings in Ghana. He contended that in Western culture, halves may not mean the same thing as half. As a result, in Ghanaian culture, half does not always imply equal halves, as Western culture portrays. The concept of a fair share in the school context may not be the same as the concept of half in the Ghanaian home context (Davis, 2010). This means that context is important when teaching mathematical concepts such as

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fractions, which serve as the foundation for learning other mathematical concepts such as measurement, algebra, and so on. If teachers remove context from their lessons, their mathematics instruction will be reduced to the study of algorithmic rules and facts, which will not promote meaning-making and conceptual understanding among pupils (Davis, 2010).

Fractional Constructs

The key fractional constructs are presented below.

Concept of fraction as part of any objects: according to Cramer and Whitney (2010), using the part whole construct is an effective way of teaching fractions to children. Part whole concepts can take the form of shading a region or a subset of a group. For example, 3/5 of the pupils in a class turned in their assignments. The denominator in the fraction as part of a whole interpretation represents the number of equal parts in the whole, and the numerator shows how many of those parts are taken out of the equal number of parts. In this case, a whole can be divided into some equal parts, and some of these parts are taken out as an interesting portion of the whole. Fractions as parts of the whole are frequently represented by an area concept, such as a shape partitioned into an equal number of parts. For example, the area of a rectangle can be divided into two equal parts. Fraction as part of a whole concept must be extended to other contexts of practical problems involving length, volume, and groups of objects, not just the area concept. As a result, we can have a third of the length, a quarter of the volume, and half of the pupils in class (Davis, 2010, 2017b). It can also be used in more practical contexts, such as a third of a sugar cane, a quarter of a bucket of water, and half of a class of pupils. All of these concepts

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demonstrate how a fraction can be used to represent a portion of a larger concept in more practical problems. Fractions as a component of a whole can also be used in abstract contexts such as a quarter of an hour or half-past six.

Concept of fraction as a measure: what measurement entails is identifying a length and then using that length as a measurement piece to determine the length of an object. For example, in the fraction 5/8, you can use the unit fraction 1/8 as the chosen length and then count or measure to show that it takes five of those to get to 5/8. As in part whole situations, this concept emphasizes how much rather than how many parts (Behr, Lesh, Post, & Silver, 1983; Martinie, 2007). The concepts and process of rectilinear measurement heavily influence fraction as a unit of measurement. Scales are commonly used when performing rectilinear measurements; we use scales. When measuring an interval with a ruler, the units of measurement are usually centimetres. This means that each centimetre represents one-hundredth of a meter in length, and measuring from the beginning of the interval to its endpoint tells us how many units the endpoint is away from zero. To get a more precise measurement, we could divide the centimetres into smaller equal parts as millimetres. Because the distance between 0 and 1 can be divided into 5 parts to produce one-fifth as a unit of measurement, the number line can be used instead of a ruler. For example, a 1/5 point indicates that the point is one unit away from zero. Students can further subdivide point 1/5 into smaller parts.

Concept of fraction as a division: consider the idea of splitting Gh20.00 among five people. Although this is not a part whole situation, it still means that each person will receive one-fifth (1/5) of the money, or 4 Ghana cedis.

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Unfortunately, most divisions are unrelated to fractions. Meanwhile, pupils have some idea of sharing from their cultural context before they arrive at school, which undermines context-based teaching (Davis, 2010, 2017b). In primary school, I was taught the popular convention of 'a over b,' which means 'a divided by b,' where 'b' is not equal to zero. For instance, the fraction one-third means 1divided by 3. That is, $1/3 = 1 \div 3$. This concept is usually used when we are converting improper fractions to a mixed numeral. For instance, $13/2 = 13 \div 2 = 6.5$. In this case, the fraction is the outcome of the division.

Concept of fractions as an operator: fractions can be used to indicate an operation, as in 4/5 of 20 square feet or 2/3 of the audience holding flags. These situations indicated a fraction of a whole number, and students may be able to figure out the answer using mental math. This concept is underemphasized in school curricula (Usiskin, 2007). Simply knowing how to represent fractions does not imply that pupils will be able to operate with fractions in a variety of other areas of mathematics (Davis, 2010; Johanning, 2008). The fraction is used to 'operate' on a quantity in this case. It implies that the fraction now behaves as if it were a function.

Concept of fractions as a ratio: another context in which fractions are used is the concept of ratio (Bezuk & Cramer, 1989; Lamon, 2006). A fraction of a fourth, for example, can indicate that an event is one in four likely. It is possible to have part-part and part-whole ratios. The ratio 3/4, for example, could refer to the proportion of those wearing jackets (part) to those who are not wearing jackets (part), or it could refer to the proportion of those wearing jackets (part)

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to those in the class (whole). Ratios, which can be illustrated with discrete items, are frequently used to express the quantitative relationship between two groups. A ratio can also be defined as the number of times one amount contains the other amount or is contained within the other amount. In describing a constant relationship in the increase or decrease of measures, such as time or length rate is used.

The Role of Context in the Teaching and Learning of Fractions

The best learning experience is achieved when teaching and learning are done in context (Davis, 2017b). One of the influential aspects of teaching and learning of fraction in context is the classroom discourse that takes learners through the three interrelated levels of Davis' three-tier teaching model for teaching mathematics in context (i.e. enculturation, transition and acculturation) and allows learners to learn mathematical concepts like fractions in multiple ways using their everyday mathematical practices in their cultural settings as a transition experience in scaffolding the concept of the In-School mathematics (Davis, 2010, 2017b). When learners are allowed to learn mathematical concepts like fractions by consciously learning it through the three interrelated levels of Davis' three-tier tier teaching model for teaching mathematics in context, learners learn mathematical concepts by making sense of mathematics through conjecturing, finding patterns, communicating their mathematical ideas with one another, and using multiple representations to make sense of the mathematics they are learning. The context of sharing and comparing In-home /everyday mathematics is not necessarily the same as in In School mathematics

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context where the context of fair sharing and comparing are key (Davis, 2010, 2017b).

The contexts of fair sharing and comparing of any object are also influential because they help pupils/students understand other mathematical concepts in primary school mathematics, such as fractions as division and the importance of the whole when comparing fractions (Spencer, 2001; Fosnot & Dolk, 2002; Dolk & Fosnot, 2006). Because of this, context help learners at the early grade to model whatever mathematical problem they faced visually using diagrams to represent their thinking. The major challenge of learners in learning fractions at the early grade is mainly as a result of the way learners are introduced to fractional concepts at the early grade since this stage form the foundation of most mathematical concepts (Davis, 2010, 2017b). A context-based model for introducing learners to fractional concepts will help learners to picture the concepts in the context of their day-to-day activities in their cultural settings and use that as a conceptual link in learning the international mathematics (scientific concept).

The introduction of fractional concepts at the earlier grade should not be limited to only area concepts but must take into consideration the lengths and volume if learners are to have a more comprehensive conception of fractional concepts at the early grade (Davis, 2010, 2017b). Literature suggests that learners are usually introduced to fractional concepts using the area of objects. This only limit learners' conception of fractional concepts and create a conceptual gap in other domains since fraction forms the foundation of most mathematical concepts like algebra.

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Challenges Faced by Learners in Learning Fractions

According to Mitchell and Home (2010) and Charles and Nason (2000) misconceptions interferes so much with pupils understanding of fractions as the children move from the early grades towards higher education. Pupils find it difficult to do a proper comparison of fractional pairs probably due to the way children are introduced to fractions at the early stage. Davis (2010, 2017b) attributed pupils' fractional difficulties to the introduction gap and failure for teachers to do teaching in context. He continued by stating that the way teachers introduce fractions to children in the early grades is problematic, making it difficult for students to develop a conceptual understanding of what they are learning. As a result, our pupils are struggling with poor performance in this day and age. Inappropriate fractional concept introduction affects pupils' understanding of fractional concepts in mathematics (Pean & Stephens, 2004). For example, according to their research, grade 8 pupils are unable to determine whether 2/3 or 3/5 is greater. Rather, the majority of pupils said 3/5 is greater than 2/3 because 3/5 "is two numbers away from being a whole" and 2/3 "is one number away from being a whole" (p. 434).

Davis' work in 2017b even introduced new dimensions of teaching fractions at the early grade by showing pupils three sticks which were broken into two parts such that only one was exactly half in each case and the children were asked to identify the fractions for each case. This was to find out from pupils their conception of half and more than three-quarter of the pupils failed to identify the appropriate fraction for half in grade 2. According to Post and Cramer (1987) grade 4 children see 3/4 and 2/3 as equal fractions because "the

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difference between numerator and denominator in each fraction was one." (p. 33). This kind of misconception is also common practice among learners at the early grade towards the learning of fractions and may go a long way to affect learners in learning other mathematical concepts. Cramer and Wyberg (2009) in their study also indicated that when pupils were asked to determine which is greater ¾ or 5/12? They identified 3/4 to be bigger than 5/12 because "5/12 still has 7 more to go" as opposed to 3/4 which has "one more to go. So, it should be bigger." (p. 241). These fractional thinking misconceptions may affect more than 25% of our students, and studies show that they are prevalent in Years 4, 6, and 8 (Mitchell & Home, 2010). They proposed that residual thinking and benchmarking could be used to close these fractional gaps (Behr *et al.*, 1984; Clarke & Roche, 2009). Residual thinking is a mathematically correct strategy for comparing fractions that are one fraction away from the whole, whereas benchmark fractions are common fractions that are used to compare other fractions. Davis (2010, 2017b) suggested a more comprehensive way to help learners in developing proper conceptual links in learning mathematical concepts like fractions. To him, mathematics teachers need to teach in context to help pupils to bring on board their everyday experiences as a prerequisite in learning the In-school concepts of mathematics.

As part of the learning process, it is natural for students/pupils to make mistakes and try out new strategies. However, if incorrect fractional thinking becomes evidence of a misunderstanding, a gap in conceptual understanding of fractional concepts forms. Misconceptions will not be corrected in general unless

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they are explicitly addressed through teaching. As a result, teachers must be aware of common misconceptions and look for evidence of them in the thinking of their students. According to Cramer and Whitney (2010), identifying misconceptions in learning mathematics necessitates careful observation or purposeful diagnostic assessment. Because students build on prior knowledge, when they encounter situations involving fractions, they naturally apply what they know about whole numbers to solve the problems. According to the study, students may struggle with fractions for a variety of reasons. Fractions can be expressed in a variety of ways, including part-whole, operator, division, ratio, measurement, and so on.

The pupil generalizes their whole-number knowledge (Bezuk & Cramer, 1989; McNamara & Shaughnessy, 2010). The teacher must assist pupils in distinguishing between similar fractions and whole numbers. This would assist pupils in not confusing whole number concepts with fractions.

According to Cramer and Whitney (2010), many children do not recognize the numerator-denominator ratio as a single value. For example, it is difficult for them to recognize that 3/5 is a single number. The researcher recommends that students use a number line to find fractional values. Students can enjoy this as a fun warm-up activity every day, with specific values written on a classroom number line or in their math journals. Measure to various levels of precision, such as the nearest tenth inch. Here Children should avoid using the phrases "three out of five" or "three over five" unless they are discussing ratios or probability. Instead, say "three-fifths" (Siebert & Gaskin, 2006). Students do not understand that 2/3 refers to three equal parts (although not necessarily equal-

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shaped objects). The researcher suggests that teachers ask pupils to create fraction representations using various manipulatives and on paper. Allow learners to appreciate fractions as a division of any object into equal parts by presenting problems in which all partitions are not already drawn. Because 5 is less than 10, students believe that a fraction like 1/5 is less than a fraction like 1/10.

Mitchell and Horne (2010) and Lamon (2006) also asserted that students may also be told the inverse (i.e., the bigger the denominator, the smaller the fraction). When such rules are taught without allowing students to conceptualize and explain why, they may lead to students overgeneralizing that 1/5 is greater than 7/10. I advise teachers to use a variety of visuals and contexts to demonstrate various aspects of the whole. For example, ask students whether they would rather spend a half-hour, a quarter-hour, or a tenth-of-an-hour outside. Consider the concept of equitable distribution: Is it fair that Kofi gets one-fourth of the bread? and Ama gets one-eighth? Instruct pupils to explain why this isn't fair and who gets the lion's share (Davis, 2010). Examples of these contexts will assist pupils in properly comparing fractional objects.

A student applies whole-number operation "rules" to fractions incorrectly, such as 1/2+1/2 = 24. This was a completely erroneous relationship. The researcher recommends that students use a variety of visuals to learn fractions in context. Pay close attention to whether or not answers emerge from conceptual thinking, and place a premium on estimation. Students who make these mistakes do not understand fractions in terms of relationships. They will continue to make errors by emphasizing whole number concepts until they grasp fractional learning (Behr & Post, 1992; Cramer & Whitney, 2010; Siegler, *et*

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al., 2010; Mitchell & Horne, 2010). In the early grades of school, children begin to use the concept of parts and wholes, beginning with halves and progressing to quarters and eighths (NaCCA, 2019). Some students will only notice the number of parts, ignoring the fact that the parts must be equal (Davis, 2010, 2017b). Whether or not these students develop appropriate understandings such as "the greater the number of parts, the smaller the parts," However, the misconception that a fraction is defined solely by its number of parts may persist. When such students examine a written fraction, they may mistake the denominator for the number of parts, failing to recognize that the fraction label only applies if the parts are equal (Davis, 2010, 2017b).

The Role of Learners' Sex in the Teaching and Learning of Mathematics

It is evident in literature that sex in a way has impacted the way learners learn mathematics in general either positively or negatively at the various levels of education (Wilmot, 2001). Sex has more influence on the learning of mathematics at the advanced level of schooling. This implies that at the lower level of education, the difference is not much significant. Some researchers asserted that the sex of the learner (i.e., male and female) may partly explain the rate at which male and female pupils develop mathematical knowledge (Wilmot, 2001; Asare-Nkoom, 2007). The past researchers have alluded to the fact that it mostly favours the male pupils (Wilmot, 2001; Frempong & Ayia, 2005; Asare-Nkoom, 2007) while other researchers have a seemly report that no recognized significant difference exists in male and female pupils' performance at the primary school level (Wilmot, 2001). Yes, these assertions are not different from the general perceptions of stakeholders in education (i.e.,

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teachers, pupils/ students, community members, parents, heads of schools, experts in mathematics education, curriculum developers, Ministry of Education, Ghana Education Service). Studies have been conducted to explain what might trigger such difference if it exists (Wilmot, 2001; Frempong & Ayia, 2005; Asare-Nkoom, 2007). Experts in mathematics education are of the view that much more effort must be put into the implemented curriculum to ensure that the difference in learning mathematics as a result of sex becomes considerably very minimal if not eliminated completely. This means that mathematics teachers must adopt an innovative way of teaching mathematics like the use of the three-tier teaching model for teaching mathematics in context approach to avoid any difference in mathematics achievement that might be a result of the influence of the learners' sex in favour of the males (Davis, 2010, 2017b).

Summary of Literature Review

From the literature reviewed so far, it is known that theoretical perspectives of ethnomathematics and Socio-cultural theories of learning re-echoed the need to put learners at the centre of the teaching and learning process. To achieve this, there is the need to do our teaching and learning in context. Meanwhile the current practice in primary schools is not promoting learner centredness pedagogy as prescribed in the standard based curriculum but rather it promotes merely teaching by telling pupils in our primary schools and this transcends to the other levels of our educational system (Davis, 2010, 2016, 2017a, 2017b). The teaching by telling approach nurtures misconceptions in learning mathematics by the pupils.

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Furthermore, Vygotskian's Zone of Proximal Development emphasizes the need for teachers to consciously and gradually reduce the support base provided to pupils as they make the effort to learn what they need to learn (Vygotsky, 1978). This necessitates teachers utilizing the learners' everyday mathematical experiences that they typically bring to class from their social and cultural settings, which is lacking in Ghanaian literature (Davis, 2010, 2013, 2017b). It was also clear from the literature that fractional concepts serve as the foundation for learning most advanced concepts in mathematics, and as such, society cannot do away with learning them in school (Clarke *et al.*, 2008; Clarke, *et al.*, 2006; Clarke & Roche, 2009; Driscoll, 1984; Theunissen, 2005; Tzur, 1999; Siegler, *et al.*, 2010). However, the literature points to the fact that teaching and learning of the concept of fractions continue to be a major problem in mathematics education especially from grade 1 to grade 8 since this is the level at which children are mostly introduced to fractional concepts in mathematics mainly in school (Clarke *et al.*, 2008; Clarke, *et al.*, 2006; Clarke & Roche, 2009; Driscoll, 1984; Cramer, Post & Demas, 2002; Theunissen, 2005; Tzur, 1999; Siegler, *et al.*, 2010; Duedu, *et al.*, 2005; Davis & Hishashi, 2007). It is also evident from the literature that children still have a challenge with the learning of fractions mainly as a result of how teachers introduce learners to the concept (Davis & Chaiklin, 2015; Davis, 2010, 2016, 2017a, 2017b).

From literature, previous pedagogical approaches that attempt to draw on learners' everyday experiences in learning mathematics did not emphasize the need for mathematics to taught in context as in the Davis' three-tier teaching

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model for teaching mathematics in context (Presmeg, 2006b, Davis & Chaiklin, 2015). Davis' three-tier teaching model for teaching mathematics in context has at its centre the need to teach and learn mathematics in context (Davis, 2017b). It is also evident from the literature that the pupils' social and cultural practices must have consequence for the teaching and learning of mathematics in order to make the subject relevant to the learners at any level they find themselves (Bishop, 1988; D'Ambrosio, 1997, 2001; Presmeg, 1998; Davis, 2010, 2016, 2017a, 2017b). These cultural activities are mathematical in nature and therefore the learning of mathematics is incomplete without considering its social and cultural contexts. The three-tier teaching model for teaching mathematics in context highlights the social and cultural nature of mathematics (Davis, 2010, 2017b). It was also evidence from literature that sex of learners (i.e., male and female) may either influenced the way learners learn mathematics in general (Wilmot, 2001; Frempong & Ayia, 2005; Asare-Nkoom, 2007).

However, what is not clear is whether all the aforementioned pedagogical approaches that the past studies came out with have what it takes to help learners to learn in context and hence the need for this present study to investigate the effect of the three-tier teaching model for teaching mathematics in context on primary one pupils' performance in fraction and also to extend the understanding of teaching in context through the use of the three-tier teaching model for teaching mathematics in context.

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CHAPTER THREE

RESEARCH METHODS

This chapter presents the research design, study areas, population, sampling procedure, data collection instruments, data collection procedures, and data processing and analysis. The quantitative phase of the data collection employed a quasi-experimental pretest-posttest non-equivalent control group design. The quantitative phase used pupils' identification of fraction worksheets as its main data collection instrument while the qualitative phase made use of a semi-structured interview guide for teachers. Data for this study was therefore collected sequentially to ascertain the performance of pupils of different ability levels who were taught using the three-tier teaching model for teaching mathematics in context across the different contexts of schools in the two districts (i.e., Below Average Achieving, Average Achieving and Above Average Achieving schools) and those taught using the conventional method (i.e., suggested approach by primary one mathematics curriculum) (NaCCA, 2019).

Research Design

The purpose of this study was to investigate the effect of the three-tier teaching model for teaching mathematics in context on the performance of primary one pupils in fractions. This study's research design was sequential explanatory mixed methods including a quasi-experimental non-equivalent pretest-posttest control group design (Creswell & Creswell, 2018). To address the research questions posed in this study, the data for this study was also collected sequentially, with quantitative data being collected first, followed by

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qualitative data from research participants (Verman, 2000; Creswell & Creswell, 2018). The researcher gathered quantitative data, analyzed and interpreted it, and then supplemented it with qualitative data to explain the study's quantitative findings. This research design was considered suitable for this study because it aimed to investigate the effect of the three-tier teaching model for teaching mathematics in context on primary one pupils' fractions performance by comparing the conventional instructional method to that of the experimental approach (Gay, 1987; Gall, Gall, & Borg, 2003; Cohen, Manion, & Morrison, 2011; Creswell & Creswell, 2018). Furthermore, pupils were not assigned to the experimental group at random. Instead, intact classes of pupils were used to avoid disrupting the school's system of classroom assignment of pupils. The number of pupils in each class was as evenly matched as possible in terms of boys and girls. For this study, school classes were randomly assigned to either the experimental or control groups, with each participant taking a pretest and a posttest to assess their performance in the identification/introduction of fractions (Mertens, 2010; Creswell & Creswell, 2018).

Pragmatism has often been noted in the literature as the appropriate paradigm for conducting mixed methods research (Silverman, 2000; Cohen, Manion, & Morrison, 2011; Creswell, 2007; Creswell & Clark, 2011; Creswell & Creswell, 2018). The pragmatic paradigm was considered suitable for this study since it gives the researchers the opportunity to work back and forth between quantitative data and qualitative data (Creswell & Creswell, 2018). It also gives the researchers the opportunity to explore useful points of

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relationship between quantitative data and qualitative data sets. Figure 1 gives the summary of the sequence of the study as shown below.

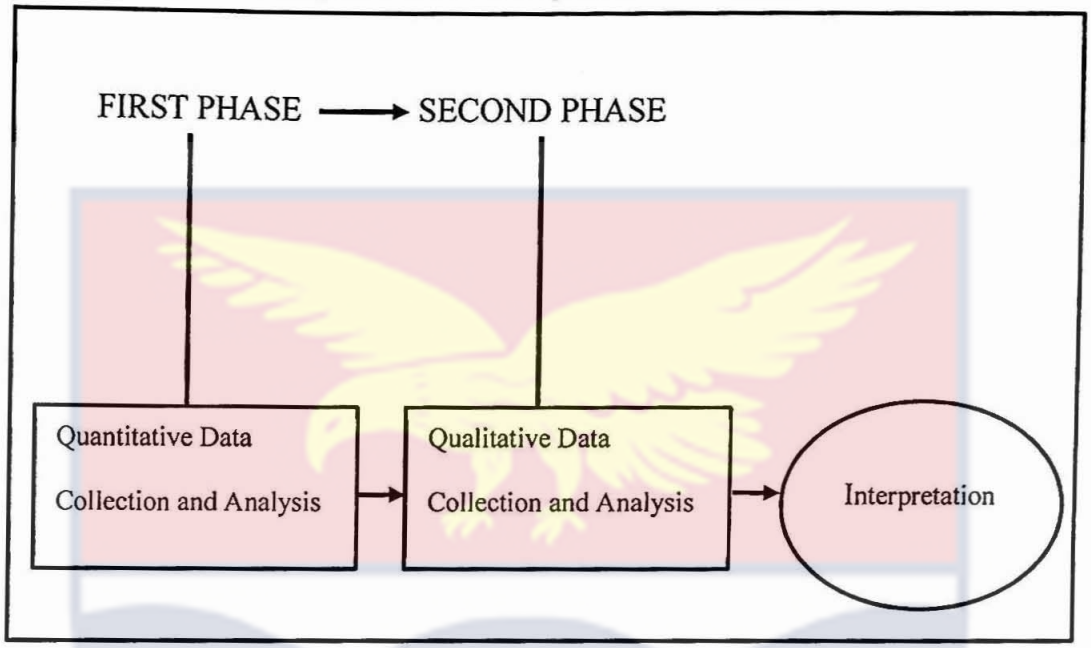


Figure 1: Sequence of the Study (Creswell & Clark, 2011)

Study Areas

Cape Coast is a metropolitan area with both rural and urban schools. The primary industry in this district is fishing and agriculture, but the area supports a variety of other businesses as well. The district is comprised of 96 primary schools and junior high schools. The primary schools have kindergarten. Approximately 3648 primary pupils attend school in this district, with each primary school having an average of 36 pupils in primary one. Pupils' population showed very little diversity with 96% of the pupils being Fante (Nation Master, 2018; Ghana Statistical Service, 2018). Approximately 100% of the pupils qualify for free lunch according to the centralized government's intervention.

Mfantsiman is also a municipality area with both rural and urban schools. The primary industry in this district is fishing and agriculture, but the area supports a variety of other businesses as well. The district is comprised of

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84 primary schools and junior high schools. The primary schools have kindergarten. Approximately 3192 primary pupils attend school in this district, with each primary school having an average of 36 pupils in primary one. Pupils' population showed very little diversity with 96% of the pupils being Fante (Nation Master, 2018; Ghana Statistical Service, 2018). Approximately 100% of the pupils in this district also qualify for free lunch according to the centralized government's intervention.

Population

The study's target population included all primary one pupils and their mathematics teachers in Central Region of Ghana. The study's accessible population consisted of all public primary one mathematics teachers and their pupils from the CCM and MFM in the Central Region of Ghana. A total of 3648 primary one pupils attends public school in the CCM. Similarly, 3192 primary one pupils attend public school in MFM district. The population for this study was made up of 6840 primary one pupils and 180 primary one mathematics teachers each from the various public schools in the Central Region. Researchers must choose a location and participants who will contribute and provide additional information to the study (Yin & Campbell, 1989). As a result, researchers may choose a location based on its convenience, accessibility, characteristics or geographical proximity (Audet & D'Amboise, 2001; Yin, 2009). Others choose a site that they believe will provide similar or divergent results to the research questions posed.

In the present study, the CCM and MFM were chosen because these two districts have predominantly about 96 % of its peoples speaking Fante in the

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Central Region and the three-tier teaching model for teaching mathematics in context approach required teachers to use a local dialect that is familiar to most (i.e., if not all) the pupils especially at the enculturation stage where the teachers allow the pupils to talk about how they experience mathematics at their local settings (Nation Master, 2018; Davis, 2017b). Hence the two districts were more appropriate since it allowed the teachers to enact the models' approach in teaching identification of fractions using Fante as a cultural artifact at the enculturation stage. The Cape Coast metropolis (CCM) and Mfantsiman municipality (MFM) "may therefore yield similar or might provide different results in relation to what is known in literature (Hedges, 2002, p. 355). In general, the selection of these sites not only provides similar or different divergent results but also produced other demographic characteristics that will contribute to a deeper acknowledging of the problem under investigation (Audet & D'Amboise, 2001).

Sampling Procedure

The research participants were chosen using a multistage sampling procedure. The first stage involved the selection of central Region out of the 16 regions in Ghana using convenient sampling technique to participate in the study. The researcher used convenient sampling technique to be more appropriate because the researcher lives in the Central Region hence conducting the study in the region would make it easy for the researcher to access the participants and also ensures cost and time effectiveness (Audet & D'Amboise, 2001; Yin, 2009). This was followed up with the purposeful selection of two districts (i.e., CCM and MFM) from the Central Region's 20 districts at the time

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of this study to participate in the study. The two districts have about 96% of its peoples speaking Fante as local dialect hence were considered more appropriate to participate in this study since the three-tier teaching model for teaching mathematics in context gives credence to flexibility in the use of language (Nation Master, 2018; Davis, 2010, 2017b). The three-tier teaching model for teaching mathematics in context required teachers to use the local dialect when teaching a mathematical concept through the enculturation stage and in this study, teachers used Fante as the local dialect as part of the language they used for their teaching (Davis, 2010, 2017b). In addition to the use of Fante in teaching at the first stage of the model's approach, the two districts that participated in this study were also known in literature to be having the highest number of professional teachers, 92% as compared to any of the remaining 18 districts as at the time of this study (Nation master, 2018; Ghana Statistical Service, 2018; MOE, 2018). These make CCM and MFM more appropriate to participate in this study out of the 20 districts in the Central Region of Ghana.

The third stage involved categorizing the public schools in the two districts based on their achievement levels, with schools classified as Below Average, Average and Above Average as informed by Performance Monitoring Test (GES, 2018). In addition, the results of the 2001 Performance Monitoring Test (PMT) influenced the selection of the context of schools. This test establishes the mean mathematics scores among Junior High School pupils at 37.8, and between 2000 and 2003, only 20 percent of Junior High School graduates qualified to enter Senior High School (Cobbold, 2006) cited in (Davis, Amposah, Kwaah & Beccles, 2019). The CCM's 96 public schools were

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made up of Below Average (32), Average (35) and Above Average (29). In order to maintain consistency, a total of 12 schools were selected from CCM. This was done using simple random sampling technique to select 4 schools each from each of the strata in CCM. Hence the 12 schools were made up of were a mix of Below Average (4), Average (4) and Above Average (4) performing schools.

Similarly, the schools in MFM were made up of Below Average (25), Average (34) and Above Average (25). Twelve (12) schools were also chosen from a pool of 84 public schools in MFM. Simple random sampling technique was also used to select 4 schools each from each of the strata. Hence this was made up of a mix of Below Average (4), Average (4) and Above Average (4) achieving schools. Hence a total of 24 public primary schools participated in the study across the two districts. The final stage involved a purposive selection of primary one mathematics teachers and their pupils. Primary one mathematics teachers and their pupils were chosen because primary one is the first level that primary school pupils were to be introduced to fractions in the Ghanaian public primary schools (NaCCA, 2019) and hence were more appropriate to participate in this study. Hence 860 primary one pupils and 24 mathematics teachers from the public schools were selected across the two districts to constitute the sample for this study. The number of pupils and teachers involved in the study accounted for 13.30 percent and 13.33 percent of the total number of pupils and teachers in the two districts. These percentages were within the acceptable proportion of a given sample for a quasi-experimental study (Krejcie & Morgan, 1970). Figure 2 shows a summary of the sampling procedure.

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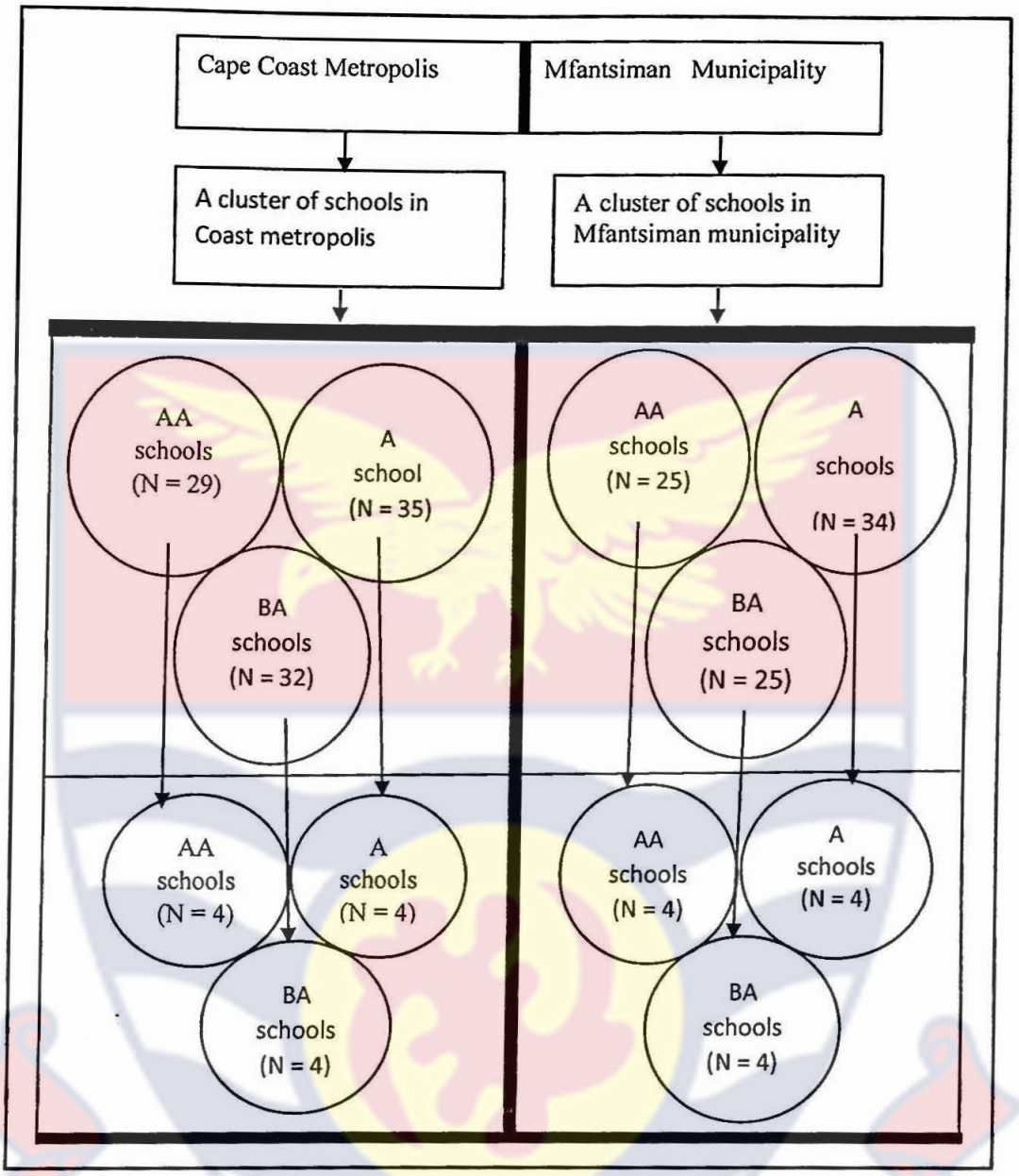


Figure 2: Summary of the Sampling Procedure

Data Collection Instruments

As previously stated, the study used a Sequential Explanatory Mixed Method. Pupils' Identification of Fraction Worksheet (Pretest) and Pupils' Identification of Fraction Worksheet (Posttest) were used to collect quantitative data on pupils' performance in Fractions (See Appendices E and F respectively). These instruments for the pretest and posttest were adapted from 2003 TIMSS (TIMSS, 2003, 2007, 2011). Both the pretest and posttest consist of four (4) main essay questions/items in identification of fractions. The first item required the pupils to write/ name the shaded portion of the diagram that showed exact

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in a symbolic form below the diagram. The second question/item expect the pupils to shade half of a picture and write/name the fraction of their shaded portion symbolically below it. The third question/item was made up of six sub questions and the fourth questions had two sub questions which required them to circle diagrams if it shows halves of the shaded portions (see Appendices E and F respectively). The fourth item consist of two questions. The first part expects the pupils to apply their concepts of halves in naming the fraction of a diagram that showed one-quarter of the shaded parts symbolically below it while the second part expect them to apply their concepts of halves in naming the fraction of a diagram that showed one-third of the shaded parts symbolically below it. In this study, the pretest and posttest were the same. This helps the researcher to gather evidence that the two tests are of similar difficulty (Van Alphen, Halfens, Hasman & Imbos,1994). The results in Appendix Z showed that learners' performance in the posttest was based on their ability level and not based on repeated responses in the pretest (See Appendix Z). This was also informed by Item Response Theory, since the items on both the pretest and posttest were of the same in structure. This theory tests the relationship between a pupil's true performance on a test item and the pupils' levels of performance on an overall measure of the ability the items were intended to measure (Embretson, Susan, Reise & Steven, 2000). In addition, the posttest was done on 3rd day of the 5th week after the pretest. This makes pupils to have forgotten nearly all of the pretest questions and answers to replicate the same answers in the posttest. Hence making the same items in the pretest and posttest to have no significant consequences on the outcome of this study.

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In the Qualitative phase of the study, the researcher then probed for details of the broader picture on the applicability of the three-tier teaching model for teaching mathematics in context using a semi-structured interview guide for teachers from the experimental schools. The semi-structured interview guide for teachers actually sought to find out teachers' perceptions about the use of the three-tier teaching model for teaching mathematics in context. The conventional teaching method involves teaching using the suggested approach by the primary one mathematics curriculum which reflects the normal practices by the teachers at the primary school level (NaCCA, 2019).

The other instructional method made use of the three-tier teaching model for teaching mathematics in context pedagogy. Two main lesson plans for three-tier teaching model for teaching mathematics in context approach were adapted from (Davis, 2017b) and the semi-structured interview guide for teachers (Davis, 2010). The semi-structured interview guide was labelled as "Semi-structured Interview guide for teachers" (See Appendix V). Lesson note on introduction to fractions for pupils in the control group (i.e. conventional instruction method lesson note-first lesson and conventional instruction method lesson note -second lesson)(See Appendices C and D) and lesson note on the identification of fractions for pupils in the experimental group (i.e. Three-tier teaching model for teaching mathematics in context instruction method lesson note-first lesson and three-tier teaching model for teaching mathematics in context instruction method lesson note -second lesson) (See Appendices A and B) were used to enact the teaching in both the control and experimental groups respectively.

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The two groups were given the same four main essay questions/items to answer after the teaching section` to demonstrate their conceptualization of the identification of fractions. Each group (control or experimental) was taught twice for 30-60 minutes per period. The marking scheme was designed to evaluate the pupil's performance in the identification of fractions. Each question/sub-question was marked out of 2 marks, except question 2 which was marked out of 4(see Appendix M). A semi-structured Interview Guide for Teachers was used to probe the applicability of the three-tier teaching model for teaching mathematics in context after the enactment of the experiment.

Validity and Reliability of the Instruments: the initial pretesting of the Pupils' Identification of Fraction Worksheet included 68 primary one pupils. These were made up of 32 and 36 pupils from the EDM and ABA districts in Central Region, respectively. These two districts were not included in the main study. My supervisors reviewed the items on the Pupils' Identification of Fraction Worksheet to ensure that they met the content and face validity requirements. In addition, for the two districts, response rates of 79 percent and 83 percent were obtained for the Pupils' Identification of Fraction Worksheet. The outcome was evaluated in order to determine the reliability of the instruments. The internal consistency of the Pupils' Identification of Fraction Worksheet was calculated using the Cronbach coefficient alpha. The Cronbach' alpha coefficient obtained for the initial pretest for the Pupils' Identification of Fraction Worksheet for the pupils that participated in the initial pretest was 0.74. Similarly, Cronbach' alpha coefficient of 0.81 was obtained for the Pupils' Identification of Fraction Worksheet (posttest). These suggest an acceptable

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and good reliability between all the elements that make up the items on the Pupils' Identification of Fraction Worksheets in the initial pretest and posttest respectively (Pallant, 2005, p.6).

Data Collection Procedures

The researcher sought ethical approval from the University of Cape Coast's Institutional Review Board (See Appendix I). Following the ethical clearance, the researcher received an introductory letter from the Head of the Department of mathematics and ICT Education from the University of Cape Coast (see Appendix J). The researcher also sought permission from the CCM and MFM Metropolitan of Education and Municipal Directors of Education, respectively, to conduct the investigation in the two districts (see Appendices K and L). The researcher made an initial visit to the district's schools to introduce himself and obtain permission to participate in the study from the school heads of the selected primary schools. A subsequent visit to the schools was made to meet the class teachers and their pupils. The purpose of the research was explained to the teachers and their pupils, and their permission to participate in the study was obtained. The consent forms were given to the pupils' parents and guardians to allow their wards to participate in the study through their class teachers. A final visit was made to the two districts' selected schools to brief them on the sequence of activities for the data collection process. Before implementing the interventions in the first phase of the study, the Pupils' Identification of Fraction Worksheet (Pretest)' was used to collect baseline data on pupils' identification of fractions for both the control and experimental groups. The pretest lasted for 45 minutes for each group (control and

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experimental). After the pretest, pupils from the control group was taught twice using the Conventional instruction method lesson note-first lesson and conventional instruction method lesson note-second lesson (see Appendices C and D) with each lesson lasting for a maximum of 30-60 minutes, while the pupils from the experimental group were also taught twice using the three-tier teaching model for teaching mathematics in context instruction method lesson note -first lesson and three-tier teaching model for teaching mathematics in context instruction method lesson note - second lesson [see Appendices A and B] with each lesson also lasting for a period of 30-60 minutes. However, teachers in the experimental group went through a day workshop on how to use the three-tier teaching model for teaching mathematics in context before the teaching for both groups started.

It was only teachers and pupils in the experimental group that took part in teaching and learning using the three-tier teaching model for teaching mathematics in context instructional package. The teaching for the control group was done solely by teachers from the control group. Teachers in the experimental group were invited for a day workshop (see Appendix G). Teachers who took part in the workshop from the experimental group were solely allowed to teach the pupils from the experimental group (see Appendix H). After the teaching sections for both the control and the experimental groups, the same pretest was re- administered as posttest to both groups using 'Pupils' Identification of Fraction Worksheet (Posttest)'(See Appendix F) to see if the intervention has yielded the expected impact in terms of improving pupil's performance in the experimental group as compared to that of the pupils in the control group in the quantitative

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phase of the study. The posttest was made up of the same items in the pretest. The pretest and posttest were administered by the researcher himself and the 12 field assistants. The posttest lasted for 45 minutes for pupils in both the control and experimental groups. The coding used for the respondents in the pretest, posttest and lesson notes were understood by only the researcher. The information about pupils and schools were considered confidential.

The Qualitative phase of the study made use of the interview to obtain qualitative data from teachers using the interview guide for primary school "teachers" from the experimental group on the applicability of the three-tier teaching model for teaching mathematics in context. The purpose of the Qualitative phase was to probe for details and explanations to the broader picture that emerged in the Quantitative phase of the study. The interview involved a focus group of six schools from the experimental group. The interview for teachers lasted for 30-45 minutes. The questions in the interview guide were Primarily about how the three-tier teaching model has impacted pupils' performance positively (i.e., strengths of the model), teachers' general impressions about the three-tier model, challenges faced in using the model, how to overcome the challenges if any and recommendations for other teachers to use the model in teaching mathematics. Teachers from the experimental group were allowed to participate in the Qualitative phase because they had benefited and experienced the model in teaching the experimental group. Data were obtained by taking down notes from the discussions with the participants.

The interview section was also recorded after consent was sought from participants. The interview for teachers was moderated by the researcher

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himself under the supervision of the researcher's principal supervisor. The coding used for the respondents was understood by only the researcher and his principal supervisor and was used for reporting in the thesis only. Because the information about teachers was deemed confidential, no one other than the researcher and the principal supervisor had access to the information gathered from the interview. All files and data collected by the researcher were securely stored in a locked cupboard in the principal investigator's office. The data was destroyed once it had been thoroughly analysed.

Similarly, the Pupils' Identification of Fraction Worksheet (Pretest)' (see Appendix E) was used to obtain the baseline data on pupils' identification of fractions for both the control and experimental group before the implementation of the intervention in the first phase of the study. The pretest lasted for 45 minutes for each group (control and experimental). After the pretest, pupils from the control group was taught twice using Conventional Instruction Method Lesson Note-First Lesson and Conventional Instruction Method Lesson Note-second Lesson with each lesson lasting for a maximum of 30 minutes, while the those of you from the experimental group was also taught twice using 'three-tier teaching model for Teaching mathematics in Context Instruction Method Lesson Note -First Lesson and three-tier teaching model For Teaching mathematics in Context Instruction Method Lesson Note - Second Lesson with each lesson also lasting for a period of 30-60 minutes. It was only pupils from the experimental group that benefited from the three-tier teaching model for teaching mathematics in context instructional package. After the learning sections for both the control and the experimental groups, the same

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posttest was administered to both groups using 'Pupils' Identification of Fraction Worksheet (Posttest)' to see if the intervention has yielded the expected impact in terms of improving pupils' performance in the experimental group as compared to that of the pupils in the control group in the quantitative phase of the study. The posttest was made up of the same items in the pretest. The pretest and posttest were administered by the researcher himself as well as any of the 12 field assistants. The posttest lasted for 45 minutes for pupils in both the control and experimental groups respectively. The coding used for the respondents in the pretest, posttest and lesson notes were understood by only the researcher and be used for the reporting in the thesis. The information about pupils in the pretest, and posttest were considered confidential.

Data Processing and Analysis

Data analysis aimed at answering research questions that guided a particular study and testing all hypotheses made in a study. The data analysis in this study were done and organized in accordance with the study's research questions and hypotheses. Generally, the quantitative data were analyzed using frequency counts, percentages, mean, standard deviation, independent sample t-test, paired sample t-test, one-way ANOVA between group means, and one-way ANCOVA between group means. The qualitative data were analyzed using thematic analysis with narrative discussions. After administering the Pretest, for the control and the experimental schools, descriptive statistics were used to calculate mean scores for each group. At the end of the first phase of the study, independent sample t-test and one-way ANOVA between groups were computed, factoring out any pre-existing differences between the groups before

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the implementation of the interventions. This provided information regarding any significant differences in achievement in groups that may be due to the intervention in the posttest.

As with the performance assessment, the mean scores of the differences in scores from pretest to posttest were examined to determine any statistically significant gains or losses. Independent sample t-test, paired sample t-test, one-way ANOVA between groups or One-way ANCOVA test between-groups was then used when appropriate to determine any significant differences between specific groups in the posttest. Paired sample t-test was further used to determine the impact of each of the interventions within groups. To clarify, the research questions and hypotheses were re-stated in this section, and the mode of data analysis for each question was presented separately from the hypotheses.

Research question one was, "What is the performance of primary one pupils in the identification of fractions in the pretest?" Data for research question one came from the pretest scores of the primary one pupils in the pretest. Data for research question one was analyzed using descriptive statistics, specifically; percentages, mean and standard deviation.

Research question 1a was, "What is the performance of primary one pupils in the identification of fractions in the pretest by districts?" Data for research question 1a came from the pretest scores of the primary one pupils by districts. Data for research question 1a was analyzed using descriptive statistics, specifically; percentages, mean and standard deviation.

Research question 1b was, "What is the performance of primary one pupils in the identification of fractions in the pretest by control and experimental

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groups?" Data for research question 1b came from the pretest scores of the primary one pupils from the control and experimental groups. Data for research question 1b was analyzed using descriptive statistics, specifically; percentages, mean and standard deviation.

Research question 1c was, "What is the performance of primary one pupils in the identification of fractions in the pretest by contexts of schools; Below Average, Average and Above Average achieving schools?" Data for research question 1c came from the pretest scores of the primary one pupils in the context of schools. Data for research question 1c was analyzed using descriptive statistics, specifically; percentages, mean and standard deviation.

Research question 1d was, "What is the performance of primary one pupils in the identification of fractions in the pretest by male and female?" Data for this research question came from the posttest scores of the primary one pupils in the two districts. Data for research question 1d was analyzed using descriptive statistics, specifically; percentages, mean and standard deviation.

Research question 2 was, "What is the performance of primary one pupils in the identification of fractions in the posttest?" Data for research question 2 came from the posttest scores of the primary one pupils. Data for research question 2 was analyzed using descriptive statistics, specifically; percentages, mean and standard deviation.

Research question 2a was, "What is the performance of primary one pupils in the identification of fractions in the posttest by districts?" Data for this research question came from the posttest scores of the primary one pupils

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by districts. Data for research question 2a was analyzed using descriptive statistics, specifically; percentages, mean and standard deviation.

Research question 2b was; "What is the performance of primary one pupils in the identification of fractions in the posttest by control and experimental groups?" Data for research question 2b came from primary one pupils' performance from the control and experimental groups in the posttest. Data for research question 2b was analyzed using descriptive statistics, specifically; percentages, mean and standard deviation.

Research question 2c was, "What is the performance of primary one pupils in the identification of fractions in the posttest by contexts of schools; Below Average, Average and Above Average achieving schools?" Data for research question 2c came from the primary one pupil's performance in identification of fractions in the posttest by Below Average, Average and Above Average achieving schools. It was analyzed using one-way ANOVA between group means.

Research question 2d was, "What is the performance of primary one pupils in the identification of fractions in the posttest by male and female?" Data for research question 2d came from the male and female primary one pupils' performance in the identification of fractions in the posttest. Data for research question 2d was analyzed using descriptive statistics, specifically; percentages, mean and standard deviation.

Research question 3 was, "What is the effect of the three-tier teaching model for teaching mathematics in context on primary one pupils' performance

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in identification of fractions?" Data for research question 3 came from primary one pupils' performance in the pretest and posttest.

Research question 4 was, "What are teachers' perceptions about the applicability of the three-tier teaching model for teaching mathematics in context after the enactment of the experimental?" Data for research question 4 came from the qualitative data from the Semi-structured Interview guide for Teachers. Data for this research question was analyzed using content analysis followed by narrative discussion.

Research hypothesis 1a was, "There is no significant difference between the performance of the primary one pupils in the control and experimental groups in the pretest". Data for this hypothesis came from the Primary one pupil's performance from the pretest administered for both the control and experimental groups before the implementation of the interventions. Data for this hypothesis was analyzed using an independent sample t-test.

Research hypothesis 1b was, "There is no significant difference between the performances of the primary one pupils in identification of fractions by context of schools in the pretest". Data for hypothesis 1b came from the pretest administered for the pupils in the context before the implementation of the interventions. Data for hypothesis 1b was analyzed using one-way ANOVA between group means.

Research hypothesis 1c was, "There is no significant difference between the performance of pupils from CCM and MFM in the pretest from the control group". Data for hypothesis 1c came from the pretest administered for the pupils

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in CCM and MFM before the implementation of the interventions. Data for this hypothesis was analyzed using an independent sample t-test.

Research hypothesis 1d was, "There is no significant difference between the performance of male and female pupils in the identification of fractions in the pretest from the control group". Data for hypothesis 1d came from male and female pupil's performance from the control group in the pretest. Data for this hypothesis was analyzed using an independent sample t-test.

Research hypothesis 1e was, "There is no significant difference in the performance of pupils in the identification of fractions in the context of schools in the pretest from the control group". Data for hypothesis 1e came from pupils' performance in the context of schools in the pretest. Data for this hypothesis was analyzed using one-way ANOVA between group means.

Research hypothesis 1f was, "There is no significant difference between the performance of pupils in the identification of fractions from CCM and MFM in the pretest from the experimental group". Data for hypothesis was obtained from pupil's performance CCM and MFM in the pretest from the experimental group. Data for hypothesis was analyzed using independent samples t-test.

Research hypothesis 1g was, "There is no significant difference between the performance of male and female pupils in the pretest from the experimental group". Data for hypothesis 1g came from the pupil's performance from the pretest administered to both the male and female pupils from the experimental groups. Data for hypothesis 1g was analyzed using an independent sample t-test.

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Research hypothesis 1h was, "There is no significant difference in the performance of male and female pupils in primary one in the pretest from the experimental group". Data for this hypothesis came from the context of schools in the pretest from the experimental group. Data for hypothesis 1h was analyzed using independent sample t-test.

Research hypothesis 2a was, "There is no significant difference between the performance of primary one pupils in the control and experimental groups in the posttest". Data for hypothesis 2a was obtained from pupils' performance from control and experimental schools in the posttest. Data for hypothesis 2a was analyzed using an independent sample t-test.

Research hypothesis 2b was, "There is no significant difference between the performances of the primary one pupils in identification of fractions by context of schools in the posttest". Data for hypothesis 2b came from the posttest administered for the pupils in the context after the implementation of the interventions. Data for hypothesis 2b was analyzed using one-way ANOVA between group means.

Research hypothesis 2c was, "There is no significant difference between the performance of primary one pupils in the identification of fractions from CCM and MFM in the posttest from the control group". Data for this hypothesis came from pupils' performance in CCM and MFM from the control group in the pretest and posttest. Data for hypothesis 2c was analyzed using one-way ANCOVA.

Research hypothesis 2d was, "There is no significant difference between the performance of the male and female pupils in primary one in the

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identification of fractions in the posttest from the control group". Data for hypothesis 2d came from the performance of male and female pupils from the experimental group in the posttest scores. Data for hypothesis 2d was analyzed using an independent sample t-test.

Research hypothesis 2e was, "There is no significant difference in the performance of primary one pupils in the identification of fractions in the context of schools in the posttest from the control group". Data for hypothesis 2e came from pupils' performance in the context of schools from the control group's posttest scores. Data for hypothesis 2e was analyzed using one-way ANOVA between group means.

Research hypothesis 2f was, "There is no significant difference between the performance of primary one pupils from CCM and MFM in the posttest from the experimental group." Data for hypothesis 2f came from the performance of pupils from CCM and MFM from the experimental group in the pretest and posttest scores. Data for hypothesis 2f was analyzed using one-way ANCOVA.

Research hypothesis 2g was, "There is no significant difference between the performance of male and female pupils in the posttest from the experimental group". Data for research hypothesis 2g came from the performance of male and female pupils in primary one in the posttest from the experimental group. It was analyzed using independent sample t-test.

Research hypothesis 2h that guided this study was, "There is no significant difference in the performance of primary one pupils in the identification of fractions in the context of schools in the posttest from the

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experimental group". Data for hypothesis 2h came from pupils' performance in the context of schools from the experimental group posttest. Data for hypothesis 2h was analyzed using one-way ANOVA between group means.

Research hypothesis 2i was, "There is no significant difference in the control group's pretest scores and that of its posttest scores". Data for hypothesis 2i came from the experimental group's pretest scores and that of its posttest scores. Data for hypothesis 2i was analyzed using paired sample t-test.

Research hypothesis 2j was, "There is no significant difference in the experimental group's pretest scores and that of its posttest scores". Data for this hypothesis came from the experimental group's pretest scores and that of its posttest scores. Data for hypothesis 2j was analyzed using paired sample t-test. Table 1 shows the relationship between research questions/hypotheses, data source/instrument and data analysis tool (Davis, 2010, p. 81-82).

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Table 1: Relationship between Research Questions/Hypotheses, Data source/Instrument and Data Analysis Tool

Research Questions/Hypotheses		Data source/Instrument	Data Analysis Tool
RQ1	What is the performance of primary one pupils in the identification of fractions in the pretest?	Pretest scores of pupils	Descriptive statistics; percentages, mean and standard deviation
RQ1a	What is the performance of primary one pupils in the identification of fractions in the pretest by districts?	Pretest scores of pupils within each district	Descriptive statistics; percentages, mean and standard deviation
RQ1b	What is the performance of primary one pupils in the identification of fractions in the pretest by control and experimental groups?	Pretest scores of pupils	Descriptive statistics; percentages, mean and standard deviation
RQ1c	What is the performance of primary one pupils in the identification of fractions in the pretest by contexts of schools; Below Average, Average and Above Average achieving schools?	Pretest scores of pupils	Descriptive statistics; percentages, mean and standard deviation
RQ1d	What is the performance of primary one pupils in the identification of fractions in the pretest by male and female?	Pretest scores of pupils	Descriptive statistics; percentages, mean and standard deviation
RQ2	What is the performance of primary one pupils in the identification of fractions in the posttest?	posttest scores of pupils	Descriptive statistics; percentages, mean and standard deviation
RQ2a	What is the performance of primary one pupils in the identification of fractions in the posttest by districts?	posttest scores of pupils by districts	Descriptive statistics; percentages, mean and standard deviation
RQ2b	What is the performance of primary one pupils in the identification of fractions in the posttest by control and experimental groups?	posttest scores of pupils	Descriptive statistics; percentages, mean and standard deviation

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Table 1 cont'd

RQ2c	What is the performance of primary one pupils in the identification of fractions in the posttest by contexts of schools; Below Average, Average and Above Average achieving schools?	posttest scores of pupils	Descriptive statistics; percentages, mean and standard deviation
RQ2d	What is the performance of primary one pupils in the identification of fractions in the posttest by male and female?	posttest scores of pupils	Descriptive statistics; percentages, mean and standard deviation
RQ3	What is the effect of the three-tier teaching model for teaching mathematics in context on primary one pupils' performance in the identification of fractions?	Pretest and posttest scores of pupils	Independent sample t-test, paired sample t-test, one-way ANOVA and ANCOVA
RQ4	What are teachers' perceptions about the applicability of the three-tier teaching model for teaching mathematics in context after the enactment of the experimental?	Semi-structured Interview guide for Teachers	Content analysis followed by narrative discussions
$H_0$1a	There is no significant difference between the performance of primary one pupils in the control and experimental groups in the pretest.	Pretest scores of pupils	Independent sample t-test
$H_0$1b	There is no significant difference between the performance of the primary one pupils by context of schools in the pretest.	Pretest scores of pupils by context of schools	One-way ANOVA test between groups means
$H_0$1c	There is no significant difference between the performance of primary one pupils from CCM and MFM in the pretest from the control group.	Pretest scores of pupils	Independent sample t-test
$H_0$1d	There is no significant difference between the performance of male and female pupils in primary one in the identification of fractions in the pretest from the control group.	Pretest scores of pupils across districts	Independent sample t-test

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Table 1cont'd

$H_0$1e	There is no significant difference in the performance of primary one pupils in the identification of fractions in the context of schools in the pretest from the control group.	Pretest scores of pupils across districts	One-way ANOVA test between groups means
$H_0$1f	There is no significant difference between the performance of primary one pupils in the identification of fractions from CCM and MFM in the pretest from the experimental group.	Pretest scores of pupils across districts	Independent sample t-test
$H_0$1g	There is no significant difference between the performance of primary one pupils in the identification of fractions in the context of schools in the pretest from the experimental group.	Pretest scores of pupils	One-way ANOVA between group means
$H_0$1h	There is no significant difference between the performance of male and female pupils in primary one in the pretest from the experimental group.	pretest scores of male and female pupils	Independent sample t-test
$H_0$2a	There is no significant difference between the performance of primary one pupils in the control and experimental groups in the posttest.	posttest scores of pupils by control and experimental group	Independent sample t-test
$H_0$2b	There is no significant difference between the performance of primary one pupils by context of schools in the posttest.	Posttest scores of pupils by context of schools	One-way ANOVA test between groups means
$H_0$2c	There is no significant difference between the performance of primary one pupils in the identification of fractions from CCM and MFM in the posttest from the control group.	Posttest scores of pupils	One-way ANCOVA test between groups means
$H_0$2d	There is no significant difference between the performance of the male and female pupils in primary one in the identification of fractions in the posttest from the control group.	Posttest scores of male and female pupils	Independent sample t-test

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Table 1cont'd

$H_0$2e	There is no significant difference in the performance of pupils in primary one in the identification of fractions in the context of schools in the posttest from the control group.	posttest scores of the control group	One-way ANOVA test between groups means
$H_0$2f	There is no significant difference between the performance of primary one pupils from CCM and MFM in the posttest from the experimental group.	Pretest and posttest scores of the experimental group	One-way ANCOVA
$H_0$2g	There is no significant difference between the performance of male and female pupils in primary one in the identification of fractions in the posttest from the experimental group.	posttest scores of the experimental group	Independent sample t-test
$H_0$2h	There is no significant difference in the performance of primary one pupils in the identification of fractions in the context of schools in the posttest from the experimental group.	posttest scores of the context of schools from the experimental group	One-way ANOVA between means
$H_0$2i	There is no significant difference in the control group's pretest scores and that of its posttest scores.	Pretest and posttest scores of the control group	Paired sample t-test
$H_0$2j	There is no significant difference in the experimental group's pretest scores and that of its posttest scores.	Pretest and posttest scores of the experimental group	Paired sample t-test

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CHAPTER FOUR

RESULTS AND DISCUSSION

The main focus of this research was to investigate the effect of the Three-tier teaching model for teaching mathematics in context on primary one pupils' performance in the identification of fractions. It also aimed to ascertain and extend understanding of teaching in context to improve pupils' performance in fractions through the use of the three-tier teaching model for teaching mathematics in context. This chapter presents the results and discussion of the research questions and hypotheses that guided the study. The results and discussion are presented based on research questions and hypotheses that were formulated to guide the study in chapter one.

Biographical Data of Participants

Table 2 presents the biographical data of the pupils who participated in the study across districts as reported by the pupils. The ages of the pupils' ranges from 6 years to 13 years across the two districts as at time of this study. In order to have a meaningful summary of the ages for all the 860 pupils, the researcher resorts to the use of the group intervals as shown below.

Table 2: Biographical Data of the Pupils who Participated in the Study across Districts

Items		Frequency	%
Age(years)	6-7	199	23.10
	8-9	478	55.60
	10-11	162	18.80
	12 years and above	21	2.40
Total		860	100.00
Group	Control	430	50.00
	Experimental	430	50.00
Total		860	100.00
Sex	M	429	49.90
	F	431	50.10

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Table 2 cont'd

Total		860	100.00
Districts	CCM	434	50.50
	MFM	426	49.50
Total		860	100.00
Context of schools	BA	287	33.40
	A	292	34.00
	AA	281	32.70
Total		860	100.00

Table 2 showed that the average age of the pupils who participated in the study was 8.52 years with a majority of 478 out of 860 of them having ages from 8 to 9 years. Very few 21(2.40%) of the pupils were at least 12 years of age. The modal age was from 8 to 9 years. Some of the pupils were more than the expected age for pupils in primary one. They have to stay in primary one for almost 2 years due to the COVID-19 pandemic. Table 2 also shows that the number of female pupils who participated in this study was the same as the number of male pupils. Table 2 shows that an equal number of pupils from the control and experimental groups participated in the study across districts.

Teachers who participated in this study were asked to indicate their highest level of their educational attainment. Table 3 presents the distribution of the highest educational attainments as reported by the teachers across districts. All the teachers who participated in the study were females.

Table 3: Distribution of the Teachers' Highest Educational Attainments as Reported by the Teachers

Item		Highest level of Education	Frequency	%
All participants	Female	1st degree	17	70.80
		M.Phil. in Basic education	7	29.20
Total			24	100
Group	Control	1st degree	7	29.20
		M.Phil. in Basic education	5	20.80

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Table 3 cont'd

	Experimental	1st degree	10	41.70
		M.Phil. in Basic education	2	8.30
Total			24	100
Districts	CCM	1st degree	9	37.50
		M.Phil. in Basic education	3	12.50
	MFM	1st degree	8	33.30
		M.Phil. in Basic education	4	16.70
Total			24	100.00
Context of school	BA	1st degree	5	20.80
		M.Phil. in Basic education	3	12.50
	Average	1st degree	7	29.20
		M.Phil. in Basic education	1	4.20
	AA	1st degree	5	20.80
		M.Phil. in Basic education	3	12.50
Total			24	100.00

BA = Below Average achieving schools, A = Average achieving schools, AA = Above Average achieving schools

The distribution of the teachers' highest educational attainment in Table 3 showed that the majority 17 out of 24 teachers reported that had they have 1st Degree as their highest education in their professional program of study with 7 teachers having Master of Philosophy in Basic Education across the two districts.

Table 4 presents the distribution of the teachers' teaching experience as reported by teachers. All the teachers who participated in the study were females across districts. This was based the Ghana Education Service categorization of teaching experience of teachers.

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Table 4: Distribution of the Teachers' Teaching Experience as Reported by Teachers

Item		Teaching Experience	Frequency	%
All participants	Female	0-4 years	0	0.00
		5-9 years	10	41.70
		10-14 years	12	50.00
		15 -19 years	2	8.30
		20 years and above	0	0.00
Total			24	100.00
Group	Control	0-4 years	0	0.00
		5-9 years	4	16.70
		10-14 years	7	29.20
		15-19 years	1	4.20
		20 years and above	0	0.00
	Experimental	0-4 years	0	0.00
		5-9 years	6	25.00
		10-14 years	5	20.80
		15 -19 years	1	4.20
		20 years and above	0	0.00
Total			24	100.00
Districts	CCM	0-4 years	0	0.00
		5-9 years	6	25.00
		10-14 years	5	20.80
		15-19 years	1	4.20
		20 years and above	0	0.00
	MFM	0-4 years	0	0.00
		5-9 years	4	16.70
		10-14 years	7	29.20
		15 -19 years	1	4.20
		20 years and above	0	0.00
Total			24	100.00
Context of schools	BA	0-4 years	0	0.00
		5-9 years	2	8.30
		10-14 years	5	20.80
		15-19 years	1	4.20
		20 years and above	0	0.00
	A	0-4 years	0	0.00
		5-9 years	4	16.70
		10-14 years	3	12.50
		15-19	1	4.20

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Table 4 cont'd

	20 years and above	0	0.00
AA	0-4 years	0	0.00
	5-9 years	4	16.70
	10-14 years	4	16.70
	15 -19 years	0	0.00
	20 years and above	0	0.00
Total		24	100.00

BA = Below Average achieving schools, A = Average achieving schools, AA = Above Average achieving schools

Table 4 displayed the distribution of teachers' teaching experience, revealing that all of the teachers who participated in the study across the two districts were experienced (i.e., they have taught for at least five years). Table 4 also shows that all of the teachers who took part in the study were females. This was typically a characteristic of teachers who teach in the early grades in Ghana.

Table 5 shows the test for equality of means for the teaching experience of the control' and 'experimental' groups.

Table 5: Test for Equality of Means for the Teaching Experience between the Control' and 'Experimental' Groups

Group	N	Mean(M)	Standard Deviation (SD)	t	Sig.
Control	12	10.67	2.27	0.751	0.46
Experimental	12	9.92	2.61		

Source: Fieldwork (2021)

The independent sample t-test results (M = 10.67, SD = 2.27) [Control group]; (M = 9.92, SD = 2.61) [Experimental], $df = 22$, $t = 0.751$, $p = 0.46$, $p > 0.05$, two-tailed) revealed no significant differences in the two groups' teaching experience across the two districts. This means that in this study, the teaching experiences of the two groups did not differ significantly.

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Findings in Relation to Research Question 1

RQ1. What is the performance of primary one pupils in the identification of fractions in the pretest?

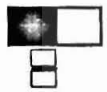
Research Question one aimed at finding out the performance of primary one pupils in the identification of fractions in the pretest.

Table 6 shows the descriptive statistics for the performance of primary one pupils in the identification of fractions in the pretest.

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Table 6: Descriptive Statistics of Pupils' Performance in Identification of Fractions in the Pretest (N = 860)

Item No.	Areas	(%) Pass	Min	Max	M	SD
1.	Write the fraction of the shaded portion in the diagram below 	52.20	0.00	2.00	1.04	1.00
2.	Colour half of the picture and write the fraction in the space provided below it 	5.30	0.00	4.00	0.17	0.75
3a.	Circle the diagram if it showed half of the shaded part/portion 	52.20	0.00	2.00	1.04	1.00
3b.	Circle the diagram if it showed half of the shaded part/portion 	49.40	0.00	2.00	0.99	1.00
3c.	Circle the diagram if it showed half of the shaded part/portion 	0.00	0.00	0.00	0.00	0.00
3d.	Circle the diagram if it showed half of the shaded part/portion 	0.00	0.00	0.00	0.00	0.00
3e.	Circle the diagram if it showed half of the shaded part/portion 	51.40	0.00	2.00	1.02	1.00

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Table 6 Cont'd

3f.	Circle the diagram if it showed half of the shaded part/portion 	0.00	0.00	0.00	0.00	0.00
	Subtotal for the 8 items on identification of halves	26.31	0.00	4.00	0.73	0.82
4a.	Write the fraction of the shaded portion in the diagram below 	19.10	0.00	2.00	0.38	0.79
4b.	Write the fraction of the shaded portion in the diagram below 	3.70	0.00	2.00	0.07	0.38
	Overall total	5.30	0.00	12.00	3.94	3.84

Source: Fieldwork (2021)

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The results in Table 6 indicated that the overall percentage pass of pupils' performance in the identification of fractions was 5.30% with M = 3.94 out of 22.00 and SD = 3.84 in the pretest. The results in Table 6 generally showed that the pupils performed very low in the pretest. This implies that only a few 46 out of 860 pupils were able to pass the test on the identification of fractions in the pretest. The analysis of results in Table 6 also revealed that the pupils performed quite better in the pretest on items 1, 3a, 3b, and 3e. The analysis of results in Table 6 revealed that the pupils performed slightly better in items 1 and 3a, with M =1.04 out of 2.00 and SD =1.00. Furthermore, the analysis of results in Table 6 revealed that slightly more than half of the 449 pupils (52.20 %) were able to passed item 1 in the pretest, which required them to correctly write the fraction of the shaded portion in diagram 1. This means that slightly less than half of the 411 pupils (47.80 %) were unable to correctly write the fraction of the shaded portion in item 1. Similarly, analysis of the results in Table 6 reveals that 449 (52.20 %) of the pupils in the pretest were able to identify the fraction of the shaded portion in item 3a as ½ (half). This means that slightly less than half of the 411 pupils (47.80 %) were unable to correctly write the fraction of the shaded portion in item 3a. This also means that in the pretest, items 1 and 3a received the same percentage passes.

The analysis of results in Table 6 also indicated that the majority of the pupils were able to identify the fraction of the shaded portion in item 3e as not half of the shaded portion and hence did not circle it as half in the pretest with M =1.02 out of 2.00, SD = 1.00. The analysis of results in Table 6 also showed that almost half of the pupils 49.6% were not able to identify that the fraction

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of the shaded portion in item 3e was not half of the shaded parts/portions. This implies that 440 (51.40%) of the pupils were able to identify the fraction of shaded parts/portions in item 3e as ½ (half). This further means that some of the pupils who were able to identify the fraction of the shaded portion/ parts in item 1a and that of 3a were not able to see that the fraction of the shaded portion /part in item 3e was not exactly half of the shaded part. From the results in Table 6, the third item that students were able to handle quite well in the pretest was item 3b, which required them to circle the picture of the diagram if it showed half of the shaded portion/part. According to the results in Table 6, nearly half of the students (425 out of 860) were able to identify the fraction of the shaded portion/part in item 3b as ½ (half) with M = 0.99 out of 2.00 and SD =1.00 in the pretest. In the pretest, item 3b had a percentage pass of 49.40 %. This implies that a slightly above half of the pupils in the pretest were not able to identify the fraction of the shaded portion/part in item 3b as ½ (half).

The analysis of results in Table 6 showed that less than a third of the pupils (26.30%) were able to write/identify the fraction of the shaded portions for the eight items as halves with M = 0.73 out of 4.00 and SD = 0.82 in the pretest. This implies that the majority (73.70%) of the pupils were not able to write/ identify the fraction of the shaded portions of the eight items as ½ (half) in the pretest.

The analysis of results in Table 6 further showed that pupils performed very low on the items that required them to apply their concepts of halves in writing the fraction that represented the items in 4a and 4b as ¼ (one-quarter) and 1/3(one- third) in the pretest respectively. The analysis of results showed

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that percentage passes of 19.10% and 3.70% were obtained for items 4a and 4b which required them to write the fractions of the shaded portions as ¼ (one-quarter) and 1/3(one-third) respectively in the pretest.

Finally, the analysis of results in Table 6 also showed that no pupil was able to identify the fraction of the shaded portions/parts in items 3c, 3d, and 3f as ½ (half) in the pretest. This implies that all the pupils were not able to identify half of the shaded portion/part in terms of the whole diagram under discussions (i.e., Fraction as a selection from a group of objects) in the pretest as in the case of items 3c, 3d, and 3f.

Findings in Relation to Research Question 1a

RQ1a. What is the performance of primary one pupils in the identification of fractions in the pretest by districts?

Research Question 1a aimed at finding out the performance of primary one pupils in the identification of fractions by districts. Table 7 shows the distributive statistics of pupils' performance in pretest by.

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Table 7: Descriptive Statistics of Pupils' Performance in Identification of Fractions in the Pretest by Districts

Item No.	Areas	CCM N = 434					MFM N = 426				
		% Pass	Min	Max	M	SD	% Pass	Min	Max	M	SD
1	Write the fraction of the shaded portion in the diagram below 	52.50	0.00	2.00	1.05	1.00	51.90	0.00	2.00	1.04	1.00
2	Colour half of the picture and write the fraction in the space provided below it 	6.50	0.00	4.00	0.20	0.81	4.20	0.00	4.00	0.14	0.68
3a	Circle the diagram if it showed half of the shaded part/portion 	52.50	0.00	2.00	1.05	1.00	51.90	0.00	2.00	1.04	1.00
3b	Circle the diagram below if it showed half of the shaded parts/portions 	48.80	0.00	2.00	0.98	1.00	50.50	0.00	2.00	1.00	1.00
3c	Circle the diagram below if it showed half of the shaded parts/portions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
3d	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
3e	Circle the diagram below if it showed half of the shaded parts/portions 	50.50	0.00	2.00	1.00	1.00	48.10	0.00	2.00	1.04	1.00
3f	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00

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Table 7 Cont'd

	Subtotal for the 8 items on identification of halves (8)	26.35	0.00	4.00	0.74	0.82	25.83	0.00	4.00	0.70	0.84
4a	Write the fraction of the shaded portion in the diagram below 	19.40	0.00	2.00	0.39	0.79	18.80	0.00	2.00	0.38	0.78
4b	Write the fraction of the shaded portion in the diagram below 	3.70	0.00	2.00	0.07	0.38	3.80	0.00	2.00	0.08	0.38
	Overall	4.23	0.00	12.00	4.23	4.12	5.40	0.00	12.00	3.64	3.54

Source: Fieldwork (2021)

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The analysis of results in Table 7 showed that the overall percentage passes for the pupils in the CCM and MFM were 4.23% and 5.40% respectively. The analysis of results in Table 7 showed the overall performance of pupils in CCM and MFM in the pretest with M = 4.13 out 22.00, SD = 4.05 and 3.75 out 22.00, SD = 3.64 respectively. This implies that generally, pupils from both districts performed very low in the pretest. However, it appeared from the descriptive statistics that pupils from CCM did slightly better than those from the MFM. The analysis of results in Table 7 also indicated the performance of pupils in the CCM and MFM for item 1 with M = 1.05 out of 2.00, SD = 1.00, and M = 1.04 out of 2.00, SD = 1.00 respectively. The analysis of results in Table 7 showed that the percentage passes of 52.50% and 51.90% were obtained for item 1 for the two districts respectively. The analysis of results in Table 7 also showed the performance of pupils in CCM and MFM for item 3a with M =1.05 out of 2.00, SD = 1.00 and M = 1.04 out of 2.00, SD = 1.00. The analysis of results in Table 7 also indicated that the percentage passes of 52.50% and 51.90% were obtained for item 3a for the pupils in the CCM and MFM respectively in the pretest. This implies that a slightly above half of the pupils in both districts passed items 1 and that of item 3a in the pretest.

The analysis of results in Table 7 also showed that the next item that pupils handled quite well was item 3e which required pupils to circle the diagram for item 3e if it showed half of the shaded portion/part. The analysis of results in Table 7 showed that just about half of the pupils 50.5% in the CCM were able to identify that the fraction of the shaded portion/part in item 3e was not exactly half of the whole diagram with M =1.04 out of 2.00, and SD =1.00.

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Similarly, the analysis of results in Table 7 showed that just a slightly less than half of the pupils 48.10% in the MFM was able to identify that the fraction of the shaded portion/part in item 3e was not exactly half of the whole diagram with M =1.04 out of 2.00, and SD =1.00. This implies that more than half of the pupils in the MFM were not able to identify that the fraction of the shaded portion in item 3e was not exactly half of the whole diagram/picture. The analysis of results in Table 7 also showed that the next item that pupils in the two districts handled quite well in the pretest was that of item 3b. The analysis of results in Table 7 showed that a slightly less than half of the pupils 48.80% in CCM were able to circle the diagram in item 3b that the fraction of the shaded portion/part showed an exact half of the whole diagram/picture with M = 0.98 out of 2.00 and SD = 1.00 while about half 50.5 % of the pupils in the MFM were able to circle the diagram in item 3b that it shows an exact half of the whole diagram/picture with M =1.04 out of 2.00 and SD = 1.00.

The analysis of results in Table 7 also indicated that less than a third (26.35%) with M = 0.70 out of 4.00, SD = 0.82 and 25.83 % with M = 0.70 out of 4.00, SD = 0.84 of the pupils in CCM and MFM were able to write/identify the fraction of the shaded portions for the eight items as ½ (halves) in the pretest respectively. This implies that the majority (73.65%) and (74.17%) of the pupils in CCM and MFM were not able to identify the fraction of the shaded portions of the eight items as halves in the pretest respectively.

The analysis of results in Table 7 further showed that pupils performed very low on the items that required them to apply their concepts of halves in writing ¼ (one-quarter) for item 1b and 1/3 (a third) for item 4b in the pretest.

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The analysis of results showed that percentage passes of 19.40% and 18.80% were obtained for items 4a for CCM and MFM which required them to write the fractions of the shaded portions as ¼ (one-quarter) respectively while 3.70% and 3.80% passes were obtained for item 4b for CCM and MFM which required them to write the fractions of the shaded portions as 1/3(one-third) respectively.

The analysis of results in Table 7 also showed that all the pupils in CCM and MFM were not able to identify the fraction of the shaded portions/parts in items 3c, 3d, and 3f as ½ (half) at all in the pretest. This implies that all the pupils from each of the two districts were not able to identify that items 3c, 3d, and 3f represent half of the shaded portions/parts in terms of the whole diagram under discussion (i.e., Fraction as a selection from a group of objects) in the pretest.

Findings in Relation to Research Question 1b

RQ1b. What is the performance of primary one pupils in the identification of fractions in the pretest by control and experimental groups?

Research Question 1b aimed at finding out pupils' performance in the pretest for the control and experimental groups.

Table 8 shows the descriptive statistics for the control and experimental groups in the pretest.

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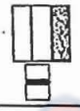
Table 8: Descriptive Statistics of Pupils' Performance in Identification of Fractions in the Pretest by Control and Experimental Groups

Item No.	Areas	Control Group N = 430					Experimental Group N = 430				
		% Pass	Min	Max	M	SD	(%) pass	Min	Max	M	SD
1	Write the fraction of the shaded portion in the diagram below 	52.30	1.05	0.00	1.05	1.00	52.10	0.00	2.00	1.04	1.00
2	Colour half of the picture below and write the fraction in the space provided below it 	4.60	1.15	0.00	1.15	0.73	6.10	0.00	4.00	0.19	0.77
3a	Circle the diagram below if it showed half of the shaded parts/portions 	52.30	1.05	0.00	1.05	1.00	52.10	0.00	2.00	1.04	1.00
3b	Circle the diagram below if it showed half of the shaded parts/portions 	50.20	1.00	0.00	1.00	1.00	48.60	0.00	2.00	0.97	1.00
3c	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3d	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Table 8 cont'd

3e	Circle the diagram below if it showed half of the shaded parts/portions 	50.20	1.04	0.00	1.04	1.00	48.60	0.00	2.00	48.60	1.00
3f	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal for the 8 items on identification of halves (8)	26.20	0.00	4.00	0.72	0.79	25.94	0.00	4.00	0.71	0.80
4a	Write the fraction of the shaded portion in the diagram below 	17.00	0.34	0.00	0.34	0.75	21.20	0.00	2.00	0.42	0.82
4b	Write the fraction of the shaded portion in the diagram below 	2.80	0.06	0.00	0.06	0.33	4.70	0.00	2.00	0.09	0.82
	Overall	4.40	12.0	0.00	4.13	4.05	6.30	0.00	12.00	3.75	3.64

Source: Fieldwork (2021)

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were able to identify the fraction of the shaded portion/part in item 3b as half with M = 0.97 out of 2.00, SD = 1.00. This implies that the control group did slightly better than the experimental group in item 3b in the pretest.

The analysis of results in Table 8 also showed that both the control and the experimental groups did quite better also in item 3e with M =1.04 out of 2.00, SD = 1.00 and M =1.00 out of 2.00, SD =1.00 respectively. Percentage passes of 50.20% and 48.60% were obtained for item 3e for the control and experimental groups respectively. This implies that about half of both the control group and the experimental group were not able to identify that the fraction of the shaded portion/part of the picture in item 3e was not exactly half of the whole picture.

The analysis of results in Table 8 showed that less than a third (26.20%) of the pupils in the control group with M = 0.72 out of 4.00, SD = 0.79 and 25.94 % of the pupils in the experimental group with M = 0.71 out of 4.00, SD = 0.80 were able to write/identify the fraction of the shaded portions for the eight items as halves in the pretest respectively. This implies that the majority (73.80%) and (74.06%) of the pupils in the control and experimental groups were not able to identify the fraction of the shaded portions of the eight items as halves in the pretest respectively.

The analysis of results in Table 8 further showed that pupils from both the control and experimental groups performed very low on the items that required them to apply their concepts of halves in writing ¼ (one-quarter) for item 4a and 1/3 (one-third) for item 4b in the pretest. The analysis of results showed that percentage passes of 17.00% and 21.20% were obtained for items 4a for the pupils in the control and experimental groups which required them to write

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the fractions of the shaded portion as ¼ (one-quarter) respectively while 2.80% and 4.70% percentage passes were obtained for item 4b for the pupils in the control and experimental groups which required them to write the fractions of the shaded portion as 1/3(one-third) respectively in the pretest.

The analysis of results in Table 8 also showed that the pupils in both the control and experimental group were not able to identify the fraction of the shaded portions/parts in items 3c, 3d, and 3f as ½ (half) at all in the pretest. This implies that all the pupils from both the control and experimental groups were not able to identify the fractions of the shaded portions/parts in items 3c, 3d, and 3f as ½ (half) in terms of the whole diagram under discussion (i.e., Fraction as a selection from a group of objects).

Findings in Relation to Research Question 1c

RQ1c. What is the performance of primary one pupils in the identification of fractions in the pretest by contexts of schools; Below Average, Average and Above Average achieving schools?

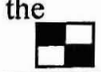
Research Question 1c aimed at finding out pupils' performance in terms of contexts of schools in the pretest.

Table 9 shows pupils' performance in the identification of fractions in the pretest for the Contexts of Schools (i.e., Below Average, Average and Above Average Achieving Schools)

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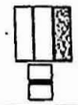
Table 9: Descriptive Statistics of Pupils' Performance in Identification of Fractions in the Pretest by the Context of Schools

Item No.	Areas	Below Average (BA) N = 287					Average (A) N = 292					Above Average (AA) N = 281				
		% Pass	Min	Max	M	SD	% Pass	Min	Max	M	SD	% Pass	Min	Max	M	SD
1	Write the fraction of the shaded portion in the diagram below 	38.00	0.0	2.0	0.76	0.96	57.90	0.0	2.0	1.16	0.99	60.90	0.0	2.0	1.22	0.98
2	Colour half of the picture below and write the fraction in the space provided below 	4.50	0.0	4.0	0.15	0.70	7.20	0.0	4.0	0.23	0.86	4.30	0.0	4.0	1.14	0.67
3a	Circle the diagram below if it showed half of the shaded parts/portions 	38.00	0.0	2.0	0.76	0.97	57.9	0.0	2.0	1.16	1.00	60.90	0.0	2.0	1.22	0.98
3b	Circle the diagram below if it showed half of the shaded parts/portions 	37.30	0.0	2.0	0.75	0.97	55.8	0.0	2.0	1.12	1.00	55.20	0.0	2.0	1.10	1.00
3c	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00
3d	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00

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Table 9 cont'd

3e	Circle the diagram below if it showed half of the shaded parts/portions 	38.00	0.0	2.0	0.76	0.97	56.50	0.0	2.0	1.13	1.00	59.1	0.0	2.0	1.18	0.99
3f	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00
	Subtotal for the 8 items on identification of halves (8)	19.48	0.0	4.0	0.67	0.93	29.41	0.0	4.0	0.76	0.72	22.66	0.0	4.0	0.68	0.95
4a	Write the fraction of the shaded portion in the diagram below 	10.80	0.0	2.0	0.22	0.62	24.00	0.0	2.0	0.48	0.86	22.40	0.0	2.0	0.45	0.84
4b	Write the fraction of the shaded portion in the diagram below 	3.80	0.0	2.0	0.77	0.38	3.10	0.0	2.0	0.06	0.35	4.30	0.0	2.0	0.09	0.41
	Overall	4.20	0.0	12.0	2.86	3.66	6.50	0.0	12.0	4.49	3.94	5.30	0.0	12.0	4.47	3.72

Source: Fieldwork (2021)

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The analysis of results in Table 9 showed that the overall percentage passes of pupils' performance for the identification of fractions for Below Average, Average, and Above Average achieving schools were 4.20% with M = 2.86 out of 22.00 and SD = 3.66; 6.50 % with M = 4.49 out of 22.00 and SD = 3.94, and 5.30 % with M = 4.47 out of 22.00 and SD = 3.72 respectively. This implies that all the three contexts of schools performed very low in the pretest. However, it appeared from the descriptive statistics that the Average achieving schools did quite better than the other two contexts of schools (i.e., Below Average and Above Average achieving schools). The analysis of results in Table 9 showed that the pupils from the three contexts (i.e., Below Average, Average, and Above Average) achieving schools did quite better in handling items 1a, 3a, 3b, and 3e as compared to other items.

The analysis of results in Table 9 showed that the percentage passes of pupils for the writing of the fraction for item 1 for the three contexts of schools Below Average, Average, and Above Average achieving schools were 38.00% with M = 0.76 out of 2.00, SD = 0.96; 57.90% with M =1.16 out of 2.00, SD = 0.99, and 60.90% with M =1.22 out of 2.00, SD = 0.98 respectively. This implies that the Below Average achieving school was the lowest-performing school from the three contexts of schools for item 1 as compared to the performance of Average and Above Average achieving schools in the pretest.

The analysis of results in Table 9 also showed that the three contexts of schools performed quite better in item 3a with M = 0.76 out of 2.00, SD = 0.96, M =1.16 out of 2.00, SD = 0.99, and M =1.22 out of 2.00, SD = 0.98 respectively in the pretest. Percentage passes of 38.00%, 57.90%, and 60.90% were obtained

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for the Below Average, Average, and Above Average achieving schools respectively in the pretest. This implies that the Below Average achieving school was the lowest-performing school from the three contexts of schools for item 3a as compared to the performance of Average and Above Average achieving schools.

The analysis of results in Table 9 also showed that the pupils from the three contexts of schools performed quite better in 3b with M = 0.75 out of 2.00, SD = 0.97, M = 1.12 out of 2.00, SD =1.00, and M =1.10 out of 2.00, SD = 1.00 respectively in the pretest. Percentage passes of 37.30%, 55.80%, and 55.20% were obtained for the performance of pupils for the Below Average, Average, and Above Average achieving schools respectively. It appears from the descriptive statistics that the pupils from the Below Average achieving schools were the lowest-performing schools from the three contexts of schools for item 3b as compared to the performance of Average and Above Average achieving schools in the pretest.

The analysis of results in Table 9 also showed that the pupils from the three contexts of schools performed quite better in 3e with M = 0.76 out of 2.00, SD = 0.97; M =1.13 out of 2.00, SD =1.00, and M =1.18 out of 2.00, SD = 0.99 respectively. Percentage passes of 38.00%, 56.50%, and 59.10% were obtained for the performance of pupils for item 3e for the Below Average, Average, and Above Average achieving schools respectively in the pretest. This implies that the Below Average achieving school was the lowest-performing school from the three contexts of schools for item 3e as compared to the performance of Average and Above Average achieving schools in the pretest.

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The analysis of results in Table 9 showed that less than a fifth (19.48%) with M = 0.67 out of 4.00, SD = 0.93 of the pupils in Below Average achieving schools were able to write/identify the fraction of the shaded portions for the eight items as halves in the pretest. The results also showed that less than a third (29.41%) with M = 0.76 out 4.00, SD = 0.72 of the pupils in the Average achieving schools and (22.66%) with M = 0.68 out of 4.00, SD = 0.95 of the pupils in Above Average achieving schools were able to identify the fraction of the shaded portions for the eight items as halves in the pretest respectively. This implies that the majority (80.52%), (70.59%) and (77.34%) of the pupils in Below Average, Average and Above Average achieving schools were not able to identify the fraction of the shaded portions of the eight items as halves in the pretest respectively.

The analysis of results in Table 9 also showed that pupils from all the three contexts of schools performed very poorly on the items that required them to apply their concepts of halves in writing ¼ (one-quarter) for item 4a and 1/3 (one-third) for item 4b in the pretest. The analysis of results showed that percentage passes of 10.80%, 24.00 % and 22.40% were obtained for items 4a for the pupils in Below Average, Average and Above Average achieving schools respectively which required them to write the fractions of the shaded portion as ¼ (one-quarter) while 3.80%, 3.10% and 4.30% percentage pass were obtained for item 4b for the pupils in Below Average, Average and Above Average achieving schools respectively which required them to write the fractions of the shaded portions as 1/3(one-third) in the pretest.

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The analysis of results in Table 9 also showed that none of the pupils from the three contexts of schools were able to identify the fraction of the shaded portions/parts in items 3c, 3d, and 3f as ½ (half) in the pretest respectively. This implies that all the pupils from the three contexts of schools were not able to identify the fractions of the shaded portions in items 3c, 3d, and 3f as half in terms of the whole diagram under discussions (i.e., Fraction as a selection from a group of objects) in items 3c 3d and 3f in the pretest.

Findings in Relation to Research Question 1d

RQ1d. What is the performance of primary one pupils in the identification of fractions in the pretest by sex?

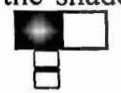
Research Question 1d aimed at finding out male and female pupils' performance in the pretest.

Table 10 showed the descriptive statistics for the male and female pupils' performance in the pretest.

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Table 10: Descriptive Statistics of Male and Female Pupils' Performance in Identification of Fractions in the Pretest

Item No.	Areas	Male N = 429					Female N = 431				
		% Pass	Min	Max	M	SD	% Pass	Min	Max	M	SD
1	Write the fraction of the shaded portion in the diagram below 	52.40	0.00	2.00	1.05	1.00	52.20	0.00	2.00	1.04	1.00
2	Colour half of the picture below and write the fraction in the space provided below it 	6.10	0.00	4.00	0.19	0.78	4.60	0.00	4.00	1.04	0.72
3a	Circle the diagram below if it showed half of the shaded parts/portions 	52.40	0.00	2.00	1.05	1.00	52.20	0.00	2.00	1.15	1.00
3b	Circle the diagram below if it showed half of the shaded parts/portions 	49.04	0.00	2.00	0.99	1.00	49.40	0.00	2.00	1.04	1.00
3c	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3d	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Table 10 Cont'd

3e	Circle the diagram below if it showed half of the shaded parts/portions 	52.70	0.00	2.00	1.05	1.05	52.70	0.00	2.00	0.99	1.00
3f	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal for the 8 items on identification of halves (8)	26.58	0.00	4.00	0.73	0.85	26.39	0.00	4.00	0.75	0.79
4a	Write the fraction of the shaded portion in the diagram below 	18.60	0.00	2.00	0.37	0.78	18.60	0.00	2.00	0.39	0.79
4b	Write the fraction of the shaded portion in the diagram below 	5.40	0.00	2.00	0.11	0.45	5.40	0.00	2.00	0.04	0.29
	Overall	6.80	0.00	12.00	3.75	3.84	3.90	0.00	12.00	3.93	3.86

Source: Fieldwork (2021)

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The analysis of results in Table 10 showed that the overall percentage passes of pupils for the identification of fractions for the male and female pupils in the pretest were 6.80% with M = 3.75 out of 22.00, SD = 3.84 and 3.90 % with M = 3.93 out of 22.00, SD = 3.86 respectively. This implies that both male and female pupils performed very low in the pretest. However, it appeared from the descriptive statistics that the female pupils did quite better than the male pupils in the pretest.

The analysis of results in Table 10 showed that the male and female pupils did quite better on items 1, 3a, 3b, and 3e as compared to other items in the pretest. The analysis of results in Table 10 showed that both pupils in the male and female groups were able to handle item 1 quite well in the pretest with M =1.05 out of 2.00, SD = 1.00, and M =1.04 out of 2.00, SD =1.00 respectively. The percentage passes for item 1 for male and female pupils in the pretest were 52.40% and 52.20% respectively. This implies that the male pupils appeared to do slightly better than their female counterparts in the pretest for item 1. The analysis of results in Table 10 also showed that the male and female pupils did quite better in item 3a in the pretest with M =1.05 out of 2.00, SD =1.00, and M =1.15 out of 2.00, SD =1.00 respectively. Percentage passes of 52.40% and 52.20% were obtained for item 3a in the pretest by the male and female respectively. This implies that the male pupils did slightly better again in item 3a than the female in the pretest.

The analysis of results in Table 10 indicated that about half (49.04%) of the male pupils were able to identify the fraction of the shaded portion/part in item 3b as half with M = 0.99 out of 2.00 and SD =1.00 while a slightly less

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than half (49.40%) of the female pupils were able to identify the fraction of the shaded portion/part in item 3b as half with M =1.04 out of 2.00, SD = 1.00. This implies the female pupils did slightly better than their male counterparts in item 3b in the pretest. The analysis of results in Table 10 also showed that both the male and the female pupils did quite better also in item 3e with M =1.05 out of 2.00, SD = 1.05 and M = 0.99 out of 2.00, SD =1.00 respectively. Percentage passes of 52.70% and 52.70% were obtained for item 3e in the pretest by the male and female pupils respectively. This implies that a slightly less than half of both the male and the female pupils were not able to identify that the fraction of the shaded portion/part of the picture in item 3e was not exactly half of the whole picture.

The analysis of results in Table 10 showed that less than a third (26.58%) with M = 0.73 out 4.00, SD = 0.85 and 26.39 % with M= 0.74 out of 4.00, SD = 0.79 of the male and female pupils were able to identify the fraction of the shaded portions for the eight items as halves in the pretest respectively. This implies that the majority (73.42%) and (73.61%) of the male and female pupils were not able to identify the fraction of the shaded portions of the eight items as halves in the pretest respectively.

The analysis of results in Table 10 further showed that both male and female pupils performed very low on the items that required them to apply their concepts of halves in writing ¼ (one-quarter) for item 4a and 1/3 (one-third) for item 4b in the pretest. The analysis of results showed that a percentage pass of 18.60% was obtained for both the male and female pupils for items 4a which required them to write the fractions of the shaded portions as ¼ (one-quarter) in

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the pretest while a 5.40% percentage pass was obtained for item 4b for both the male and the female pupils in the pretest which required them to write the fractions of the shaded portions as 1/3(one-third).

The analysis of results in Table 10 also showed that both male and female pupils in the pretest were not able to identify the fraction of the shaded portions/parts in items 3c, 3d, and 3f as ½ (half) at all in the pretest across districts. This implies that all the male and female pupils were not able to identify the fractions of the shaded portions/parts in items 3c, 3d, and 3f as ½ (half) in terms of the whole diagram under discussion (i.e., Fraction as a selection from a group of objects).

Findings in Relation to Research Hypothesis 1a

$H_0$1a: There is no significant difference between the performance of the primary one pupils in the control and experimental groups in the pretest.

Research hypothesis 1a aimed at determining whether a significant difference exists between the mean performance of primary one pupils in the control group and those in the experimental group in the pretest.

Table 11 shows the test for equality of means between the control group (those who were to be taught using the suggested approach by the primary one mathematics curriculum) (NaCCA, 2019] and experimental (those who were to be taught using the three-tier teaching model for teaching mathematics in context approach) in the pretest. All assumptions underlying normality and homogeneity have been met (Tabachnick & Fidell, 2013) (See Appendix N).

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Table 11: Test for Equality of Means for the 'Control' and Experimental' Groups in the Pretest

Group	N	M	SD	t	Sig.
Control	430	4.13	4.05	1.436	0.15
Experimental	430	3.75	3.64		

Source: Fieldwork (2021)

The independent sample t-test results (Mean = 4.13 out of 22.00, SD = 4.05 [Control group]; M = 3.75 out of 22.00, SD = 3.64 [Experimental group], df = 858, t = 1.436, p = 0.15, $p > 0.05$ (two-tailed) revealed no significant difference in the two groups' pretest scores. This means that the two groups' performance in the identification of fractions in the pretest did not differ significantly from one another.

Findings in Relation to Research Hypothesis 1b

$H_0$1b: There is no significant difference between the performances of primary one pupils by context of schools in the pretest. Research hypothesis 1b aimed at determining whether a significant difference exists between the mean performance of pupils by the contexts; Below Average, Average and Above Average achieving schools) in the pretest.

Table 12 shows the ANOVA test for equality of means in the performance of the pupils by contexts of schools in the pretest.

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Table 12: ANOVA test for equality of means between the contexts of schools in the pretest

Context of schools	Sum of squares	Df	Mean Square	F	Sig.
Between groups	502.528	2	251.264	17.613	0.000
Within groups	12226.081	857	14.266		
Total	12728.60	859			

Source: Fieldwork (2021)

A p-value of less than 0.05 was required for a significant difference in performance. At a significance level of 0.05, the ANOVA test for equality of means was performed. There was a significant difference in performance in the identification of fractions between the three contexts of schools (i.e., Below Average, Average, and Above Average) achieving schools with F (2, 857) = 17.613, $p = 0.00$, $p < 0.05$ (two-tailed) in the pretest.

Despite reaching statistical significance among the three school contexts, the actual difference in mean scores between the groups in the pretest was quite small. Using eta squared, the effect size was calculated to be 0.04. The magnitude of the effect was very small. Post-hoc pairwise comparisons using the Tukey HSD test revealed that the mean score for pupils in Above Average (AA) achieving schools (M = 4.47 out of 22.00, SD = 3.72) and that of pupils in Below Average (BA) achieving schools (M = 2.86 out of 22.00, SD = 3.66) differed significantly in performance (See Appendix O). Similarly, in the pretest, pupils in the Average achieving schools (M = 4.49 out of 22.00, SD

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= 3.94) performed significantly better than pupils in the Below Average achieving schools (M = 2.86 out of 22.00, SD = 3.66) [see Appendix O]. In the pretest, however, the mean score for pupils in Above Average achieving schools (M = 4.47 out of 22.00, SD = 3.72) did not differ significantly from those in Average achieving schools (M = 4.49 out of 22.00, SD = 3.94). (See Appendix O).

Findings in Relation to Research Hypothesis 1c

$H_0$1c: There is no significant difference between the performance of primary one pupils from CCM and MFM in the pretest from the control group. Research hypothesis 1c aimed at determining whether a significant difference exists between the mean performance of primary one pupils from the CCM and MFM in the pretest from the control group.

Table 13 shows the test for equality of means between the performance of pupils CCM and MFM in the pretest from the control group.

Table 13: Test for Equality of Means between Pupils from CCM and MFM in the Pretest for the Control Group

Districts	N	M	SD	t	Sig.
CCM	220	4.79	4.48		0.00
MFM	210	3.42	3.41	3.56	

Source: Fieldwork (2021)

The analysis of results in Table 13 using independent sample t-test, with $t\,(1, 428) = 3.56$, $p = 0.00$, $n^2 = 0.03$, $p < 0.05$ (two-tailed) revealed a significant difference in performance between primary one pupils from the CCM in the control group (M = 4.79 out of 22.00, SD = 4.48) and those from the MFM in the control group (M = 3.42 out of 22.00, SD = 3.41) who took the pretest. This

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means that in the pretest, pupils from CCM in the control group and those from MFM differ statistically in their performance in identification of fractions.

Findings in Relation to Research Hypothesis 1d

$H_0$1d: There is no significant difference between the performance of male and female pupils in primary one in the pretest from the control group.

Research hypothesis 1d aimed at determining whether a significant difference exists between the mean performance of male and female pupils in the pretest from the control group.

Table 14 shows the test for equality of means between the performance of male and female pupils in the pretest from the control group.

Table 14: Test for Equality of Means between Male and Female Pupils in the Pretest from the Control Group

Sex	N	M	SD	t	Sig.
Male	208	4.39	4.08	1.33	0.18
Female	222	3.87	4.00		

Source: Fieldwork (2021)

The analysis of results in Table 14 using independent sample t-test, t (1, 428) = 1.33, p = 0.18, p > 0.05 (two-tailed) revealed that there was no significant difference in performance between male pupils (M = 4.39 out of 22.00, SD = 4.08) and female pupils (M = 3.87 out of 22.00, SD = 4.00) who took the pretest from the control group. This means that the performance of male and female pupils in the pretest does not differ statistically from that of the control group.

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However, based on their means scores in the identification of fractions, it appears that the males performed slightly better than their male counterparts.

Findings in Relation to Research Hypothesis 1e

$H_0$1e: There is no significant difference in the performance of primary one pupils in the identification of fractions in the context of schools in the pretest from the control group.

Research hypothesis 1e aimed at determining if a significant difference exists in the context of schools; Below Average, Average and Above Average achieving schools from the control group in the pretest.

Table 15 shows the ANOVA test for the equality of means in the context of schools from the control group in the pretest.

Table 15: ANOVA Test for Equality of Means for the Context of Schools from the Control Group in the Pretest

Context of schools	Sum of squares	Df	Mean Square	F	Sig.
Between groups	123.124	2	61.562	3.806	0.02
Within groups	6906.095	427	16.174		
Total	7029.219	429			

Source: Fieldwork (2022)

For the context of schools, the ANOVA test for equality of means in pupils' performance in identification of fractions from the control group was tested at a 0.05 significance level. Using one-way ANOVA between group

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means (i.e., Below Average, Average, and Above Average) achieving schools, there was a statistically significant difference in performance between the three contexts of schools from the control group with F (2, 427) = 3.806, p = 0.02, p < 0.05 (two-tailed) in the pretest. This means that in the pretest, the three contexts of schools from the control group differed in performance in the identification of fractions. The Post-hoc pairwise comparisons test was applied to determine the actual context of schools that contributed to the difference in performance across the contexts of schools. The post-hoc test using the Tukey HSD revealed that the mean score for pupils in Above Average achieving schools from the control group in the pretest (M = 4.75 out of 22.00, SD = 3.94) and that of pupils in Below Average (BA) achieving schools from the control group in the pretest (M = 3.41 out of 22.00, SD = 4.00) differed significantly (see Appendix P). Similarly, in the pretest, the performance of pupils in the Average achieving schools in the control group (M = 4.25 out of 22.00, SD = 4.11) was significantly different from the performance of pupils in the Below Average achieving schools in the control group (M = 3.41 out of 22.00, SD = 4.00) [see Appendix P]. However, in the pretest, the mean score for pupils in Above Average achieving schools in the control group (M = 4.75 out of 22.00, SD = 3.94) did not differ significantly from those in Average achieving schools in the control group (M = 4.25 out of 22.00, SD = 4.11) (see Appendix P).

Findings in Relation to Research Hypothesis 1f

$H_0$1f: There is no significant difference between the performance of primary one pupils from CCM and MFM in the pretest from the experimental group. Research hypothesis 1f aimed at determining whether a significant difference

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exists between the mean performance of primary one pupils from the CCM and MFM in the pretest from the experimental group.

Table 16 shows the test for equality of means between the performance of primary one pupils from CCM and MFM in the pretest from the experimental group.

Table 16: Test for Equality of Means between Pupils from CCM and MFM in the Pretest from the Experimental Group

Districts	N	M	SD	t	Sig.
CCM	214	3.37	3.50	-2.138	0.03
MFM	216	4.12	3.73		

Source: Fieldwork (2021)

The analysis of results in Table 16 using independent sample t-test with t (1, 428) = -2.138, p = 0.03, n^2 = 0.01, $p < 0.05$ (two-tailed) revealed a significant difference in performance between pupils from CCM in the experimental group (M = 3.37 out of 22.00, SD = 3.50) and those from MFM in the experimental group (M = 4.12 out of 22.00, SD = 3.75) who took the pretest. This means that the experimental group's MFM and CCM pupils performed statistically differently on the pretest. The eta squared statistic indicated that although the performance of pupils in identifying fractions from the experimental group differed statistically between CCM and MFM, however, the difference was not much at all.

Findings in Relation to Research Hypothesis 1g

$H_0$1g: There is no significant difference in the performance of primary one pupils in the identification of fractions in the context of schools in the pretest from the experimental group.

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Research hypothesis 1g aimed at determining if a significant difference exists in the context of schools; Below Average, Average and Above Average achieving schools from the experimental group in the pretest.

Table 17 shows the ANOVA test for equality of means between Below Average, Average and Above Average achieving schools for the experimental group in the pretest.

Table 17: ANOVA Test for Equality of Means between the Contexts of Schools for the Experimental Group in the Pretest

Context of schools	Sum of squares	Df	Mean Square	F	Sig.
Between groups	268.492	2	134.246	10.615	0.000
Within groups	5400.382	427	12.647		
Total	5668.874	429			

Source: Fieldwork (2021)

For the context of schools, the ANOVA test for equality of means in pupils' performance in identifying fractions from the experimental group was tested at a 0.05 significance level. Using one way ANOVA between group means (i.e., Below Average, Average, and Above Average) achieving schools, there was a statistically significant difference in performance among the three contexts of schools from the experimental group with F (2, 427) =10.615, p = 0.00, $p < 0.05$ (two-tailed) in the pretest. This means that in the pretest, the

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performance of the three contexts of schools from the experimental group differed in the identification of fractions.

Using eta squared statistic, the effect size was calculated to be 0.04. The magnitude of the effect was very small. Post-hoc pairwise comparisons using the Tukey HSD test revealed that the mean score for pupils in Above Average achieving schools from the experimental group in the pretest (M = 4.35 out of 22.00, SD = 3.84) and that of pupils in Below Average (BA) achieving schools from the experimental group in the pretest (M = 2.65 out of 22.00, SD = 3.35) differ significantly from each other.

Similarly, in the pretest, the performance of pupils in the Experimental group (M = 4.28 out of 22.00, SD = 3.44) from the Average achieving schools was significantly different from that of pupils in the Below Average achieving schools (M = 2.65 out of 22.00, SD = 3.35 [see appendix Q] from the experimental group. However, in the pretest (see Appendix Q), the mean score for pupils in Above Average achieving schools from the experimental group (M = 4.35 out of 22.00, SD = 3.84) did not differ significantly from those in Average achieving schools from the experimental group (M = 4.28 out of 22.00, SD = 3.44). This means that the performance of pupils in identification of fractions between the Above Average and Average context of schools was similar in the pretest from the experimental group in the pretest.

Findings in Relation to Research Hypothesis 1h

$H_0$1h: There is no significant difference between the performance of male and female pupils in primary one in the pretest from the experimental group.

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Research hypothesis 1h aimed at determining whether a significant difference exists between the mean performance of male and female pupils in primary one in the pretest from the experimental group.

Table 18 shows the test for equality of means between the performance of male and female pupils in primary one in the pretest from the experimental group.

Table 18: Test for Equality of Means between Male and Female Pupils in the Pretest from the experimental Group

Sex	N	M	SD	t	Sig.
Male	210	3.88	3.56	0.776	0.44
Female	220	3.61	3.72		

Source: Fieldwork (2021)

The analysis of results in Table 18 revealed no significant difference in performance between male pupils from the experimental group (M = 3.88 out of 22.00, SD = 3.56) and their female counterparts in primary one (M = 3.61 out of 22.00, SD = 3.72) from the experimental group who took the pretest using independent sample t-test, t (1, 428) = 0.776, p = 0.44, $p > 0.05$ (two-tailed). This implies that the performance of both males and females in the pretest from the experimental group do not differ from each other.

Findings in Relation to Research Question 2

RQ2. What is the performance of primary one pupils in the identification of fractions in the posttest?

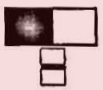
Research Question two aimed at finding out the performance of primary one pupils in the identification of fractions in the posttest.

Table 19 shows the overall performance of primary one pupils in the identification fractions in the posttest.

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Table 19: Descriptive Statistics of Pupils' Performance in Identification of Fractions in the Posttest (N = 860)

Item No.	Areas	% Pass	Min	Max	M	SD
1	Write the fraction of the shaded portion in the diagram below 	99.80	0.00	2.00	2.00	0.10
2	Colour half of the picture below and write the fraction in the space provided below it 	86.50	0.00	4.00	3.46	1.37
3a	Circle the diagram below if it showed half of the shaded parts/portions 	99.80	0.00	2.00	2.00	0.10
3b	Circle the diagram below if it showed half of the shaded parts/portions 	99.80	0.00	2.00	2.00	0.10
3c	Circle the diagram below if it showed half of the shaded parts/portions 	46.60	0.00	2.00	0.93	1.00
3d	Circle the diagram below if it showed half of the shaded parts/portions 	45.30	0.00	2.00	0.91	1.00
3e	Circle the diagram below if it showed half of the shaded parts/portions 	76.60	0.00	2.00	1.53	0.85

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Table 19 Cont'd

3f	Circle the diagram below if it showed half of the shaded parts/portions 	11.00	0.00	2.00	0.22	0.63
	Subtotal for the 8 items on identification of halves (8)	70.68	0.00	4.00	2.94	1.08
4a	Write the fraction of the shaded portion in the diagram below 	66.70	0.00	2.00	1.33	0.94
4b	Write the fraction of the shaded portion in the diagram below 	57.60	0.00	2.00	1.15	0.99
	Overall	79.90	6.00	22.00	15.52	4.49

Source: Fieldwork (2021)

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The analysis of results in Table 19 showed that the overall percentage pass of the pupils in the identification of fractions in the posttest was 79.90% with M =15.52 out 22.00 and SD = 4.49. The overall minimum and maximum scores of the pupils in the posttest were 6.00 and 22.00 respectively. This implies that generally, the pupils performed higher in the identification of fractions in the posttest.

The analysis of results in Table 19 also showed that generally, the pupils performed higher in items 1, 2, 3a,3b, and 3e in the posttest on the identification of fractions. The analysis of results in Table 19 showed that a percentage pass of 99.80 % was obtained by pupils for items 1, 3a, and 3b with M = 2.00 out 2.00 and SD = 0.10. This means that almost all the pupils were able to write/identify the fractions of the shaded portions in items 1, 3a, and 3b as ½ (one-half) correctly in the posttest. The analysis of results in Table 19 also showed that the pupils did better in items 2, and 3e as well with percentage passes of 86.50% and 76.60 %; M = 3.46 out of 4.00, SD = 1.37 and M = 1.53 out of 2.00, SD = 0.85 respectively. This implies that the pupils also did better in items 2, and 3e in addition to items 1, 3a, and 3b in the posttest.

The analysis of results in Table 19 showed that the majority, 70.68 % of the pupils were able to identify the fraction of the shaded portions for the eight items as halves with M = 2.94 out 4.00 and SD = 1.08 in the posttest. This implies that a significant minority, 29.32% of the pupils were not able to identify the fraction of the shaded portions of the eight items as halves in the posttest.

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The analysis of results in Table 19 showed that the majority 66.70% with M = 1.33 and SD = 0.94 of the pupils were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth) in the posttest. This implies that about 33.30% of the pupils in the posttest were not able to apply their concepts of halves in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth). Similarly, the analysis of results in Table 19 showed that a slightly above half of the pupils, 57.60% with M = 1.15 out 2.00 and SD = 0.99 in the posttest were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third). This implies that the remaining 42.40% of the pupils in the posttest were not able to apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third).

The analysis of results in Table 19 also showed that pupils performed very low in item 3f in the posttest with a percentage pass of 11.00% and M = 0.22 out of 2.00, SD = 0.63 across districts. This means almost 90% of the pupils could not identify the fraction of the sum of the shaded portions in item 3f as half of the total number of parts in the diagram (i.e., Fraction as a selection from a group of objects).

Findings in Relation to Research Question 2a

RQ2a. What is the performance of primary one pupils in the identification of fractions in the posttest by districts?

Research Question 2a aimed at finding out the performance of primary one pupils in the identification of fractions in the posttest by districts.

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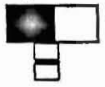
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Table 20 shows the distributions of primary one pupils' performance in the identification of fractions in the posttest by districts.

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Table 20: Descriptive Statistics of Pupils' Performance in Identification of Fractions in the Posttest by Districts

Item No.	Areas	CCM N = 434					MFM N = 426				
		% Pass	Min	Max	M	SD	% Pass	Min	Max	M	SD
1	Write the fraction of the shaded portion in the diagram below 	100.00	0.00	2.00	2.00	0.14	99.50	0.00	2.00	2.00	0.14
2	Colour half of the picture below and write the fraction in the space provided below it 	80.60	0.00	4.00	3.22	1.58	92.50	0.00	4.00	3.70	1.06
3a	Circle the diagram below if it showed half of the shaded parts/portions 	99.80	0.00	2.00	2.00	0.10	99.80	0.00	2.00	2.00	0.10
3b	Circle the diagram below if it showed half of the shaded parts/portions 	99.80	0.00	2.00	99.80	0.10	99.80	0.00	2.00	2.00	0.10
3c	Circle the diagram below if it showed half of the shaded parts/portions 	53.70	0.00	2.00	1.07	1.00	39.40	0.00	2.00	0.79	0.98
3d	Circle the diagram below if it showed half of the shaded parts/portions 	44.00	0.00	2.00	0.88	1.00	46.70	0.00	2.00	0.93	1.00

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Table 20 Cont'd

3e	Circle the diagram below if it showed half of the shaded parts/portions 	83.60	0.00	2.00	1.67	0.74	69.50	0.00	2.00	1.40	0.92
3f	Circle the diagram below if it showed half of the shaded parts/portions 	15.70	0.00	2.00	0.31	0.73	6.30	0.00	2.00	0.13	0.49
	Subtotal for the 8 items on identification of halves (8)	72.15	0.00	4.00	2.95	1.06	69.19	0.00	4.00	2.93	1.14
4a	Write the fraction of the  shaded portion in the diagram below	66.80	0.00	2.00	1.33	0.94	66.70	0.00	2.00	1.33	0.94
4b	Write the fraction of the shaded portion in the diagram below 	59.70	0.00	2.00	1.19	0.98	55.40	0.00	2.00	1.10	1.00
	Overall	85.70	6.00	22.00	15.70	4.66	74.20	6.00	22.00	15.34	4.31

Source: Fieldwork (2021)

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The analysis of results in Table 20 showed that the overall percentage passes of the pupils' performance in the identification of fractions in the posttest within the CCM and MFM were 85.70% with M = 15.70 out of 22.00, SD = 4.66 and 74.20% with M = 15.34 out of 22, SD = 4.31. The minimum and maximum scores of the pupils in CCM and MFM in the posttest were 6.00 and 22.00 respectively. This implies that generally, the pupils in both CCM and MFM performed higher in the identification of fractions in the posttest. However, it appears from the descriptive statistics that pupils from CCM performed slightly better than their counterparts from the MFM.

The analysis of results in Table 20 also showed that specifically, the pupils in CCM and MFM performed higher in items 1, 2, 3a, 3b, and 3e in the posttest in the identification of fractions. The analysis of results in Table 20 showed that a percentage pass of 100.00 % was obtained by pupils in CCM for item 1, while a percentage pass of 99.50% was obtained by the pupils in MFM for item 1. This showed that almost all the pupils in the two districts were able to write the fraction of the shaded portion in item 1 as ½ (half) in the posttest. The analysis of results also showed that almost all the pupils in CCM and MFM were able to identify the fraction of the shaded portion in items 3a and 3b as ½ (half) with the same percentage pass of 99.80% respectively in the posttest.

The analysis of results in Table 20 also showed that the majority of the pupils from CCM and MFM were able to handled item 2 well in the posttest as expected of them with a percentage pass of 80.60% and 92.50% respectively. The mean performance for the pupils from CCM and MFM were M = 3.22 out of 4.00, SD =1.58; and M = 3.70 out of 4.00, SD =1.06 in the posttest for item 2. It

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appears from the descriptive statistics that pupils from MFM did better in item 2 than those pupils from the CCM.

The analysis of results in Table 20 showed that the majority of the pupils from CCM and MFM performed higher in item 3e which required them to identify whether the fraction of the shaded portion in item 3e was exact half with percentage passes of 83.60% and 69.50% respectively. The mean performance for the pupils from CCM and MFM in the posttest in the identification of fractions for item 3e were M = 1.67 out of 2.00, SD = 0.74; and M = 1.40 out of 2.00, SD = 0.92 respectively. This implies that pupils from CCM performed slightly better in item 3e in the posttest as compared to their counterparts in MFM.

The analysis of results in Table 20 showed that majority (72.15%) and (69.19%) with M = 2.95 out of 4.00, SD = 1.06 and M = 2.93 out of 4.00, SD = 1.14 of the pupils in CCM and MFM were able to write/identify the fraction of the shaded portions for the eight items as halves in the posttest respectively. This implies that a significant minority (27.85%) and (30.81%) of the pupils in CCM and MFM were not able to identify the fraction of the shaded portions of the eight items as halves in the posttest respectively.

The analysis of results in Table 20 showed that the majority of the pupils in Cape Coast and MFM were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth) in the posttest with a percentage pass of 66.80% and 66.70% respectively. This implies that a third of the pupils, 33.20% and 33.30 % within CCM and MFM in the posttest were not able to apply their concepts of halves in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth) respectively. Similarly, the analysis of results

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in Table 20 showed that a slightly above half of the pupils, 59.70% and 55.40% in the posttest within the cape Coast and MFM were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third) respectively. This implies that two-fifth of the pupils; 40.30% and 44.60 % within CCM and MFM in the posttest were not able to apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third) respectively.

The analysis of results in Table 20 also showed that pupils within CCM and MFM performed very low in item 3f in the posttest with a percentage pass of 15.70% and 6.30 % respectively. This means almost 85% and 94.00% of the pupils within the CCM and MFM could not identify the fraction of the sum of the shaded portions in item 3f as half of the total number of parts in the diagram in the posttest by districts respectively.

Findings in Relation to Research Question 2b

RQ2b. What is the performance of primary one pupils in the identification of fractions in the posttest by control and experimental groups?

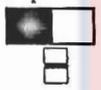
Research Question 2b aimed at finding out pupils' performance in the control and experimental groups in the posttest.

The analysis results in Table 21 shows pupils' performance in the posttest in the identification of fractions for the control and experimental groups.

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Table 21: Descriptive Statistics for the Pupils' Performance in Identification of Fractions in the Posttest by Control and Experimental Groups

Item No.	Areas	Control N = 430					Experimental N = 430				
		% Pass	Min	Max	M	SD	% Pass	Min	Max	M	SD
1	Write the fraction of the shaded portion in the diagram below 	99.50	0.00	2.00	1.99	0.14	100.00	0.00	2.00	2.00	0.00
2	Colour half of the picture below and write the fraction in the space provided below it 	73.00	0.00	4.00	2.92	1.78	100.00	0.00	4.00	4.00	0.00
3a	Circle the diagram below if it showed half of the shaded parts/portions 	99.50	0.00	2.00	1.99	0.14	100.00	0.00	2.00	2.00	00
3b	Circle the diagram below if it showed half of the shaded parts/portions 	99.50	0.00	2.00	1.99	0.14	100.00	0.00	2.00	2.00	0.00
3c	Circle the diagram below if it showed half of the shaded parts/portions 	8.60	0.00	2.00	1.17	0.56	84.70	0.00	2.00	1.69	0.72
3d	Circle the diagram below if it showed half of the shaded parts/portions 	7.70	0.00	2.00	0.15	0.53	100	0.00	2.00	1.66	0.75
3e	Circle the diagram below if it showed half of the shaded parts/portions 	53.30	0.00	2.00	1.07	1.00	100	0.00	2.00	2.00	0.00
3f	Circle the diagram below if it showed half of the shaded parts/portions 	0.00	0.00	2.00	0.00	0.00	22.10	0.00	2.00	0.44	0.83

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Table 21 cont'd

	Subtotal for the 8 items on identification of halves (8)	55.14	0.00	4.0	2.68	1.22	88.35	0.0	4.0	3.24	0.70
4a	Write the fraction of the shaded portion in the diagram below 	33.50	0.00	2.00	0.67	0.95	100.00	0.00	2.00	2.00	0.00
4b	Write the fraction of the shaded portion in the diagram below 	24.90	0.00	2.00	0.50	0.87	90.20	0.00	2.00	1.80	0.59
	Overall	60.00	6.00	22.00	11.44	1.84	100.00	14.00	22.00	19.60	1.91

Source: Fieldwork (2021)

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The analysis of results in Table 21 showed that the overall percentage passes of pupils in the control and experimental groups in the posttest were 60.00% and 100.00% with M =11.44 out of 22.00, SD =1.84 and M =19.60 out of 22.00, SD =1.91 respectively. Generally, the minimum and maximum scores for the control group were 6.00 and 16.00 respectively while the experimental group had a minimum and maximum score of 14.00 and 22.00 respectively in the posttest. The results showed that all the pupils from the experimental group in the posttest performed far higher while the pupils in the control group performed just averagely in the posttest. The results also showed that all the pupils in the experimental group passed the posttest in the identification of fractions while 40% of the pupils from the control group failed the posttest. It appears generally from the descriptive statistics that pupils from the experimental group performed far better than their counterparts in the control group in the posttest.

The analysis of results in Table 21 showed that pupils from both the control and experimental groups performed very well in items 1, 3a, and 3b in the posttest with the same percentage passes respectively. The analysis of results showed that percentage passes of 99.5% and 100.00% with M =1.99 out of 2.00, SD = 0.14, and M = 2.00 out of 2.00, SD = 0.00 were obtained by the control and experimental groups in the posttest respectively in the posttest.

The analysis of results in Table 21 showed that percentage passes of 73.00% and 100.00% with M = 2.92 out of 4.00, SD =1.73 and M = 4.00 out of 4.00, SD = 0.00 were obtained for item 2 by the control and the experimental groups respectively in the posttest. The results showed that all the pupils from

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the experimental groups were able to shade half of the picture in item 2 while 27.00% of the pupils from the control group were not able to shade half of the picture in item 2 correctly as expected of them.

The analysis of results in Table 21 showed that more than half (55.14%) of the pupils with M = 2.68 out of 4.00, SD = 1.22 of the pupils in the control group were able to identify the fraction of the shaded portions for the eight items as halves in the posttest while majority 88.35 % of the pupils with M = 3.24 out of 4.00, SD = 0.70 of the pupils in the experimental group were able to identify the fraction of the shaded portions for the eight items as halves in the posttest. This implies that a slightly less than half (44.86%) of the pupils in the control group were not able to identify the fraction of the shaded portions of the eight items as halves in the posttest while minority 11.65% of the pupils in the experimental group were not able to identify the fraction of the shaded portions of the eight items as halves in the posttest.

The analysis of results in Table 21 showed that the majority 66.5% of the pupils in the control group were not able to apply their concepts of halves in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth) in the posttest with M = 0.67 out of 2.00 and SD = 0.95. This implies that a significant minority 33.50% of the pupils in the control group in the posttest were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth) while all the pupils in the experimental group in the posttest were able to apply their concepts of halves in writing that the fraction of the shaded portion in item 4a as ¼ (one-fourth). Similarly, the analysis of results in Table 21 showed that the majority,75.1% of the pupils in the control

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group in the posttest were not able to apply in writing the fraction of the shaded portion in item 4b as 1/3 (one-third). This implies that only one-fourth 24.90% of the pupils in the control group were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third) in the posttest while more than nine- tenth (90.2%) of the pupils in the experimental were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third) respectively. This implies that a very insignificant number 0.80% of the pupils in the experimental group in the posttest were not able to apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third). This finally implies that pupils from the experimental group were able to apply their concepts of halves in writing ¼ (one-fourth) and 1/3 (one-third) in the posttest far more than their counterparts in the control group.

The analysis of results in Table 21 also showed that all the pupils in the control group in the posttest were not able to identify the fraction of the sum of the shaded portions in item 3f as ½ (half) while quite a significant minority 22.10% of the pupils in the experimental group in the posttest were able to identify the fraction of the sum of the shaded portions in item 3f as ½ (half). This implies that quite a significant number of the pupils in the experimental group were able to see fractions in terms of a group of objects while no pupil from the control group was able to do that in the posttest.

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Findings in Relation to Research Question 2c

RQ2c. What is the performance of primary one pupils in the identification of fractions in the posttest by Below Average, Average and Above Average achieving schools?

Research Question 2c aimed at finding out pupils' performance in the posttest for the contexts of schools.

Table 22 shows pupils' performance in the identification of fractions in the Posttest for the Contexts of Schools (i.e., Below Average, Average and Above Average Achieving Schools).

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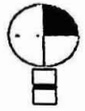
Table 22: Descriptive Statistics for the Pupils' Performance in Identification of Fractions in the Posttest by Context of Schools

Item No.	Areas	Below Average (BA) N = 287					Average (A) N = 292					Above Average (AA) N = 281				
		% Pass	Min	Max	M	SD	% Pass	Min	Max	M	SD	% Pass	Min	Max	M	SD
1	Write the fraction of the shaded portion in the diagram below 	100.00	0.0	2.0	2.00	0.00	100.00	0.0	2.0	2.00	0.00	100.00	0.0	2.0	1.99	0.17
2	Colour half of the picture below and write the fraction in the space provided below it 	81.20	0.0	4.0	3.25	1.57	88.00	0.0	4.0	3.52	1.30	90.40	0.0	4.0	3.62	1.18
3a	Circle the diagram below if it showed half of the shaded parts/portions 	100.00	0.0	2.0	2.00	0.00	99.70	0.0	2.0	1.99	0.12	99.60	0.0	2.0	1.99	0.12
3b	Circle the diagram below if it showed half of the shaded parts/portions 	99.70	0.0	2.0	2.00	0.00	99.60	0.0	2.0	1.99	0.12	99.60	0.0	2.0	1.99	0.12
3c	Circle the diagram below if it showed half of the shaded parts/portions 	37.30	0.0	2.0	0.75	0.97	38.40	0.0	2.0	0.77	0.97	64.80	0.0	2.0	1.30	0.96

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Table 22 Cont'd

3d	Circle the diagram below if it showed half of the shaded parts/portions 	35.20	0.0	2.0	0.70	0.96	41.40	0.0	2.0	0.83	0.99	59.80	0.0	2.0	1.20	0.98
3e	Circle the diagram below if it showed half of the shaded parts/portions 	70.40	0.0	2.0	1.41	0.91	83.60	0.0	2.0	0.67	0.74	75.80	0.0	2.0	1.52	0.86
3f	Circle the diagram below if it showed half of the shaded parts/portions 	10.10	0.0	2.0	0.20	0.60	11.00	0.0	2.0	0.22	0.63	12.10	0.0	2.0	0.24	0.65
	Subtotal for the 8 items on identification of halves (8)	66.74	0.0	4.0	2.93	1.03	70.21	0.0	4.0	2.92	1.00	74.89	0.0	4.0	2.96	1.04
4a	Write the fraction of the shaded portion in the diagram below 	67.90	0.0	2.0	1.36	0.94	66.10	0.0	2.0	1.32	0.95	66.20	0.0	2.0	1.32	0.95
4b	Write/name/describe the fraction of the shaded portions below 	56.80	0.0	2.0	1.14	1.00	57.50	0.0	2.0	1.15	1.00	58.40	0	2.0	1.17	0.99
	Overall	68.30	6.0	22.	14.79	4.67	85.30	8.0	22.0	15.4	4.32	86.50	6.0	22.0	16.32	4.36

Source: Fieldwork (2021)

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The analysis of results in Table 22 showed that the overall percentage passes for each of the contexts of schools in the posttest were 68.30%, 85.30%, and 86.50% with M =14.79 out of 22.00, SD = 4.67; M =15.47 out of 22.00, S = 4.34 and M = 16.32 out of 22.00, SD = 4.36 respectively. The minimum scores for BA, A and AA achieving schools were 6.00, 8.00 and 6.00 respectively in the posttest while each of these contexts of schools has a maximum score of 22.00. This showed that majority of the pupils from each of the contexts of schools performed higher in the posttest. However, it appears from the descriptive statistics that the performance of the pupils from the Above Average schools outweighs those from the other two contexts of schools (i.e., Below Average and Average) achieving schools. This was slightly different in the pretest where the Average achieving schools outperformed the other two contexts of schools (see Table 9).

The analysis of results in Table 22 showed that all the pupils from the Below Average and Average achieving schools were able to write the fraction of the shaded portion in item 1 as half with the same percentage passes of 100.00% while 99.30 % of the pupils from the Above Average achieving schools were able to write that the fraction of the shaded portion in item 1a as ½ (half) in the posttest. This showed that Pupils from the Below Average and Average achieving schools did better in item 1a in the posttest.

The analysis of results in Table 22 also showed that all the pupils from Below Average achieving schools were able to identify the fraction of the shaded portion in item 3a as ½ (half) with percentage passes of 100.00% while percentage passes of 99.70% and 99.6% were obtained for pupils from Average

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and Above Average achieving school in the posttest were able to identify the fraction of the shaded portion in item 3a as ½ (half) respectively. This means that all the pupils from the three contexts of schools performed very well in item 3a in the posttest.

The analysis of results in Table 22 also showed that almost all the pupils from the contexts of schools in the posttest were able to identify the fraction of the shaded portion in item 3b as ½ (half) with percentage passes of 99.70%, 99.60% and 99.60% with M = 2.00 out 2.00, SD = 0.00; M =1.99 out of 2.00, SD = 0.12 and M =1.99 out of 2.00, SD = 0.12 respectively. This means that almost all the pupils from each of the contexts of schools performed very well in item 3b in the posttest.

The analysis of results in Table 22 also showed that the majority of the pupils from each of the contexts of schools in the posttest were able to identify the fraction of the shaded portion in item 2 as ½ (half) with percentage passes of 81.20%, 88.00%, and 90.40%; M = 3.25 out of 4.00, SD = 1.57; M = 3.52 out of 4.00, SD =1.30; and M = 3.62 out of 4.00, SD = 1.18 respectively. This means that all the pupils from the contexts of schools performed above average in item 2 in the posttest. However, the results showed that pupils from the Above Average achieving schools performed better than the other two contexts of schools in the posttest.

The analysis of results in Table 22 also showed that the majority, 66.74% with M = 2.93 out of 4.00, SD = 1.03 of the pupils in Below Average achieving schools were able to write/identify the fraction of the shaded portions for the eight items as halves in the posttest. The results also showed that the

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majority, 70.21%, with M = 2.92 out of 4.00, SD =1.00 and 74.89% with M = 2.96 out of 4.00, SD =1.04 of the pupils in Average achieving schools were able to write/identify the fraction of the shaded portions for the eight items as halves in the posttest. This implies that a significant minority, 33.26%, 29.79% and 25.11% of the pupils in Below Average, Average and Above Average achieving schools were not able to write/identify the fraction of the shaded portions of the eight items as halves in the posttest respectively.

The analysis of results in Table 22 also showed that the majority of the pupils from the contexts of schools (i.e., BA, A, and AA) achieving schools were able to apply their concepts of halves in writing that the fraction of the shaded portion in item 4a as ¼ (one-fourth) with percentage passes of 67.90%, 66.10%, and 66.20%; M =1.36 out of 2.00, SD = 0.94; M =1.15 out of 2.00, SD =1.00, and M =1.32 out of 2.00, SD = 0.95. This showed that pupils from each of the contexts of schools in the posttest performed above average in item 4a.

Similarly, the analysis of results in Table 22 showed that a slightly above half of the pupils from each of the context of schools (i.e., Below Average, Average and Above Average) achieving schools in the posttest were able to apply their concepts of halves in writing that the fraction of the shaded portion in item 4b as 1/3 (one-third) with percentage passes of 56.80%, 57.50%, and 58.40%; M =1.14 out of 2.00, SD = 1.00; M = 1.99 out of 2.00, SD = 0.12; M = 1.17 out of 2.00 and SD = 0.99 respectively. This implies that the remaining 43.20%, 42.50% and 41.60% of the pupils from the three contexts of schools (i.e., Below Average, Average and Above Average) achieving schools respectively were not able to

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apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third).

The analysis of results in Table 22 showed that pupils from each of the contexts of schools (i.e., Below Average, Average and Above Average) in the posttest performed very low in item 3f with percentage passes of 10.10%, 11.00%, and 12.10%; M = 0.20 out of 2.00, SD = 0.60; M = 0.22 out of 2.00, SD = 0.63, and M = 0.24 out of 2.00, SD = 0.65 respectively. This means almost 89.90%, and 89.00% and 87.90% of the pupils from each of the context of schools could not identify the fraction of the sum of the shaded portions in item 3f as half of the total number of parts in the diagram in the posttest respectively.

Findings in Relation to Research Question 2d

RQ2d. What is the performance of primary one pupils in the identification of fractions in the posttest by sex?

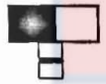
Research Question 2d aimed at finding out male and female pupils' performance in the posttest.

Table 23 shows the descriptive statistics for the Male and Female pupils' performance in the Posttest.

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Table 23: Descriptive Statistics for Male and Female Pupils' Performance in Identification of Fractions in the Posttest by Sex

Item No.	Areas	Male N = 429					Female N = 431				
		% Pass	Min	Max	M	SD	% Pass	Min	Max	M	SD
1	Write the fraction of the shaded portion in the diagram below 	99.5	0.00	2.00	1.99	0.14	100.0	0.00	2.00	2.00	0.00
2	Colour half of the picture below and write the fraction in the space provided below it 	76.50	0.00	4.00	3.06	1.70	96.50	0.00	4.00	3.86	0.73
3a	Circle the diagram below if it showed half of the shaded parts/portions 	99.50	0.00	2.00	1.99	0.14	100	0.00	2.00	2.00	0.00
3b	Circle the diagram below if it showed half of the shaded parts/portions 	99.50	0.00	2.00	1.99	0.14	100	0.00	2.00	2.00	0.00
3c	Circle the diagram below if it showed half of the shaded parts/portions 	45.20	0.00	2.00	0.90	1.00	48.00	0.00	2.00	0.96	1.00
3d	Circle the diagram below if it showed half of the shaded parts/portions 	42.20	0.00	2.00	0.84	0.99	48.50	0.00	2.00	0.97	1.00
3e	Circle the diagram below if it showed half of the shaded parts/portions 	81.60	0.00	2.00	1.63	0.78	71.70	0.00	2.00	1.43	0.90

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Table 23 cont'd

3f	Circle the diagram below if it showed half of the shaded parts/portions 	5.10	0.00	2.00	0.10	0.44	16.90	0.00	2.00	0.34	0.75
	Subtotal for the 8 items on identification of halves (8)	68.64	0.00	4.00	2.87	1.11	72.70	0.00	4.00	2.96	1.03
4a	Write the fraction of the shaded portion in the diagram below 	81.60	0.00	2.00	1.63	0.78	52.00	0.00	2.00	1.04	1.00
4b	Write the fraction of the shaded portion in the diagram below 	66.90	0.00	2.00	1.34	0.94	48.30	0.00	2.00	0.97	1.00
	Overall	86.90	6.00	22.00	15.47	3.85	73.10	6.00	22.00	15.57	5.05

Source: Fieldwork (2021)

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The analysis of results in Table 23 showed that the overall percentage passes of male and female pupils in the identification of fractions in the posttest were 86.90%, and 73.10% with M = 15.47 out of 22.00, SD = 3.85 and M = 15.57 out of 22.00, SD = 5.05 respectively. The results showed that both male and female pupils performed higher in the posttest. However, it appears from the descriptive statistics that the female pupils performed slightly better than their male counterparts in the posttest.

The analysis of results in Table 23 showed that almost all the male and female pupils in the posttest were able to write/identify the fraction of the shaded portions in items 1, 3a, and 3b as ½ (half) with the same percentage passes of 99.5% and 100.00%; M =1.99 out of 2.00, SD = 0.14; and M = 2.00 out of 2.00, SD = 0.00 respectively. The analysis of results in Table 23 showed that the majority of the male and female pupils in the posttest were able to identify that the fraction of the shaded portion in item 3e was not exactly half of the whole with a percentage pass of 81.60 and 71.70%; M =1.63 out of 2.00, SD = 0.78; and M =1.43 out of 2.00, SD = 0.90 respectively.

The analysis of results in Table 23 showed that majority (68.64%) with M = 2.87 out of 4.00, SD = 1.11 and 72.70 % with M = 2.96 out of 4.00, SD = 1.03 of the male and female pupils were able to write/identify the fraction of the shaded portions for the eight items as halves in the posttest respectively. This implies that a significant minority, 31.36% and 27.30% of the male and female pupils were not able to identify the fractions of the shaded portions of the eight items as halves in the posttest respectively.

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The analysis of results in Table 23 showed that the majority of the male pupils 81.60 % with M = 1.63 out of 2.00, SD = 0.78 were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth) while a slightly more than half of the female pupils 52.00% with M = 1.04 out of 2.00, SD = 1.00 were able to apply their concepts of half in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth).

Similarly, the analysis of results in Table 23 showed that the majority of the male pupils in the posttest, 66.90% with M = 1.34 out of 2.00 and SD = 0.94 were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third) while a slightly less than half of the female pupils 48.30% with M = 0.97 out of 2.00, SD = 1.00 were able to apply their concepts of half in writing the fraction of the shaded portion in item 4b as 1/3 (one-third).

The analysis of results in Table 23 showed that both the male and female pupils in the posttest performed very low in identifying the fraction of the shaded portion of item 3f with percentage passes of 5.10%, and 16.90%; M = 0.10 out of 2.00, SD = 0.44, and M = 0.34 out of 2.00, SD = 0.75 respectively.

Findings in Relation to Research Hypothesis 2a

$H_0$2a: There is no significant difference between the performance of primary one pupils in the control and experimental groups in the posttest.

Research hypothesis 2a aimed at determining whether a significant difference between the performance of primary one pupils in the control and experimental groups in the posttest.

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Table 24 shows the test for equality of means between the control group (those who were taught using the conventional approach) and experimental (those who were taught using the three-tier teaching model for teaching mathematics in context approach). All assumptions underlying normality and homogeneity have been met (Tabachnick & Fidell, 2013) (See Appendix R).

Table 24: Test for Equality of Means between the 'Control' and 'Experimental' Groups in the Posttest

Group	N	M	SD	t	Sig.
Control	430	11.44	1.84	-63.832	0.00
Experimental	430	19.60	1.96		

Source: Fieldwork (2021)

The independent sample t-test analysis of the results in Table 24 (Mean = 11.44 out of 22.00, SD = 1.84 [Control group]; M =19.60 out of 22.00, SD =1.96 [Experimental group], $df = 858$, $t = -63.832$, $p = 0.00$, $p < 0.05$, $n^2 = 0.83$, (two-tailed) revealed a significant difference between the two groups posttest scores. The partial effect size between the control and experimental groups was 0.83, indicating a significant difference in posttest performance between the two groups. This means that the type of groups in which the pupils found themselves in the posttest explained 83 percent of the variance in their performance.

Findings in Relation to Research Hypothesis 2b

H_02b: There is no significant difference between the performance of primary one pupils by context of schools in the posttest. Research hypothesis 2b aimed at determining whether a significant difference exists between the mean performance of pupils by the contexts the posttest.

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Table 25 shows the ANOVA test for equality of means in the performance of the contexts of schools; Below Average, Average and Above Average in the posttest.

Table 25: ANOVA Test for Pupils' Performance in the Contexts of Schools in Posttest

Context of schools	Sum of squares	Df	Mean Square	F	Sig.
Between groups	334.633	2	167.317	8.441	0.00
Within groups	16987.990	857	19.823		
Total	17322.623	859			

Source: Fieldwork (2021)

The ANOVA test for equality of means was performed at a significance level of 0.05. With F (2, 857) = 8.441, and p = 0.00, $p < 0.05$ (two-tailed) in the posttest, there was a significant difference in performance among the three contexts of schools (i.e., Below Average, Average, and Above Average) achieving schools at the 0.05 significance level.

Despite reaching statistical significance in all three school contexts, the actual difference in mean scores between the groups was quite small. In the posttest, the effect size was calculated using eta squared and was 0.02. In the posttest, post-hoc pairwise comparisons using the Tukey HSD test revealed that the mean score for pupils in Below Average achieving schools (M =14.79 out of 22.00, SD = 4.67) was significantly different from the mean score for pupils in Above Average achieving schools (M =16.32 out of 22.00, SD = 4.36) [see Appendix S]. In the posttest, however, the mean score for pupils in Average achieving schools (M =15.47, SD = 4.32) did not differ significantly from that of pupils in Below Average achieving schools (M =14.79 out of 22.00, SD =

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4.67). (See Appendix S). Similarly, the mean scores of pupils in Above Average achieving schools (M =16.32 out of 22.00, SD = 4.36) did not differ significantly from those in Average achieving schools (M =15.47 out of 22.00, SD = 4.32) in the posttest (see Appendix S).

Findings in Relation to Research Hypothesis 2c

H_02c: There is no significant difference between the performance of primary one pupils from CCM and MFM in the posttest from the control group.

Research hypothesis 2c aimed at determining whether a significant difference exists between the mean performance of primary one pupils from the CCM and MFM in the posttest from the control group.

Table 26 shows the test for equality of means between the performance of pupils CCM and MFM in the posttest from the control group.

Table 26: ANCOVA Test for Equality of Means between Pupils from CCM and MFM in the Posttest for the Control Group

Context of schools	Type III sum of squares	Df	Mean square	F	Sig.
Corrected model	176.883[a]	2	88.442	29.662	0.00
Intercept	26843.132	1	26843.13	9002.787	0.00
Control group's Pretest score	3.041	1	3.041	1.020	0.31
Districts	163.896	1	163.896	54.968	0.00
Error	1273.163	427	2.982	54.968	
Corrected total	1450.047	429			

Source: Fieldwork (2021)

The analysis of results in Table 26 revealed a significant difference in performance between pupils from the CCM in the control group (M = 12.10 out of 22.00, SD = 1.94) and those from the MFM in the control group (M = 10.82

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out of 22.00, SD = 1.50) who participated in the posttest after using pretest scores as a covariate with F (1, 427) = 54.97, p = 0.00, $p < 0.05$ (two-tailed). This means that in the posttest, pupils from CCM in the control group and those from MFM differ statistically in their performance in the identification of fractions.

Findings in Relation to Research Hypothesis 2d

$H_0$2d: There is no significant difference between the performance of male and female pupils in primary one in the posttest from the control group.

Research hypothesis 2d aimed at determining whether a significant difference exists between the mean performance of male and female pupils in primary one in the posttest from the control group.

Table 27 shows the test for equality of means between the performance of male and female pupils in primary one in the posttest from the control group.

Table 27: Test for Equality of Means between Male and Female Pupils in the Posttest from the Control Group

Sex	N	M	SD	t	Sig.
Male	208	11.47	1.88	0.319	0.75
Female	222	11.41	1.80		

Source: Fieldwork (2021)

The analysis of results in Table 27 revealed that there was no significant difference in performance between male pupils in primary one (M =11.47 out of 22.00, SD = 1.88) and female pupils (M =11.41 out of 22.00, SD = 1.80) who participated in the posttest from the control group using independent sample t-test with t (1, 428) = 0.319, p = 0.75, $p > 0.05$ (two-tailed).

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This means that the performance of male and female pupils in the posttest does not differ statistically from that of the control group.

Findings in Relation to Research Hypothesis 2e

$H_0$2e: There is no significant difference in the performance of primary one pupils in the identification of fractions in the context of schools in the posttest from the control group.

Research hypothesis 2e aimed at determining whether a significant difference exists in the context of schools; Below Average, Average and Above Average achieving schools from the control group in the posttest.

Table 28 shows the ANOVA test for the equality of means in the context of schools from the control group in the posttest.

Table 28: ANOVA test for equality of means for the context of schools from the control group in the posttest

Context of schools	Sum of squares	Df	Mean Square	F	Sig.
Between groups	81.764	2	40.882	12.758	0.000
Within groups	1368.283	427	3.204		
Total	1450.047	429			

Source: Fieldwork (2021)

For the context of schools, the ANOVA test for equality of means in primary one pupils' performance in identifying fractions from the control group was tested at a 0.05 significance level. Using one-way ANOVA between group means (i.e., Below Average, Average, and Above Average) achieving schools, there was a statistically significant difference in performance among the three

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contexts of schools from the control group with F (2, 427) = 12.758, p = 0.00, p < 0.05 (two-tailed) in the posttest. This means that in the posttest, the three contexts of schools from the control group performed differently in the identification of fractions. The Post-hoc pairwise comparisons test was applied to the actual context of schools that contributed to the difference in performance across contexts. The post-hoc test using the Tukey HSD revealed that the mean score for pupils in Above Average achieving schools from the control group in the posttest (M = 11.75 out of 22.00, SD = 1.12) differed significantly from that of pupils in Below Average (BA) achieving schools from the control group in the posttest (M = 10.81 out of 22.00, SD = 2.26). Similarly, in the posttest, pupils in the Average achieving schools in the control group (M =11.74 out of 22.00, SD = 1.76) performed significantly better than pupils in the Below Average achieving schools in the control group (M =10.81 out of 22.00, SD = 2.26) [see Appendix T]. However, the mean posttest score for pupils in Above Average achieving schools in the control group (M =11.75 out of 22.00, SD = 1.12) did not differ significantly from that of pupils in Average achieving schools in the control group (M =11.74 out of 22.00, SD = 1.76) (see Appendix T).

Findings in Relation to Research Hypothesis 2f

$H_0$2f: There is no significant difference between the performance of primary one pupils from CCM and MFM in the posttest from the experimental group.

Research hypothesis 2f aimed at determining whether a significant difference exists between the mean performance of primary one pupils from the CCM and MFM in the posttest from the experimental group.

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Table 29 shows the test for equality of means between the performance of primary one pupils from the CCM and MFM in the posttest from the experimental group.

Table 29: ANCOVA Test for Equality of Means between CCM and MFM in the Posttest for the Experimental Group

Context of schools	Type III sum of squares	Df	Mean square	F	Sig.
Corrected model	89.077[a]	2	44.538	12.901	0.00
Intercept	79594.388	1	79594.388	23055.605	0.00
Experimental group's Pretest score	0.463	1	0.463	0.134	0.714
Districts	89.048	1	89.048	89.048	0.00
Error	1474.123	427	3.452		
Corrected total	1563.200	429			

Source: Fieldwork (2021)

The analysis of results in Table 29 revealed that there was a significant difference in performance between pupils from CCM in the experimental group (M = 20.06 out of 22.00, SD = 1.75) and those from MFM in the experimental group (M = 19.15 out of 22.00, SD = 1.95) who participated in the posttest after using their pretest scores as a covariate with F (1, 427) = 25.79, p = 0.00, $p <$ 0.05 (two-tailed). This means that in the posttest, pupils from CCM and MFM performed statistically differently in the identification of fractions.

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Findings in Relation to Research Hypothesis 2g

$H_0$2g: There is no significant difference between the performance of male and female pupils in primary one in the posttest from the experimental group.

Research hypothesis 2g aimed at determining whether a significant difference exists between the mean performance of male and female pupils in primary one in the posttest from the experimental group.

Table 30 shows the test for equality of means between the performance of male and female pupils in primary one in the posttest from the experimental group.

Table 30: Test for Equality of Means between Male and Female Pupils in the Posttest from the Experimental Group

Sex	N	M	SD	t	Sig.
Male	210	18.62	2.07	-12.029	0.00
Female	220	20.54	1.12		

Source: Fieldwork (2021)

The analysis of results in Table 30 revealed that there was a significant difference in performance between male pupils (M = 18.62 out of 22.00, SD = 2.07) and female pupils in primary one (M = 20.54 out of 22.00, SD = 1.12) who participated in the posttest from the control group using independent sample t-test with t (1, 428) = -12.029, p = 0.00, $p < 0.05$, $n^2 = 0.25$ (two-tailed). This means that male and female students' performance in identifying fractions in the posttest from the experimental group differs statistically in favor of the female students. The effect size of 0.25 indicated that, while the two groups differed statistically in their performance in identification of fractions in the posttest, the difference was not much.

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Findings in Relation to Research Hypothesis 2h

$H_0$2h: There is no significant difference in the performance of primary one pupils in the identification of fractions in the context of schools in the posttest from the experimental group.

Research hypothesis 2h aimed at determining whether a significant difference exists in the context of schools; Below Average, Average and Above Average achieving schools from the experimental group in the posttest.

Table 31: ANOVA Test for Equality of Means between the Context of Schools from the Experimental Group

Context of schools	Sum of squares	Df	Mean Square	F	Sig.
Between groups	127.33	2	63.67	18.93	0.000
Within groups	1435.87	427	3.36		
Total	1563.20	429			

Source: Fieldwork (2021)

For the context of schools, the ANOVA test for equality of means in pupils' performance in identification of fractions from the experimental group was tested at a 0.05 significance level. Using one-way ANOVA between group means (i.e., Below Average, Average, and Above Average) achieving schools, there was a statistically significant difference in performance among the three contexts of schools from the experimental group with F (2, 427) =18.93, $p = 0.00$, $p < 0.05$ (two-tailed) in the posttest. This means that in the posttest, the three contexts of schools from the experimental group performed differently in the identification of fractions. Post-hoc pairwise comparisons using the Tukey HSD test revealed that the mean score for pupils in Above Average achieving schools from the

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experimental group in the posttest (M = 20.17 out of 22.00, SD =1.29) and that of pupils in Below Average (BA) achieving schools from the experimental group in the post test (M =18.88 out of 22.00, SD = 2.20) differ significantly in performance. Similarly, in the posttest, the performance of pupils in the Experimental group (M = 19.74 out of 22.00, SD = 1.91) was significantly different from that of pupils in the Below Average achieving schools (M = 18.88 out of 22.00, SD = 2.20 [see Appendix U] from the Experimental group. However, in the posttest (see Appendix U), the mean score for pupils in Above Average achieving schools from the experimental group (M = 20.17 out of 22.00, SD = 1.29) did not differ significantly from those in Average achieving schools from the experimental group (M = 19.74 out of 22.00, SD = 1.91). This means that in the posttest from the experimental group, pupils' performance in identifying the Above Average and Average context of schools is comparable.

Findings in Relation to Research Hypothesis 2i

$H_0$2i: There is no significant difference in the control group's pretest scores and that of its posttest scores.

Research hypothesis 2i aimed at determining whether a significant difference exists between the control group's pretest scores and that of its posttest scores.

A paired-samples t-test was used to evaluate the impact of the conventional approach on pupils' performance in the identification of fractions for the pupils in the Control group using their pretest and posttest scores to determine whether the conventional approach had a significant impact on pupils' performance in the Control group after the implementation of the conventional approach. From pretest (M = 4.13, SD = 4.05) to posttest (M = 11.44, SD =

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1.84), there was a statistically significant difference in pupils' performance in identification of fractions scores for the pupils in the control group who were taught using the conventional approach, t (429) = -35.41, p = 0.00, n^2 = 0.75, p < 0.05 (two-tailed) (See Appendix W). The eta squared statistic was 0.75, indicating that the effect size was large. This means that the conventional approach used to teach them explains 75% of the pupils' performance in identifying fractions in the posttest from the control group.

Findings in Relation to Research Hypothesis 2j

$H_0$2j: There is no significant difference in the experimental group's pretest scores and that of its posttest scores.

Research hypothesis 2j aimed at determining whether a significant difference exists between the experimental group's pretest scores and that of its posttest scores.

A paired-samples t-test was used to evaluate the impact of the three-tier teaching model for teaching mathematics in context on pupils' performance in the experimental group (those taught using the three-tier teaching model for teaching mathematics' pedagogy) after its implementation. The results showed a statistically significant difference in pupil performance in fraction identification from pretest (M = 3.75, SD = 3.64) to posttest (M = 19.60, SD 1.91), t (429) = -78.68, p = 0.00, n^2 = 0.94, p < 0.05 (two-tailed) (See Appendix X). The eta squared statistic of 0.94 indicated that the effect size was very large. This means that the use of the three-tier teaching model for teaching mathematics in context pedagogy explains 94 percent of the experimental group's performance in identification of fractions in the posttest.

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Findings in Relation to Research Question 4

RQ4. What are teachers' perceptions about the applicability of the three-tier teaching model for teaching mathematics in context after the enactment of the experiment?

Research Question 4 aimed at finding out the teachers' perceptions about the applicability of the three-tier teaching model for teaching mathematics in context after the enactment of the experiment.

Table 32 shows the coding framework for the findings in relation to research question 4. The coding framework has three main themes, one main sub-theme, thirteen categories/codes and the interview segments. The coding framework that guided the qualitative findings is presented below.

Table 32: Coding Framework for the Qualitative Findings

Theme	Sub-theme	Category/code	Interview Segment
General impression /recommendations	Strengths	Learner centeredness	"Ok, it helped us because our new curriculum says our teaching should be child-centred and this model is also more child-centred than we use to teach them" (T1).
			"It makes teaching easier and interesting for the learners since they were involved and they have to work on

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Table 32 cont'd

	something. It makes the lesson interesting for them" (T2).
	"Yh, I think it is really good because the children have come to appreciate that they did a lot of learning by themselves so, it wasn't like the teacher is teaching by telling them" (T5).
Relates learners' everyday mathematical experiences to In-school math	"Relates learners' everyday mathematical experiences to In-school math" (T6).
	"Sure, I will recommend this model to be used by other teachers Please with the "ky3 mu p3" (divide equally) method, it helps learners to relate their In-school concepts of mathematics to that of their home mathematical experiences" (T4).

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Table 32 cont'd

Activity-Based	"I think when I was teaching, I saw that my pupils were involved, they all seemed to be doing something because of the activities involved" (T3).
	"Mostly, pupils fear mathematics when it comes to learning so, but if they are also allowed to be doing something with their hands, with their brains, it helped them to learn better as in the case of the three-tier approach" (T2).
Teachers learn from pupils as well	"We got new ideas or new things that we don't know from our pupils using the three-tier" (T1).
Introduces concepts from multiple perspectives	"Please, I think the pupils have gotten to know that it is not only paper that they will get half from. They can get half in many things around

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Table 32 cont'd

	Culturally oriented	"After the teaching using the model, myself and the children got to realize that fraction is a cultural concept" (T6).
Challenges	Class control	"When I gave the worksheets out to them, it was quite difficult controlling them. They won't wait for you to tell them what to do, some have even started doing the work on the worksheets. That side was really difficult for me to control" (T5).
	Movement in class	"The challenging aspect was that when you give the material to them, controlling them was quite difficult because children are such a way that they are hyper(T5).
Suggested remedies	Form smaller groups	"Yea I think we can overcome the challenge of controlling the pupils by forming smaller groups say a

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Table 32 cont'd

		minimum of two and maximum three members in each group to make it easier for us to monitor them" (T1).
	Have leaders for each group	"I think we can ask each group to elect a leader among themselves and ensure that he/she gets the group in order and with that, they will pay attention" (T3, T4)
	Develop value for paying attention in class in learners	"I think, we should also let the pupils take responsibility for their learning so let them know that if they don't concentrate, it will affect them negatively" (T6).

Source: Fieldwork (2021); NB: T1 = Teacher 1, T2 = Teacher 2, T3 = Teacher 3, T4 = Teacher 4, T5 = Teacher 1, T6 = Teacher 6

Teachers' Perspectives of Implementing the Model

Teachers' general impressions or perceptions highlighted the strengths of the three-tier teaching model for teaching mathematics in context over the conventional approach. They acknowledged the ability of the three-tier teaching model for teaching mathematics in context in improving the teaching and learning of fractions and recommended the model to be used by other teachers.

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They also highlighted some challenges that relate to the use of the model. Their views on the strengths and challenges are presented below.

Strengths of the Three-tier Teaching Model

First, three of the teachers appreciated the learner-centeredness nature of the model, recognizing that it falls in line with the recommended teaching approach of the new curriculum. As one teacher stated, "It helped us because our new curriculum says our teaching should be child-centred and this model is more child-centred than we used to teach them." (T1). Another teacher echoed this, emphasizing children's appreciation of the teaching model, "I think it is really good because the children have come to appreciate that they did a lot of learning by themselves so, it wasn't like the teacher is teaching by telling them."(T5).

Closely related to learner-centeredness is the teachers' recognition of the Three-tier model as an activity-based approach. In particular, one teacher noted an increase in pupil interest and participation:

> "I think when I was teaching, I saw that my pupils were involved, they all seemed to be doing something because of the activities involved." (T3).

Two teachers extended this notion further, highlighting how the activities of the three-tier model can support brain stimulation and better understanding that can lead to a reduction in pupil fear or anxiety associated with the study of mathematics:

> "Mostly, pupils fear mathematics when it comes to learning it. But if they are also allowed to be doing something with

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their hands, with their brains, it helped them to learn better as in the case of the three-tier approach." (T 2).

"I think the three-tier model takes the fear of mathematics away from children because they do it as you are doing it with them. Before, they realize they have learned the concept. So, it takes the fear away from children. They don't learn with fear because the children are involved." (T 5).

Another strength of the model mentioned by the teachers was that it offers flexibility in the use of teaching and learning materials. According to the teachers, this helps in improving children's understanding and reinforces their learning of fractions:

"I think the approach that we used in teaching them is different from the one we were using at first. Using the sticks to introduce the lesson to them was different from the other one and the understanding was better than the other one." (T 3).

Expressing a similar view, Teacher 4 added, "I think the pupils have gotten to know that it is not only paper that they will get half from. They can get half in many things around them when they are asked to share things."

Finally, one of the teachers thought the three-tier teaching model for teaching mathematics in context reflects the cultural context and allows learners to make connections between their everyday experiences of fractions and what is taught in school. The following comments illustrate what the teacher said:

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"After the teaching using the model, I and the children got to realize that fraction is a cultural concept. It relates learners' everyday mathematical experiences to in-school math." (T 6).

Challenges with the Use of the Model

Though the teachers acknowledged the effectiveness of the three-tier model, they identified the difficulty in managing children's behaviour as a key challenge that may serve as a barrier to the use of the model. Importantly, they highlighted the difficulty in controlling class as problematic. For example, one teacher noted the children's inability to regulate themselves and work with instructions, saying that, "When I gave the worksheets out to them, it was quite difficult controlling them. They won't wait for you to tell them what to do, some have even started doing the work on the worksheets. That side was really difficult for me to control." (T 5).

Teacher 5 also noted how children's eagerness to do the activities made the management of their behaviour difficult, "The challenging aspect was that when you give the material to them, controlling them was quite difficult because children are such a way that they are hyper." (T 5).

The teachers were asked to suggest possible ways to address this challenge. And they identified three solutions – using small groups, appointing a leader for each group and supporting children's development of socio-emotional skills, including following directions, listening and paying attention. From the thematic analysis and the narrative discussions concerning research question four, it was revealed that the three-tier teaching model for teaching mathematics in context support learner centeredness pedagogy, relates learners'

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everyday mathematical experiences to the In-school concepts of mathematics, introduces mathematical concepts from multiple perspectives, allow teachers to learn from pupils, uses authentic teaching-learning resources, and reduces mathematical anxiety among learners. Therefore, the teachers perceived the Three-tier teaching model for teaching mathematics in context as a teaching model that supports teachers to teach mathematics in context. The findings from the qualitative data supports the need for mathematics to be taught in context using the three-tier teaching model for teaching mathematics in context pedagogy in Ghana.

Discussion

The performance of the pupils in the identification of fractions in the pretest was very low with M = 3.94 out of 22.00 and SD = 3.84. This was also seen in their attainment of a very low percentage pass of 5.30% in the identification of fractions in the pretest. This shows that the pupils have very low knowledge in the identification of fractions in the pretest. Similarly, the low performance of pupils in the identification of fractions in the pretest by districts shows that pupils from the both CCM and MFM performed equally very low in the identification of fractions with percentage passes of 4.23% and 5.40% respectively just as they performed across districts. The low performance of pupils in the identification of fractions by the context of schools; Below Average, Average and Above Average achieving schools in the pretest was equally very low just as their general performance in the pretest. This shows that all the pupils from the three contexts of schools have low knowledge in identification of fractions in the pretest.

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The low performance of pupils in the identification of fractions in the pretest by both male and female pupils indicates how low their knowledge was in identification of fractions irrespective of sex. The situation was not different by the performance of the pupils in identification of fractions in the control and experimental groups in the pretest. Pupils from both the control and experimental group have demonstrated a low conception of identification of fractions in the pretest. The low knowledge they have in the identification of fractions contributed to just a few of the pupils from both the control and experimental groups passing the pretest with the percentage passes of 4.40% and 6.30% respectively. The minimum and maximum scores of pupils in the pretest either across districts or by group, districts, the context of schools or sex were 0 and 12 respectively. This was not surprising to the researcher at all because they have not been taught fractions at school yet. All the knowledge they have in the identification of fractions in the pretest was Primarily what they brought from home or their cultural settings. Studies have shown that before the children come to school to learn in the four corners of the classroom, they already possessed some knowledge from their cultural settings which can serve as a prerequisite knowledge for the learning of the school concepts of halves but teachers do not create the enabling environment that fosters the effective use of the pupils' prior knowledge (Bishop, 1988; Davis, 2010, 2016, 2017b; Davis, *et al.*, 2009).

Also, the general performance of pupils in the identification of fractions in the posttest was higher with M =15.52 out 22.00 and SD = 4.49. This implies that the performance of the pupils in the identification of fractions in the posttest

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has generally improved. Similarly, the improved performance of pupils in the identification of fractions in the posttest by districts showed that pupils' performance in the identification of fractions in the posttest for both CCM and MFM were higher with M = 15.70 out of 22.00, SD = 4.66; and M = 15.34 out of 22.00, SD = 4.31 respectively. This was evident in the percentage passes of 85.70% and 74.20% of the pupils' performance in the identification of fractions for the pupils from the CCM and MFM respectively in the posttest. This shows that the performance of pupils in the identification of fractions in both districts have improved in the posttest. Despite the improvement in pupils' performance in the identification of fractions by pupils in each of the two districts, failure rates of 14.30 % and 25.80% were obtained by the pupils from CCM and MFM respectively in the posttest.

These failure rates were coming from the performance of pupils from the control group in the posttest. These failure rates showed that some of the pupils in the control group still have low knowledge in the identification of fractions in the posttest (Mitchell & Horne, 2010; Davis, 2017a). This also points to the fact that fractions remain a challenge to pupils in mathematics education (Davis, 2010, 2017a, 2017b). These failure rates of pupils from the two districts may be as a result of the way teachers from the control group introduced pupils to fractional concepts which did not help the pupils from the control group handling the application questions well in the identification of fractions in the posttest (Davis, 2010, 2017b). This is also consistent with the study conducted by Davis in 2017 where he asserted that fractional learning will

continue to be a challenge to pupils if teachers fail to teach mathematics in context (Davis, 2010, 2017b).

Generally, the study found out that pupils in the control group performed just averagely in the identification of fractions in the posttest with M =11.44 out of 22.00 and SD =1.84 while the experimental group performed higher in the identification of fractions in the posttest with M =19.60 out of 22.00, SD =1.91 respectively. The percentage pass of pupils' performance in the identification of fractions from the experimental group in the posttest was 100%. The results also show that all the pupils in the experimental group passed the posttest in the identification of fractions while 40% of the pupils from the control group failed the posttest in the identification of fractions. The failure rate of 40% of pupils in the identification of fractions in the control group tells us the weaknesses in the conventional approach used by the teachers in the control group in introducing pupils to the identification of fractions. The pupils in the control group could not answer those items or areas that required them to apply their concepts of halves in solving related problems in the identification of fractions and hence could not pass the posttest. This was confirmed by earlier studies that the current practice of mathematics teachers in our primary schools is considerably characterized by teaching by telling (Mack, 2001; Davis, 2010, 2017a, 2017b).

Literature also supports that pupil's difficulty in learning mathematics is mainly due to the approach teachers used in introducing pupils to fractional concepts at the early grade and this may transcend in learning advanced mathematical concepts since fractions form the basis for the learning of most

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advanced mathematical concepts (Mack, 2001; Cramer & Whitney, 2010; Davis, 2017a). This implies that the poor performance of pupils in the identification of fractions in the posttest from the control group was mainly due to the teachers' pedagogical gap in teaching mathematical concepts (Davis, 2010, 2017b). On the other hand, the pupils from the experimental group experienced higher performance in the identification of fractions which symbolizes the positive impact of the three-tier teaching model for teaching mathematics in context pedagogy. This confirmed the studies conducted by Davis in, 2010, 2016, and 2017 where he asserted that pupils' performance in mathematics can be improved if more innovative approaches are used by teachers in teaching mathematics in context (Davis, 2010, 2016, 2017b).

Further analysis of the posttest results for the identification of fractions in the posttest by the context of schools indicated that pupils from the three contexts of schools; Below Average, Average, and Above Average achieving schools performed higher with M =14.79 out of 22.00, SD = 4.67; M =15.47 out of 22.00, SD = 4.32 and M = 16.32 out of 22.00, SD = 4.36 respectively. The overall percentage passes of the pupils from each of the three contexts of schools; Below Average, Average, and Above Average achieving schools in the posttest were 68.30%, 85.30%, and 86.50% respectively. Although there was an improvement in performance for the pupils from all the three contexts of schools in the posttest, failure rates of 31.70%, 14.70% and 13.50% were still obtained by the pupils in the Below Average, Average and Above Average achieving schools in the posttest respectively. These failure rates were coming from the pupils from the three contexts of schools from the control group in the

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posttest. These failure rates show that the learning of fractions by the pupils from the control group in these contexts of schools remains a challenge (Mitchell & Horne, 2010; Misquitta, 2011; Davis, 2010, 2017a, 2017b).

The study also found out that both male and female pupils in the posttest performed higher with M =15.47 out of 22.00, SD =3.85; and M =15.57 out of 22.00, SD = 5.05 respectively. Percentage passes of 86.90 and 73.10% were obtained for both the male and female pupils in the identification of fractions respectively in the posttest. However, failure rates of 13.10 % and 26.90% were obtained by the male and female pupils from the control group in the posttest respectively. These failure rates show that some of the male and female pupils in the control group were not able to develop the appropriate conception of identification of fractions in the posttest (Mitchell & Horne, 2010; Misquitta, 2011, Davis, 2017a). This further points to the fact that fraction remains a challenge to some of the pupils the male and female pupils in the control group (Davis, 2010, 2017b).

Generally, the study also found out that no significant difference exists in the mean performance between the performance of the pupils in the identification of fractions from the control and experimental groups in the pretest using independent sample t-test with t (1,857) =1.436, $p = 0.15, p > 0.05$ (two-tailed). This means that pupils from both the control and experimental groups in the pretest were similar in performance in the identification of fractions. In other words, pupils from both groups have similar low knowledge in the identification of fractions (Davis, 2010). The study also found out that a significant difference exists between the performance of pupils in the

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identification of fractions in the pretest from the CCM in the control group (M = 4.79 out of 22.00, SD = 4.48) and that of their counterparts from the MFM in the control group (M = 3.42 out of 22.00, SD = 3.41) who participated in the pretest with t (1, 428) = 3.56, p = 0.00, n^2 = 0.03, $p < 0.05$ (two-tailed). This means that the low performance of the pupils in the identification of fractions in the pretest from CCM in the control group and those from MFM differ statistically in performance in identification of fractions in the pretest in favour of those from CCM. The effect size was very moderate indicating that although the low performance of the pupils from the CCM in the control group differed from those from the MFM, however, the difference was not much at all in the pretest. This was because pupils from both districts in the control group in the pretest were not taught fractions yet. All the knowledge they had in the pretest was what they brought from home.

Also, no significant difference between the performance of male pupils in the identification of fractions in the pretest (M = 4.39 out of 22.00, SD = 4.08) and that of their female counterparts (M = 3.87 out of 22.00, SD = 4.00 who participated in the pretest from the control group with t (1, 428) = 1.33, p = 0.18, $p > 0.05$ (two-tailed). This means that the male pupils and the female pupils do not differ statistically in performance in the pretest from the control group. This means that both male and female pupils from the control group in the pretest have low knowledge in the identification of fractions in the pretest and as such do not differ in performance in the identification of fractions in the pretest. Similarly, there was a statistically significant difference in the performance of the pupils in the identification of fractions in the pretest among the three

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contexts of schools from the control group using one-way ANOVA between group means (i.e., Below Average, Average and Above Average) achieving schools with F (2, 427) = 3.806, p = 0.02, $p < 0.05$ (two-tailed) in the pretest. This means that although pupils from the three contexts of schools from the control group in the pretest have low knowledge in the identification of fractions in the pretest, however, they differ in performance in the identification of fractions in the three contexts of schools. The post- hoc test using the Tukey HSD indicated that the mean score for the pupils in the identification of fractions in the pretest in the Above Average achieving schools from the control group (M = 4.75 out of 22.00, SD =3.94) and that of the pupils in Below Average (BA) achieving schools from the control group in the pretest (M = 3.41 out of 22.00, SD = 4.00) differ significantly from each other. Similarly, the performance of pupils in the identification of fractions in the pretest in the Average achieving schools in the control group (M = 4.25 out of 22.00, SD = 4.11) was found to be significantly different from the performance of the pupils in the Below Average achieving schools from the control group in the pretest (M =3.41 out of 22.00, SD = 4.00) in the pretest. However, the mean score for pupils in Above Average achieving schools from the control group in the pretest (M = 4.75 out of 22.00, SD = 3.94) did not differ significantly from those in the Average achieving schools in the control group (M = 4.25 out of 22.00, SD = 4.11) in the pretest. This means although the pupil's performance in the contexts of schools differed among the pupils from the three contexts of schools in the

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control group in the pretest, however, those from Above Average and Average achieving schools were similar.

Similarly, no significant difference was found between the performance of pupils in the identification of fractions in the pretest from CCM in the experimental group (M = 3.37 out of 22.00, SD = 3.50) and that of their counterparts from the MFM the experimental group (M = 4.12 out of 22.00, SD = 3.75) who participated in the pretest with t (1, 428) = -2.138, p = 0.03, $p <$ 0.05 (two-tailed). This means that the low Knowledge of the pupils in the identification of fractions in the pretest from MFM was similar to those from the CCM in the experimental group. However, a statistically significant difference was found in the performance of the pupils in the identification of fractions in the pretest among the three contexts of schools from the experimental group using one-way ANOVA between group means (i.e., Below Average, Average and Above Average) achieving schools with F (2, 427) = 10.615, p = 0.00, $p < 0.05$ (two-tailed) in the pretest. This means that the three contexts of schools from the experimental group in the pretest differed in performance in the identification of fractions despite their low performance in the identification of fractions in the pretest. Post-hoc pairwise comparisons using the Tukey HSD test indicated that the mean score for the pupils in the identification of fractions in the pretest in the Above Average achieving schools from the experimental group (M = 4.35 out of 22.00, SD = 3.84) and that of the pupils in Below Average (BA) achieving schools (M = 2.65 out of 22.00, SD =

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3.35) from the experimental group in the pretest differ significantly from each other.

Similarly, the performance of pupils in the Average achieving schools (M = 4.28 out of 22.00, SD = 3.44) from the experimental group was significantly different from the pupils in the Below Average achieving schools from the experimental group (M = 2.65 out of 22.00, SD = 3.35 from the experimental group in the pretest. However, the mean score for pupils in the identification of fractions in the pretest in Above Average achieving schools from the experimental group (M = 4.35 out of 22.00, SD = 3.84) did not differ significantly from those in the Average achieving schools from the experimental group (M = 4.28 out of 22.00, SD = 3.44) in the pretest from the experimental group. This means that the performance of pupils in the identification of fractions in the pretest between the Above Average and Average context of schools are similar in the pretest from the experimental group.

Also, no significant difference was found between the performance of male pupils from the experimental group (M = 3.88 out of 22.00, SD = 3.56) and that of their female counterparts (M = 3.61 out of 22.00, SD = 3.72) from the experimental group who participated in the pretest with t (1, 428) = 0.776, $p = 0.44$, $p > 0.05$ (two-tailed). This implies that the performance of both males and females do not differ from each other from the experimental group in the pretest since both sexes performed lowly in the identification of fractions in the pretest. The analysis of the mean difference in pupils' performance in the identification of fractions using the independent sample t-test (Mean = 11.44 out of 22.00, SD = 1.84 [Control group]; M =19.60 out of 22.00, SD =1.96

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[Experimental group], $df = 858$, $t = -63.832$, $p = 0.00$, $p < 0.05$, $n^2 = 0.83$, two-tailed) showed that generally, there was a significant difference between the two groups posttest scores. The partial effect size between the control group and experimental group was 0.83 indicating a very high difference in performance between the two groups in the posttest. This means that 83% of the variance in pupils' performance was explained by the kind of groups that the pupils found themselves in.

The study also found out that a significant difference exists between the performance of pupils in the identification of fractions in the posttest from the CCM in the control group (M = 12.10 out of 22.00, SD =1.94) and that of their counterparts from the MFM in the control group (M =10.82 out of 22.00, SD = 1.50) who participated in the posttest after using the pretest score as a covariate with F (1, 427) = 54.97, $p = 0.00$, $p < 0.05$, $n^2 = 0.12$ (two-tailed). This means that the pupils from CCM in the control group and those from MFM do differ statistically in performance in the identification of fractions the posttest in favour of those from Cape coast however, the effect size was quite moderate. This means that although pupils from both districts in the control group in the posttest have improved their knowledge in the identification of fractions, however, the difference was not much between the two districts.

There was no significant difference between the performance of male pupils in the identification of fractions (M = 11.47 out of 22.00, SD = 1.88) and that of their female counterparts (M = 11.41 out of 22.00, SD = 1.80) who participated in the posttest from the control group with t (1, 428) = 0.319, p = 0.75, $p > 0.05$ (two-tailed). This means that the performance of the male pupils

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and the female pupils do not differ statistically in the identification of fractions in the posttest in the control group despite both male and female pupils' improvement in performance in the identification of fractions. This finding is similar with the studies by Nyala in 2008 which studies the attitudes of male and female pupils in Junior high schools in Ghana towards the learning of mathematics and found out that the male and female pupils do not differ in attitude towards the learning of mathematics (Nyala, 2008).

There was a statistically significant difference in the performance of the pupils in the identification of fractions among the three contexts of schools from the control group using one-way ANOVA between group means (i.e., Below Average, Average and Above Average) achieving schools with F (2, 427) = 12.758, $p = 0.00$, $p < 0.05$ (two-tailed) in the posttest. This means that the three contexts of schools from the control group in the posttest differed in performance in the identification of fractions. The post-hoc pairwise comparison using the Tukey HSD test indicated that the mean score for the pupils in the Above Average achieving schools from the control group in the posttest (M = 11.75 out of 22.00, SD = 1.12) and that of the pupils in Below Average (BA) achieving schools from the control group in the posttest (M =10.81 out of 22.00, SD = 2.26) differ significantly from each other. Similarly, the performance of pupils in the Average achieving schools in the control group (M = 11.74 out of 22.00, SD = 1.76) was significantly different from the performance of pupils in the identification of fractions in the Below Average achieving schools from the control group in the posttest (M =10.81 out of 22.00, SD = 2.26) in the posttest. However, the mean score for pupils in Above Average achieving schools from the control group in

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performance of pupils in the identification of fractions in the two districts from the experimental group showed higher improvement in both districts.

There was a statistically significant difference in the performance among the three contexts of schools from the experimental group using one-way ANOVA between group means (i.e., Below Average, Average and Above Average) achieving schools with F (2, 427) = 18.93, p = 0.00, $p < 0.05$ (two-tailed) in the posttest. This means that the three contexts of schools from the experimental group in the posttest differed in performance in the identification of fractions. Post-hoc pairwise comparisons using the Tukey HSD test indicated that the mean score for the pupils in the identification of fractions in the Above Average achieving schools from the experimental group in the posttest (M = 20.17 out of 22.00, SD = 1.29) and that of the pupils in Below Average (BA) achieving schools (M =18.88 out of 22.00, SD = 2.20) from the experimental group in the posttest differ significantly from each other. Similarly, the performance of pupils in the identification of fractions in the Average achieving schools (M = 19.74 out of 22.00, SD = 1.91) from the experimental group was significantly different from the pupils in the Below Average achieving schools from the experimental group (M = 18.88 out of 22.00, SD = 2.20) from the experimental group in the posttest. However, the mean score for pupils in Above Average achieving schools from the experimental group (M = 20.17 out of 22.00, SD = 1.29) did not differ significantly from those in the Average achieving schools from the experimental group (M = 19.74 out of 22.00, SD = 1.91) in the posttest from the experimental group. This means that the performance of pupils in identification between the Above Average and Average context of schools are similar in the posttest from

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the experimental group. This finding is also consistent with the works of Davis, Amponsah, Kwaah, and Beccles in 2019 which asserted that a significant difference exists between the performance of primary 2 pupils from Below Average achieving and Above Average achieving schools in mathematics, English Language and Integrated science in three selected districts in the Central Region of Ghana. However, they also didn't find a significant difference between the performance of pupils from the Above Average and that Average achieving schools in the three selected districts in the Central Region of Ghana in mathematics, English language and integrated Science (Davis, Amponsah, Kwaah, & Beccles, 2019).

There was also a significant difference between the performance of male pupils in the identification of fractions from the experimental group (M = 18.62 out of 22.00, SD = 2.04) and that of their female counterparts (M = 20.54 out of 22.00, SD = 1.14) from the experimental group who participated in the posttest with t (1, 428) = -12.029, p = 0.00, $p < 0.05$ (two-tailed). This implies that the performance of both males and females in the identification of fractions differed from each other in the posttest from the experimental group in favour of the female pupils from the experimental group. This means the three-tier teaching model for teaching mathematics in context yielded more impact on the female pupils in the experimental group in the posttest than that of their male counterparts. This was not so in the control group. In the Control group the male pupils (M = 11.47, SD = 1.88) did slightly better than their female counterparts (M = 11.41, SD = 1.80) in the identification of fractions in the posttest.

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To ascertain whether the conventional approach has yielded a significant impact on pupils' performance in the Control group after the implementation of the conventional approach, a paired-samples t-test was conducted to evaluate the impact of the conventional approach on pupils' performance in the identification of fractions for the pupils in the Control group using their pretest scores and their posttest scores. There was a statistically significant increase in pupils' performance in identification of fractions scores for the pupils in the control group which was taught using the conventional approach from pretest (M = 4.13, SD = 4.05) to posttest (M = 11.44, SD = 1.84), t (429) = -35.41, p = 0.00, $p <$ 0.05, $n^2 = 0.75$ (two-tailed) (See Appendix W). The eta squared statistic was 0.75 indicated a large effect size.

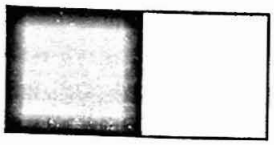
To appreciate the discussions of the findings on why pupils in the experimental group performed better than their counterparts in the control group, the researcher probed further into the performance of both groups in the posttest using some excerpts. As indicated earlier, two pupils in the posttest from the control group could not represent the fraction of the shaded portion for item 1 as ½ whereas all the pupils in experimental group were able to write it as ½ while none of their counterparts in experimental group had it wrongly in the posttest. The presentation in figure 3 showed how the two pupils presented their answers for item 1 which required them to represent the fraction of the shaded portion for item 1 as ½ (half). These two pupils from the control group in the posttest wrote the symbol for ½ as 2/1 as shown in figure 3. An excerpt from pupils' presentation in figure 3 shows some of the weaknesses in the conventional approach.

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Write the fraction of the shaded portion in each of the diagrams below

a)



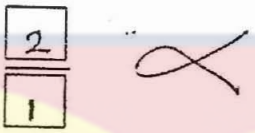


Figure 3: Pupils' Presentation of Writing the Fraction for Item 1

It was also an indication from pupils' presentations from the control group in the posttest that some of the pupils, 286 out 430 had item 4a wrong while none of their counterpart from the experimental group had this item wrongly. One hundred and seventy-eight (178) out of the 286 pupils presented their solutions for item 4a as 3/1. This illustration could mean a ratio of three unshaded parts to one shaded part. One could wonder how pupils in the control could think this way after they have been taught using the conventional approach that was spelt out the in new curriculum. Such a presentation could mean that such pupils have not grasped the concepts of equal division well. It could also mean that pupils failed to identify the total number of equal parts that the picture was divided into. This child also reversed the orientation of the writing fraction where the part/parts that are taken out of the total number of parts is written at the numerator part while the denominator of the fraction is represented with a total number of equal parts in which the object was divided into. An excerpt from pupils' presentations in figure 4 shows some of the weaknesses in the conventional approach.

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b)

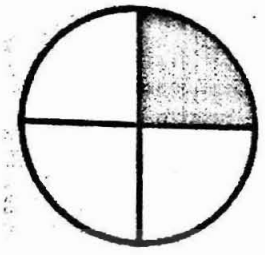




Figure 4: Pupils' Presentation of Writing the Fraction for Item 4a

A common challenge exhibited by the some of the pupils, 108 out of the 278 pupils who had item 4a wrong from the control group in this presented their solutions for item 4a as 1/3 as shown in the excerpt in figure 5 below which was not the case with their counterpart in the experimental group. They interchanged one-quarter for one-third as in the case of the excerpt in figure 5.

This was very rare of a pupil who has developed the conception for identification of fractions. This may be characteristics of a teaching approach that does not foster relational understanding in learners. In the case of this study, once the pupils have developed the conceptions of halves, it was expected of them to be able to apply it in identifying other related fractions. Considering the conventional lesson notes used in the control group, one could see that identification of fractions was mainly done using only the area concepts ignoring all other concepts like lines, volume, and groups which could help the pupils to develop the appropriate conceptions of identification fractions at the early grade (See Appendices C and D). From the lesson notes for the conventional group, pupils were limited to identifications of fractions using

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only the area concept which does not help learners to develop the conception of identification of fractions in a more relational manner. The pupils who presented their solutions like what we saw in excerpts in figure 5 may have multiple challenges such as number sense and fractional ideas.

As indicated earlier in the analysis of the descriptive statistics, the above challenge demonstrated by pupils in the control group in the posttest has negatively caused more than half, 286 out of 430 (66.60%) of the participants from the control group in the posttest not to answer item 4a appropriately (see Table 21). These challenges demonstrated by the pupils in the control group in the posttest brought to bear some of the weaknesses in the conventional approach which does not promote relational learning among pupils. The challenge demonstrated by pupils in the control group in the posttest towards item 4a go a long way to affect their learning of mathematics if not corrected as soon as possible for them. An excerpt from pupils' presentations in figure 5 shows some of the weaknesses in the conventional approach.

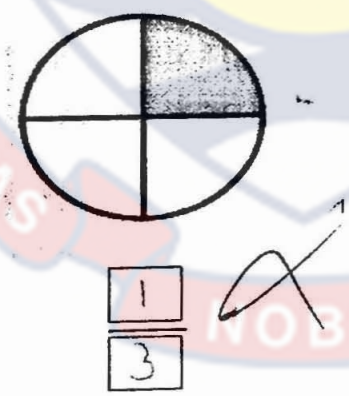


Figure 5: Pupils' Presentation of Writing the Fraction for Item 4a

Some of the pupils in the control group also presented their solutions for item 4b as ½ (half) instead of 1/3 (one-third). This still points to the fact that their conception of writing fractions symbolically was not properly formed.

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This may be characteristics of a teaching approach that does not promote learners' mathematical conceptions as in the case of the conventional approach in this study. An excerpt from pupils' presentations in figure 6 shows some of the weaknesses in the conventional approach.



Figure 6: Pupils' Presentation of Writing the Fraction for Item 4b in terms of Half

Similarly, in writing 1/3 (One-third) for item 4b, majority 323(75%) of the pupils in the control group could not answered as expected of them. They presented their answers as ¼ (one-quarter) instead of 1/3 (one-third). These pupils have not formed the appropriate conception of the writing of 1/3 so is like they were found interchanging one-quarter for one-third instead. This means that their conceptions of identifications of fractions were not properly formed and hence they wrote ¼ for 1/3 in the posttest. Few of the pupils, 42 out of the 430 participants from the experimental group also got the answer for item 4b wrongly. An example of an excerpt from pupils' presentations in figure

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which was not the case as shown in the excerpt is shown in figure 10. Though they were able to symbolically represent half as ½, they were marked wrong because their shaded portions do not match with their symbolic representation of half in terms of division into two equal parts. An excerpt from pupils' presentation in figure 10 shows some of the weaknesses in the conventional approach.

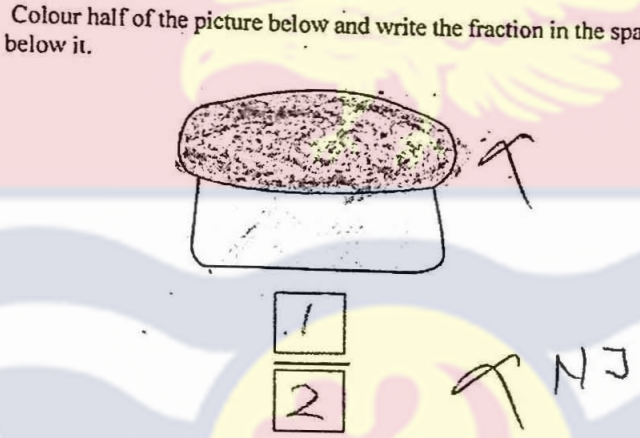


Figure 10: Pupils' Presentation of Writing the Fraction for Item 2 in terms of Shading just the Top.

As indicated earlier in the descriptive analysis in the posttest in Table 21 where 393 out of 430 of the pupils in the control group were not able to identify the fraction of the shaded portions in item 3c as ½ (half) while just a few, 66 out of the 430 pupils in the experimental group had item 2 wrong. The scenario in the excerpt as presented in figure 13 shows how 393 out of 430 participants from the control group failed to circle item 3c as ½ (half). This implies that although almost all the participants except two pupils in the control group were able to identify items 3a and 3b as halves in the posttest. However, a number of them could not identify the fraction of the shaded portion in 3c as half.

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Similarly, as indicated earlier in the descriptive analysis in the posttest in Table 21; 397 out of 430 of the pupils in the control group were not able to identify the fraction of the shaded portions in item 3d as half. The scenario in the excerpt presented in figure 11 shows how the 397 pupils out of 430 participants from the control group failed to circle item 3d as ½ (half). This implies that although almost all the participants except two in the control group were able to identify items 3a and 3b as halves in the posttest. However, a number of them failed to identify the fraction of the shaded portions in 3d as ½ (half).

The greatest of all the challenges was shown in the excerpt in figure 11 where 201(46.70%) out of the 430 participants in the control group in the posttest circled item 3e as a picture showing half of the shaded parts which should not be the case. This means that 46.70% of the participants in the control group have not fully developed the concept of halves in the posttest. This could also mean that their successes in identifying other pictures/shapes as halves were mainly algorithmic in nature. This was not the case in the experimental group. Those in the experimental could identify that item 3e is not showing half of shaded part.

The worst situation occurred where no pupil in the control group was able to identify item 3f as $\frac{1}{2}$ (half) in the posttest but 95 out of 430 pupils in the experimental group were able to identify the fraction of the shaded portions in item 3f as $\frac{1}{2}$ (half). An excerpt from pupils' presentation in figure 13 shows some of the weaknesses in the conventional approach.

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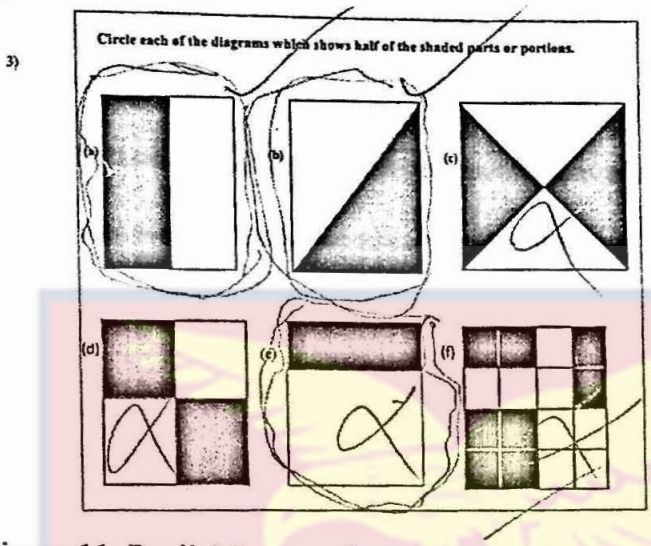


Figure 11: Pupils' Presentation of Writing the Fraction for Item 3

To ascertain whether the three-tier teaching model for teaching mathematics in context approach has yielded a significant impact on pupils' performance in the experimental group (those taught using the three-tier teaching model for teaching mathematics' pedagogy) after its implementation, a paired-samples t-test was conducted to evaluate the impact of the three-tier teaching model for teaching mathematics in context on pupils' performance in the identification of fractions for the pupils in the Experimental group. The analysis of results indicated statistically significant increase in the performance of pupils in identification of fractions from pretest (M = 3.75, SD = 3.64) to posttest (M = 19.60, SD = 1.91), t (429) = -78.68, p = 0.00, $p < 0.05$, $n^2 = 0.94$ (two-tailed) (See Appendix X). The eta squared statistic was 0.94 indicated a very large effect size. It appears both interventions have yielded a positive impact on pupils' performance in the posttest. However, comparing the effect sizes of the two approaches indicated that the three-tier teaching model for teaching mathematics in context yielded more impact on pupils' performance in

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the posttest with an effect size of 0.94 than that of the conventional approach that had an effect size of 0.75.

The teachers perceived that the three-tier teaching model for teaching mathematics in context support learner centeredness pedagogy, relates learners' everyday mathematical experiences to the In-school concepts of mathematics, introduces mathematical concepts from multiple perspectives, allow teachers to learn from pupils, uses authentic teaching-learning resources, and reduces mathematical anxiety among learners. However, they said class control can be challenging because the pupils were enthusiastic to work on the tasks given them due to the practical nature of three-tier teaching model for teaching mathematics in context approach which connects the in- school concepts of mathematics to their daily realities. Therefore, the teachers perceived the three-tier teaching model for teaching mathematics in context as a teaching model that supports teachers to teach mathematics in context. The findings from the qualitative data support the need for mathematics to be taught in context using the three-tier teaching model for teaching mathematics in context pedagogy in Ghana.

Hence teachers' general impressions or perceptions about the use of the model highlighted the strengths of the three-tier teaching model for teaching mathematics in context over the conventional approach. They acknowledged that the three three-tier teaching model for teaching mathematics in context improves the teaching and learning of fractions and recommended the model to be used by other teachers in teaching mathematics. This was confirmed by a study conducted by Davis in 2017b which found out that the three-tier teaching

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model for teaching mathematics in context was an innovative way of teaching mathematics in context (Davis, 2010, 2017b). The works of Davis and Chaiklin (2015) also highlighted how culture influences mathematics learning positively among pupils.

Summary of the Findings

The summary of the findings is drawn below:

1. Research Question one aimed at finding out the performance of primary one pupils in the identification of fractions in the pretest. The study found out that the performance of the primary one pupils in the identification of fractions in the pretest was low with M = 3.94 out of 22.00 and SD = 3.84.
    a. Research Question 1a aimed at finding out the performance of primary one pupils in the identification of fractions by districts. The study found out that the performance of the primary one pupils in the identification of fractions in CCM and MFM in the pretest were low with M = 4.13 out 22.00, SD = 4.05 and 3.75 out 22.00, SD = 3.64 respectively.
    b. Research Question 1b aimed at finding out the pupils' performance in the pretest for the control and experimental groups. The study found out that the performance of the primary one pupils in the identification of fractions in the control and experimental group in the pretest were low with M = 4.13 out of 22.00, SD = 4.04 and M =3.75 out of 22.00, SD = 3.64 respectively.

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c. Research Question 1c aimed at finding out the pupils' performance in terms of contexts of schools in the pretest. The study found out that the performance of the primary one pupils in the identification of fractions for the context of schools Below Average, Average and Above Average in the pretest were generally low with M = 2.86 out of 22.00, SD = 3.66; M = 4.49 out of 22.00, SD = 3.94 and M = 4.47 out of 22.00, SD = 3.72 respectively.

d. Research Question 1d aimed at finding out the male and female primary one pupils' performance in the pretest. The study found out that the performance of the primary one pupils in the identification of fractions for the male and female pupils in the pretest was low with M = 3.75 out of 22.00, SD = 3.84 and M = 3.93 out of 22.00, SD = 3.86 respectively.

2. Research Question two aimed at finding out the performance of primary one pupils in the identification of fractions in the posttest. The study found out that the performance of the primary one pupils in the identification of fractions in the posttest was generally high with M =15.52 out 22.00 and SD = 4.49. The overall minimum and maximum scores of the pupils in the posttest were 6.00 and 22.00 respectively.

   a. Research Question 2a aimed at finding out the performance of primary one pupils in the identification of fractions in the posttest by districts. The study found out that the performance of the primary one pupils in the identification of fractions in the

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posttest for the pupils in CCM and MFM were generally high with M = 15.70 out of 22.00, SD = 4.66 and M = 15.34 out of 22.00, SD = 4.31 respectively. The minimum and maximum scores of the pupils in CCM and MFM in the posttest were 6.00 and 22.00 respectively.

b. Research Question 2b aimed at finding out the pupils' performance in the control and experimental groups in the posttest. The study found out that the performance of the primary one pupils in the identification of fractions in the posttest for the control was a slightly above average with M = 11.44 out of 22.00 and SD = 1.84 while the experimental group performed generally high in the posttest with M = 19.60 out of 22.00 and SD = 1.91. Generally, the minimum and maximum scores for the control group were 6.00 and 16.00 respectively while the experimental group had a minimum and maximum score of 14.00 and 22.00 respectively in the posttest. The percentage passes for the control and experimental groups in the posttest were 60% and 100% respectively. The study also found out that the majority 66.5% of the pupils in the control group were not able to apply their concepts of halves in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth) in the posttest with M = 0.67 out of 2.00 and SD = 0.95. Also, the majority, 75.1% of the pupils in the control group in the posttest were not able to apply their concepts of halves in writing the fraction of the shaded portion

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in item 4b as 1/3 (one-third). However, the study found out that all the pupils in the experimental group in the posttest were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4a as ¼ (one-fourth). Also, more than nine- tenth (90.2%) of the pupils in the experimental were able to apply their concepts of halves in writing the fraction of the shaded portion in item 4b as 1/3 (one-third).

c. Research Question 2c aimed at finding out the pupils' performance in the posttest for the contexts of schools. The study found out that the performance of the primary one pupils in the identification of fractions in the posttest for each of the contexts of schools; BA, A and AA in the posttest were high with M=14.79 out of 22.00, SD = 4.67; M =15.47 out of 22.00, S = 4.34 and M = 16.32 out of 22.00, SD = 4.36 respectively. The percentage passes for each of the context of schools; BA, A and AA in the posttest were 68.30%, 85.30%, and 86.50%. The minimum scores for BA, A and AA achieving schools were 6.00, 8.00 and 6.00 respectively in the posttest while each of these contexts of schools has a maximum score of 22.00.

d. Research Question 2d aimed at finding out the male and female pupils' performance in the posttest. The study found out that the performance of the primary one pupils in the identification of fractions in the posttest for male and female pupils was high with M = 15.47 out of 22.00, SD = 3.85 and M = 15.57 out of 22.00,

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SD = 5.05 respectively. The percentage passes of male and female pupils in the identification of fractions in the posttest were 86.90%, and 73.10% respectively.

3. Research question three;

The purpose of research hypothesis 1a was to see if there was a significant difference in the pretest mean performance of primary one pupils in the control group and those in the experimental group. The independent sample t-test results (M = 4.13 out of 22.00, SD = 4.05 [Control group]; M = 3.75 out of 22.00, SD = 3.64 [Experimental group], df = 858, t = 1.436, p = 0.15, $p > 0.05$ (two-tailed) revealed no significant difference in the two groups' pretest scores.

In the pretest, research hypothesis 1b wanted to determine whether a significant difference exists between the mean performance of primary one pupils by context (Below Average, Average, and Above Average achieving schools). Using one-way ANOVA between group means, there was a significant difference in primary one pupils performance in the identification of fractions among the three contexts of schools (i.e., Below Average, Average, and Above Average) achieving schools with F (2, 857) =17.613, p = 0.00, $p < 0.05$ (two-tailed) in the pretest. Post-hoc pairwise comparisons using the Tukey HSD test revealed that the mean score for pupils in Above Average (AA) achieving schools (M = 4.47 out of 22.00, SD = 3.72) differed significantly from that of pupils in Below Average (AA) achieving schools (M =2.86 out of 22.00, SD = 3.66) achieving schools. Similarly, in the pretest, pupils in the Average achieving schools (M = 4.49 out of 22.00, SD

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= 3.94) performed significantly better than pupils in the Below Average achieving schools (M =2.86 out of 22.00, SD = 3.66). In the pretest, however, the mean score for pupils in Above Average achieving schools (M = 4.47 out of 22.00, SD = 3.72) did not differ significantly from those in Average achieving schools (M = 4.49 out of 22.00, SD = 3.94).

The purpose of research hypothesis 1c was to see if there was a significant difference in the pretest performance of primary one pupils from the CCM and MFM compared to the control group. The results showed that there was a significant difference in performance between primary one pupils from the CCM in the control group (M = 4.79 out of 22.00, SD = 4.48) and those from the MFM in the control group (M = 3.42 out of 22.00, SD = 3.41) who took the pretest with t (1, 428) = 3.56, p = 0.00, n^2 = 0.03, $p < 0.05$ (two-tailed).

The purpose of research hypothesis 1d was to see if there was a significant difference in the mean performance of male and female pupils in primary one in the pretest compared to the control group. The results showed that there was no significant difference in performance between male pupils (M = 4.39 out of 22.00, SD = 4.08) and female pupils (M = 3.87 out of 22.00, SD = 4.00) who participated in the pretest from the control group with t (1, 428) = 1.33, p = 0.18, $p > 0.05$ (two-tailed).

In the pretest, research hypothesis 1e wanted to determine whether there is a significant difference in the performance of primary one pupils in the context of schools; Below Average, Average, and Above Average achieving schools from the control group. Using one-way ANOVA between group means (i.e., Below Average, Average, and Above Average) achieving schools, there

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was a statistically significant difference in performance between the three contexts of schools from the control group with F (2, 427) = 3.806, p = 0.02, p < 0.05 (two-tailed) in the pretest. The post-hoc pairwise comparisons test using the Tukey HSD revealed that the mean score for pupils in Above Average achieving schools from the control group in the pretest (M = 4.75 out of 22.00, SD = 3.94) differed significantly from that of pupils in Below Average (BA) achieving schools from the control group in the pretest (M = 3.41 out of 22.00, SD = 4.00). Similarly, pupils in the Average achieving schools in the control group (M = 4.25 out of 22.00, SD = 4.11) performed significantly better than pupils in the Below Average achieving schools in the control group (M = 3.41 out of 22.00, SD = 4.00) in the pretest. However, the mean pretest score for pupils in Above Average achieving schools in the control group (M = 4.75 out of 22.00, SD = 3.94) did not differ significantly from that of pupils in Average achieving schools in the control group (M = 4.25 out of 22.00, SD = 4.11).

The purpose of research hypothesis 1f was to see if there was a significant difference in the mean performance of primary one pupils from the CCM and MFM in the pretest from the experimental group. The results showed that there was no significant difference in performance between pupils from CCM in the experimental group (M = 3.37 out of 22.00, SD = 3.50) and those from MFM in the experimental group (M = 4.12 out of 22.00, SD = 3.75) who took the pretest with t (1, 428) = -2.138, p = 0.03, n^2 = 0.01, p < 0.05 (two-tailed).

In the pretest, research hypothesis 1g wanted to determine whether there is a significant difference in the performance of primary one pupils in the

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context of schools; Below Average, Average, and Above Average achieving schools from the experimental group. Using one-way ANOVA between group means (i.e., Below Average, Average, and Above Average) achieving schools, there was a statistically significant difference in performance among the three contexts of schools from the experimental group with F (2, 427) =10.615, p = 0.00, $p < 0.05$ (two-tailed) in the pretest. Post-hoc pairwise comparisons using the Tukey HSD test revealed that the mean score for pupils in Above Average achieving schools from the experimental group in the pretest (M = 4.35 out of 22.00, SD = 3.84) and that of pupils in Below Average (BA) achieving schools from the experimental group in the pretest (M = 2.65 out of 22.00, SD = 3.35) differ significantly from each other. Similarly, in the pretest, the performance of pupils in the Experimental group (M = 4.28 out of 22.00, SD = 3.44) was significantly different from that of pupils in the Below Average achieving schools (M = 2.65 out of 22.00, SD = 3.35 from the Experimental group). However, in the pretest from the experimental group, the mean score for pupils in Above Average achieving schools (M = 4.35 out of 22.00, SD = 3.84) did not differ significantly from those in Average achieving schools (M = 4.28 out of 22.00, SD = 3.44). This means that in the pretest, pupils' performance in identifying fractions between the Above Average and Average context of schools was comparable to that of the experimental group.

The purpose of research hypothesis 1h was to see if there was no significant difference in the mean performance of male and female pupils in primary one in the pretest from the experimental group. The results showed that there was a significant difference in performance between male pupils from the

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experimental group (M = 3.88 out of 22.00, SD = 3.56) and female pupils from the experimental group (M = 3.61 out of 22.00, SD = 3.72) who participated in the pretest with t (1, 428) = 0.776, $p = 0.44$, $p > 0.05$ (two-tailed).

The purpose of research hypothesis 2a was to see if there was a significant difference in posttest performance between primary one pupils in the control and experimental groups. The independent sample t-test revealed a significant difference between the two groups' posttest scores (Mean = 11.44 out of 22.00, SD = 1.84 [Control group]; M = 19.60 out of 22.00, SD =1.96 [Experimental group], df = 858, t = -63.832, $p = 0.00$, $p < 0.05$, $n^2 = 0.83$, two-tailed). The partial effect size between the control and experimental groups was 0.83, indicating a significant difference in posttest performance between the two groups.

The purpose of research hypothesis 2b was to see if there was a significant difference in the mean performance of primary one pupils based on the contexts of the posttest. Using one-way ANOVA between group means, there was a significant difference in performance among the three contexts of schools (i.e., Below Average, Average, and Above Average) achieving schools with F (2, 857) = 8.441, and $p = 0.00$, $p < 0.05$ (two-tailed) in the posttest. In the posttest, post-hoc pairwise comparisons using the Tukey HSD test revealed that the mean score for pupils in Below Average achieving schools (M =14.79 out of 22.00, SD = 4.67) was significantly different from the mean score for pupils in Above Average achieving schools (M =16.32 out of 22.00, SD = 4.36). In the posttest, however, the mean score for pupils in Average achieving schools (M =15.47, SD = 4.32) did not differ significantly from that of pupils in Below

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Average achieving schools (M =14.79 out of 22.00, SD = 4.67). Similarly, in the posttest, the mean scores of pupils in Above Average achieving schools (M = 16.32 out of 22.00, SD = 4.36) did not differ significantly from those in Average achieving schools (M = 15.47 out of 22.00, SD = 4.32).

The purpose of research hypothesis 2c was to see if there was a significant difference in the mean performance of primary one pupils from the CCM and MFM in the posttest compared to the control group. The analysis of results using one-way ANCOVA between group means revealed a significant difference in performance between pupils from the CCM in the control group (M = 12.10 out of 22.00, SD = 1.94) and those from the MFM in the control group (M = 10.82 out of 22.00, SD = 1.50) who participated in the posttest after using pretest scores as a covariate with F (1, 427) = 54.97, p = 0.00, $p < 0.05$ (two-tailed).

The purpose of research hypothesis 2d was to see if there was no significant difference in the mean performance of male and female pupils in primary one in the posttest compared to the control group. The analysis of results using an independent sample t-test revealed that there was no significant difference in performance between male pupils (M = 11.47 out of 22.00, SD = 1.88) and female pupils (M = 11.41 out of 22.00, SD = 1.80) who participated in the posttest from the control group, t (1, 428) = 0.319, p = 0.75, $p > 0.05$ (two-tailed).

In the posttest, research hypothesis 2e wanted to determine whether a significant difference exists in the context of schools; Below Average, Average, and Above Average achieving schools from the control group. Using one-way

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ANOVA between group means (i.e., Below Average, Average, and Above Average) achieving schools, there was a statistically significant difference in performance among the three contexts of schools from the control group with F (2, 427) = 12.758, p = 0.00, $p < 0.05$ (two-tailed) in the posttest. The post-hoc test using the Tukey HSD revealed that the mean score for pupils in Above Average achieving schools from the control group in the posttest (M = 11.75 out of 22.00, SD = 1.12) differed significantly from that of pupils in Below Average (BA) achieving schools from the control group in the posttest (M = 10.81 out of 22.00, SD = 2.26) Similarly, the performance of pupils in the Average achieving schools in the control group (M = 11.74 out of 22.00, SD = 1.76) in the posttest was significantly different from that of pupils in the Below Average achieving schools in the control group (M = 10.81 out of 22.00, SD = 2.26) in the posttest. However, the mean posttest score for pupils in Above Average achieving schools in the control group (M = 11.75 out of 22.00, SD = 1.12) did not differ significantly from that of pupils in Average achieving schools in the control group (M = 11.74 out of 22.00, SD = 1.76).

The purpose of research hypothesis 2f was to see if there was a significant difference in the mean performance of primary one pupils from the CCM and MFM in the posttest from the experimental group. The analysis of results using one-way ANCOVA between group means revealed a significant difference between the performance of primary one pupils from the CCM in the experimental group (M = 20.06 out of 22.00, SD = 1.75) and that of their counterparts from the MFM in the experimental group (M = 19.15 out of 22.00, SD = 1.95) who participated in the posttest after using their pretest scores as a

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covariate, with F (1, 427) = 25.79, p = 0.00, $p < 0.05$ (two-tailed). This means that the pupils from CCM and MFM do differ statistically in performance in the identification of fractions in the posttest.

The purpose of research hypothesis 2g was to see if there was a significant difference in the mean performance of male and female pupils in primary one in the posttest from the experimental group. The analysis of results using the independent sample t-test revealed that there was a significant difference in performance between male pupils (M =18.62 out of 22.00, SD = 2.07) and female pupils (M =20.54 out of 22.00, SD = 1.12) who participated in the posttest from the experimental group, with t (1, 428) = -12.029, p = 0.00, $n^2 = 0.25$, $p < 0.05$ (two-tailed) in favour of the female pupils.

In the posttest, research hypothesis 2h wanted to determine whether a significant difference exists in the context of schools; Below Average, Average, and Above Average achieving schools from the experimental group. Using one-way ANOVA between group means (i.e., Below Average, Average, and Above Average) achieving schools, there was a statistically significant difference in performance among the three contexts of schools from the experimental group, with F (2, 427) =18.93, p = 0.00, $p < 0.05$ (two-tailed) in the posttest. Post-hoc pairwise comparisons test using the Tukey HSD test revealed that the mean score for pupils in Above Average achieving schools from the experimental group in the posttest (M = 20.17 out of 22.00, SD =1.29) and that of pupils in Below Average (BA) achieving schools from the experimental group in the posttest (M =18.88 out of 22.00, SD = 2.20) differ significantly in performance. Similarly, in the posttest, the performance of pupils in the Average achieving

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schools (M = 19.74 out of 22.00, SD = 1.91) from the experimental group was significantly different from that of pupils in the Below Average achieving schools (M = 18.88 out of 22.00, SD = 2.20 from the experimental group). However, in the posttest from the experimental group, the mean score for pupils in Above Average achieving schools (M = 20.17 out of 22.00, SD = 1.29) did not differ significantly from those in Average achieving schools (M = 19.74 out of 22.00, SD = 1.91). This means that in the posttest from the experimental group, pupils' performance in identifying the Above Average and Average context of schools is similar.

The purpose of research hypothesis 2i was to see if there was a significant difference between the control group's pretest and posttest scores. There was a statistically significant difference in pupils' performance in fraction identification from pretest (M = 4.13, SD = 4.05) to posttest (M = 11.44, SD = 1.84), using paired sample t-test with t (429) = -35.41, $p = 0.00$, $p < 0.05$ (two-tailed). The eta squared statistic was 0.75, indicating that the effect size was large.

The purpose of research hypothesis 2j was to see if there was a significant difference between the experimental group's pretest and posttest scores. The analysis of results indicated statistically significant difference in the performance of pupils in identification of fractions from pretest (M = 3.75, SD = 3.64) to posttest (M = 19.60, SD = 1.91), using paired sample t-test with t (429) = -78.68, $p = 0.00$, $p < 0.05$ (two-tailed). The eta squared statistic was 0.94 indicated a very large effect size.

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4. Research Question 4 aimed at finding out the teachers' perceptions about the applicability of the three-tier teaching model for teaching mathematics in context after the enactment of the experiment. The study found out that teachers who participated in this study perceived the Three-tier teaching model for teaching mathematics in context as a teaching model that supports learner centeredness pedagogy, relates learners' everyday mathematical experiences to the In-school concepts of mathematics, introduces mathematical concepts from multiple perspectives, allow teachers to learn from pupils, uses authentic teaching-learning resources, and reduces mathematical anxiety among learners. However, they said class control can be challenging because the pupils were enthusiastic to work on the tasks given them due to the practical nature of the three-tier teaching model for teaching mathematics in context approach which connects the in-school concepts of mathematics to their daily realities.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The main focus of this study was to investigate the effect of the three-tier teaching model for teaching mathematics in context on primary one pupils' performance in the identification of fractions. It also aimed to ascertain and extend understanding of teaching in context to improve pupils' performance in fractions through the use of the three-tier teaching model for teaching mathematics in context. The study drew on socio-cultural theory and ethnomathematics as its main theories. The sequential explanatory mixed method was primarily used. A quasi-experimental pretest-posttest design were employed in this study. A multistage sampling technique was employed in this study. Pupils Identification of Fraction Worksheets were used to collect data across different contexts of schools from 860 public primary one pupils from 24 selected schools with 12 primary schools from each of the two districts. The qualitative data were collected using a semi-structured Interview Guide for Teachers. The quantitative data for this study were analyzed using frequency counts, percentages, mean, standard deviation, independent sample t-test, paired sample t-test, one-way ANOVA between groups' means and one-way ANCOVA between groups' means. The qualitative data was analyzed through the use of themes and narrative discussions.

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Key Findings

The summary of key the findings is presented below:

1. The study found out that the performance of the primary one pupils in the identification of fractions in the pretest was generally low with M = 3.94 out of 22.00 and SD = 3.84. The percentage pass of the pupils in identification of fractions in the pretest was 5.30%.
    a) Primary one pupils' performance from both the control and experimental groups in the identification of fractions in the pretest was low with M = 4.13 out of 22.00, SD = 4.04 and M = 3.75 out of 22.00, SD = 3.64 respectively. The overall minimum and maximum scores of primary one pupils' performance in identification of fractions in the pretest from both the control and experimental group were 0 and 12 respectively. However, no significant difference was found between the performance of the primary one pupils from the control group and the experimental group using the independent sample t-test (Mean = 4.13 out of 22.00, SD = 4.05 [Control group]; M = 3.75 out of 22.00, SD = 3.64 [Experimental group], $df = 858$, $t = 1.436$, $p = 0.15$, $p > 0.05$, two-tailed) in the pretest.
    b) Also, primary one pupils' performance in the pretest in the identification of fractions by the context of schools; Below Average, Average and Above Average achieving schools in the pretest was low with M = 2.86 out of 22.00, SD = 3.66; M = 4.49 out of 22.00, SD = 3.94, and M = 4.47 out of 22.00, SD = 3.72

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respectively. But the context of schools differed significantly in performance in identification of fractions from the control group using one-way ANOVA between group means (i.e., Below Average, Average and Above Average) achieving schools with F (2, 427) = 3.806, p = 0.02, $p < 0.05$ (two-tailed) in the pretest. Similarly, a statistically significant difference was also found in the performance of the primary one pupils in the identification of fractions in the pretest among the three contexts of schools from the experimental group using one way ANOVA between group means (i.e., Below Average, Average and Above Average) achieving schools with F (2, 427) =10.615, p = 0.00, $p < 0.05$ (two-tailed) in the pretest.

c) The performance of both male and female pupils in primary one in the identification of fractions in the pretest was low with M= 3.75 out of 22.00, SD = 3.84 and M = 3.93 out of 22.00, SD = 3.86 respectively. However, no significant difference was found between the performance of male pupils in the identification of fractions in the pretest (M = 4.39 out of 22.00, SD = 4.08) and that of their female counterparts (M = 3.87 out of 22.00, SD = 4.00 who participated in the pretest from the control group with t (1, 428) = 1.33, p = 0.18, $p > 0.05$. Similarly, no significant difference was found between the performance of male pupils in primary one from the experimental group (M = 3.88 out of 22.00, SD = 3.56) and that of their female counterparts (M = 3.61 out

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of 22.00, SD = 3.72) from the experimental group who participated in the pretest with t (1, 428) = 0.776, p = 0.44, $p >$ 0.05 (two-tailed).

2. The study found out that the general performance of primary one pupils in the identification of fractions in the posttest was high with M=15.52 out of 22.00 and SD = 4.49. The percentage pass of primary one pupils' performance in the identification of fractions in the posttest was 79.90%. The overall lowest and highest scores of the pupils in the posttest were 6.00 and 22.00 respectively.

    a) It was generally found out that the primary one pupils in the control group performed just averagely in the identification of fractions in the posttest with M =11.44 out of 22.00 and SD =1.84 while the experimental group performed higher in the identification of fractions in the posttest with M =19.60 out of 22.00, SD =1.91 respectively. The percentage pass of pupils' performance in the identification of fractions from the experimental group in the posttest was 100%. The results also showed that all the pupils in the experimental group passed the posttest in the identification of fractions while 40% of the pupils from the control group failed the posttest in the identification of fractions. However, the analysis of the mean difference in pupils' performance in the identification of fractions using the independent sample t-test (Mean = 11.44 out of 22.00, SD = 1.84 [Control group]; M =19.60 out of 22.00, SD =1.96

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[Experimental group], $df = 858$, $t = -63.832$, $p = 0.00$, $p < 0.05$, $n^2 = 0.83$ (two-tailed) showed that generally, there was a significant difference between the two groups posttest scores. The partial effect size between the control group and experimental group was 0.83 indicating a larger difference in performance between the two groups in the posttest. Those who were taught using the three-tier teaching model for teaching mathematics in context approach were more able to apply their concepts of identification of halves in solving related problems in the identification of fractions.

b) The study also found out that both male and female pupils in primary one in the posttest performed high with M =15.47 out of 22.00, SD = 3.85; and M =15.57 out of 22.00, SD = 5.05 respectively. The Percentage passes of male and female pupils in the identification of fractions in the posttest were 86.90 % and 73.10% respectively. No significant difference was found between the performance of male pupils in primary one in the identification of fractions (M =11.47 out of 22.00, SD =1.88) and that of their female counterparts (M =11.41 out of 22.00, SD = 1.80) who participated in the posttest from the control group with t (1, 428) = 0.319, $p = 0.75$, $p > 0.05$ (two-tailed). However, a significant difference was found between the performance of male pupils in the identification of fractions from the experimental group (M =18.62 out of 22.00, SD = 2.07) and that

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of their female counterparts (M = 20.54 out of 22.00, SD = 1.12) from the experimental group who participated in the posttest with t (1, 428) = -12.029, p = 0.00, $p < 0.05$, $n^2 = 0.25$ (two-tailed) in favour of the females.

c) The performance of the primary one pupils in the identification of fractions in the posttest from three contexts of schools; Below Average, Average, and Above Average achieving schools were high with M = 14.79 out of 22.00, SD = 4.67; M = 15.47 out of 22.00, SD = 4.32 and M = 16.32 out of 22.00, SD = 4.36 respectively. There was a statistically significant difference in the performance of the primary one pupils in the identification of fractions among the three contexts of schools from the control group using one way ANOVA between group means (i.e., Below Average, Average and Above Average) achieving schools with F (2, 427) = 12.758, p = 0.00, $p < 0.05$ (two-tailed) in the posttest.

d) There was a statistically significant difference in the performance among the three contexts of schools from the experimental group using one-way ANOVA between group means (i.e., Below Average, Average and Above Average) achieving schools with F (2, 427) = 18.93, p = 0.00, $p < 0.05$ (two-tailed) in the posttest.

e) There was also a statistically significant difference in the performance among the three contexts of schools from the

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experimental group using one-way ANOVA between group means (i.e., Below Average, Average and Above Average) achieving schools with F (2, 427) =18.93, p = 0.00, $p < 0.05$ (two-tailed) in the posttest.

3. There was a statistically significant difference in the mean performance of the control group's pretest scores (M = 4.13, SD = 4.05) and its posttest scores (M = 11.44, SD = 1.84) with t (429) = -35.41, p = 0.00, $p < 0.05$, $n^2 = 0.75$ (two-tailed) using paired sample t-test. Similarly, there was a statistically significant difference in the mean performance of the experimental group's pretest scores (M = 3.75, SD = 3.64) and its posttest scores (M = 19.60, SD = 1.91) with t (429) = -78.68, $p = 0.00$, $p < 0.05$ (two-tailed). The eta squared statistic was 0.94 indicating a very large effect size.
4. The teachers perceived the three-tier teaching model for teaching mathematics in context as a teaching model that supports learner centeredness pedagogy, relates learners' everyday mathematical experiences to the In-school mathematics, introduces mathematical concepts from multiple perspectives, allows teachers to learn from pupils, uses authentic teaching-learning resources, and reduces mathematical anxiety among learners. Teachers therefore recommend the model to be used by other mathematics teachers in the primary school. However, they said class control can be challenging because the pupils were

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enthusiastic to work on the tasks given them due to the practical nature of the three-tier teaching model for teaching mathematics in context approach which connects the in- school concepts of mathematics to their daily realities.

Conclusions

The following conclusions were drawn for the research questions that guided the study:

1. The study found out that the performance of the primary one pupils in the identification of fractions in the pretest was generally low. It can be concluded that the primary one pupils have low knowledge in the identification of fractions before the interventions in both groups.

a) The study also found out that primary one pupils' performance in the pretest in the identification of fractions by the context of schools; Below Average, Average and Above Average achieving schools in the pretest were low. But a significant difference was found between the context of schools from the control group (i.e., Below Average, Average and Above Average) achieving schools in the pretest and also, a statistically significant difference was found in the performance of the pupils in the identification of fractions in the pretest among the three contexts of schools from the experimental group (i.e., Below Average, Average and Above Average) achieving schools in the pretest. It can therefore be concluded that the performance of pupils from the three contexts of schools differed in performance although they have low knowledge in

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identification of fractions in the pretest from both the control and experimental groups.

b) It was also found out that the performance of both male and female pupils in primary one in the identification of fractions in the pretest was low. There was no significant difference in the performance of male pupils in primary one in the identification of fractions in the pretest and that of their female counterparts who participated in the pretest from the control group. Similarly, no significant difference was found between the performance of male pupils from the experimental group and that of their female counterparts from the experimental group who participated in the pretest with.

2. The study found out that the performance of primary one pupils in the identification of fractions in the posttest was generally high. It can be concluded that the primary one pupils generally improved their knowledge in the identification of fractions in the posttest.

   a) The study found out that the primary one pupils in the control group performed just averagely in the identification of fractions in the posttest. It was therefore concluded that the performance of pupils from the control group in the posttest had not seen much improvement in their knowledge in the identification of fractions.

   b) The study found out that the primary one pupils in the experimental group performed higher in the identification of fractions in the posttest. It was therefore concluded that the

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performance of primary one pupils from the experimental group in the posttest had seen higher improvement in their knowledge in the identification of fractions.

c) The study found out that those who were taught using the three-tier teaching model for teaching mathematics in context approach were more able to apply their concepts of identification of halves in solving related problems in the identification of fractions. It was therefore concluded that the those were taught using the three-tier teaching model for teaching mathematics in context approach were more able to apply their concepts of identification of halves in solving more related problems in identification of fractions.

d) However, a significant difference was found between the performance of the control group's posttest scores and their counterparts from the experimental group in favour of those from the experimental group. It was therefore concluded that the two groups differed in performance in the posttest in the identification of fractions.

e) The study also found out that the primary one pupils in the experimental group performed higher in the identification of fractions in the posttest as compared to their counterparts in the control group. It was therefore concluded that the performance of pupils from the experimental group in the posttest had seen

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higher improvement in their knowledge in the identification of fractions.

f) The study also found out that performance of both male and female pupils in Primary one in the identification of fractions in the posttest was high. It was concluded that both male and female pupils in primary one have improved their knowledge in the identification of fractions in the posttest.

g) The study found out that the performance of the primary one pupils in the identification of fractions from the three contexts of schools was high in the posttest. It was concluded that the performance of primary one pupils from the three contexts of schools in the posttest have improved their knowledge in the identification of fractions.

h) The study found out that a statistically significant difference exists in the performance of the primary one pupils in the identification of fractions among the three contexts of schools from the experimental group in the posttest. It was therefore concluded that the three contexts of schools in experimental group differed in performance in posttest scores.

3. It was found out that a statistically significant difference exists in the performance of the primary one pupils in the identification of fractions in the pretest among the three contexts of schools from the control (i.e., Below Average, Average and Above Average) achieving schools. It was

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therefore concluded that the performance of pupils differed by the context of schools in the pretest.

a) It was found out that a statistically significant difference exists in the performance of the primary one pupils in the identification of fractions in the pretest among the three contexts of schools (i.e., Below Average, Average and Above Average) achieving schools from the control group. It was therefore concluded that the performance of primary one pupils in the control group differed by the context of schools in the pretest.

b) It was found out that a statistically significant difference exists in the performance of the primary one pupils in the identification of fractions in the pretest among the three contexts of schools (i.e., Below Average, Average and Above Average) achieving schools from the experimental group in the pretest. It was therefore concluded that the performance of primary one pupils in the experimental group differed by the context of schools in the pretest.

c) It was found out that no significant difference exists between the performance of male pupils in primary one in the identification of fractions and that of their female counterparts who participated in the pretest from the control group. It was therefore concluded that both male and female pupils' performance in the identification of fractions from the control group were similar in the pretest.

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d) The study found out that no significant difference exists between the performance of male pupils in primary one in the identification of fractions and that of their female counterparts who participated in the pretest from the experimental group. It was therefore concluded that both male and female pupils' performance in the identification of fractions from the experimental group were similar in the pretest.

e) The study found out that a significant difference exists between the performance of primary one pupils in the identification of fractions from the experimental group in the posttest and that of their counterparts who participated from the control group in the posttest. It was therefore concluded that the experimental groups' posttest scores differed from that of the control group's posttest scores.

f) The study found out that a statistically significant difference exists in the performance of the primary one pupils in the identification of fractions among the three contexts of schools from the control group in the posttest. It was therefore concluded that the three contexts of schools differed from that of the control group's posttest scores.

g) The study found out that a statistically significant difference exists in the performance of the primary one pupils in the identification of fractions among the three contexts of schools from the control group in the posttest. It was therefore concluded

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that the three contexts of schools differed from that of the control group's posttest scores.

h) The study found out that a statistically significant difference exists in the performance of the primary one pupils in the identification of fractions among the three contexts of schools from the experimental group in the posttest. It was therefore concluded that the three contexts of schools differed from that of the experimental group's posttest scores.

i) There was no significant difference between the performance of male pupils in primary one in the identification of fractions and that of their female counterparts who participated in the posttest from the control group. It was therefore concluded that both male and female pupils' performance in the identification of fractions from the control group were similar in the posttest.

j) The study found out that the female pupils in primary one in the experimental group did better than their male counterparts in the posttest. It is therefore concluded that the three-tier teaching model for teaching mathematics in contexts enhances female pupils' as well male pupils' performance in mathematics.

k) There was a statistically significant difference in the performance of the primary one pupils in the identification of fractions for the pupils in the control group's pretest scores and that of its posttest's scores with a large effect size. It was therefore concluded that the performance of the primary one

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pupils in the identification of fractions from the control group's pretest scores differed from its posttest scores.

l) There was a statistically significant in primary one pupils' performance in the identification of fractions for the pupils in the experimental group's pretest scores and that of its posttest's scores with a larger effect size. It was therefore concluded that the performance of the pupils in the identification of fractions from the experimental group's pretest scores differed from its posttest scores.

4. The teachers perceived the Three-tier teaching model for teaching mathematics in context as a teaching model that supports learner centeredness pedagogy, relates learners' everyday mathematical experiences to the In-school concepts of mathematics, introduces mathematical concepts from multiple perspectives, allows teachers to learn from pupils, uses authentic teaching-learning resources, and reduces mathematical anxiety among learners and hence recommend the model to be used by other teachers who teach mathematics in the primary school.

Recommendations

1. Since the knowledge of pupils in the identification of fractions before the interventions in both control and experimental groups was low, it was therefore recommended that Stakeholders in education (i.e., teachers, pupils, heads of schools, curriculum developers, academic experts in mathematics education, Ghana Education Service and

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Ministry of Education) should pay attention to the teaching and learning of fractions in the primary one.

2. Since the performance of primary one pupils in the identification of fractions improved higher in the experimental group than their counterparts from the control group, it was therefore recommended that primary one mathematics teachers should use more innovative teaching approaches like the three-tier teaching model for teaching mathematics in context pedagogy to improve pupils' performance in fractions.
3. Since the three contexts of schools differed in performance in identification of fractions in both the pretest and posttest, it was therefore recommended that Ghana Education Service and other stakeholders in education (i.e., teachers, pupils, heads of schools, curriculum developers, academic experts in mathematics education and Ministry of Education) should consider the context of schools when planning the primary one school mathematics curriculum. Since the performance of the primary one pupils in Above Average and Below Average achieving schools differed in identification of fractions in favour of the Above Average achieving schools, teachers should pay attention to the teaching and learning of identification of fractions for the primary one pupils from the Below Average achieving schools to help bridge the gap between the performance of pupils in these contexts of schools.

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4. Since the three-tier teaching model for teaching mathematics in context improves female pupils' performance higher than their male counterparts in the posttest in identification of fractions, primary one mathematics teachers should capitalize on their differences to help the both male and females' pupils to increase their knowledge in the identification of fractions.
5. Since a significant difference exist in the performance of the primary one pupils in the identification of fractions between the experimental group and the control group in favour of those from the experimental group in the posttest, primary one mathematics teachers should use more innovative teaching approaches like the three-tier teaching model for teaching mathematics in context to teach the identification of fractions. Also, in-service training in teaching identification of fractions in context should be frequently organized for teachers to update and sharpen their skills in teaching mathematics in context. In-service training of teachers on teaching in context will equip them with pedagogical skills that will help teachers to teach the identification of fractions in context at the primary school level since this will go a long way to improve pupils' performance in learning mathematics at all levels.
6. Since those who were taught using the three-tier teaching model for teaching mathematics in context approach were more able to apply their concepts of identification of halves in solving related problems in the identification of fractions and my study has found the three-tier

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teaching model for teaching mathematics in context to be more effective in teaching identification of fractions, primary one mathematics teachers are encouraged to use the three-tier teaching model for teaching mathematics in context in teaching identification of fractions and its related concepts.

7. It was evident from the study that the three-tier teaching model for teaching mathematics in context yielded more impact in improving primary one pupils' performance in the identification of fractions than the conventional approach. It was therefore recommended that the primary one mathematics teachers should use the three-tier teaching model for teaching mathematics in context approach to teach their pupils identification of fractions in primary one.
8. Since the three-tier teaching model for teaching mathematics in context was more effective as compared to that of the suggested approach by the primary school mathematics curriculum in improving pupils' performance in the identification of fractions, this means that the three-tier teaching model for teaching mathematics in context is pedagogically more effective in improving leaners' understanding of identification of fractions so primary one mathematics teachers should use the three-tier teaching model for teaching mathematics in the context in teaching identification of fractions and its related concepts at primary school level of education.
9. Since the teachers in this study perceived the three-tier teaching model for teaching mathematics in context as a teaching model that supports

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learner centeredness pedagogy, relates learners' everyday mathematical experiences to the In-school concepts of mathematics, introduces mathematical concepts from multiple perspectives, gives teachers the opportunity to learn from pupils, uses authentic teaching-learning resources, and reduces mathematical anxiety among learners. It is therefore recommended that the three-tier teaching model for teaching mathematics in context should be used by primary one mathematics teachers in the primary schools in teaching fractions.

10. Finally, teacher training institutions and other stakeholders in education (i.e., teachers, heads of schools, curriculum developers, academic experts in mathematics education, Ghana Education Service and Ministry of Education) should put teaching in context at the center of their training to equip prospective teachers with the necessary skills, knowledge and value to extend the understanding of teaching in a context through the use of more innovative teaching approaches like the three-tier teaching model for teaching mathematics in contexts pedagogy in teaching mathematics.

Suggestions for Further Research

1. Further studies should investigate the impact of the three-tier teaching model for teaching mathematics in context should be used to teach other aspects of fractions in other primary classes.
2. Further research should investigate the impact of the three-tier teaching model for teaching mathematics in context using different mathematical concepts other than fractions at the primary school level.

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APPENDICES

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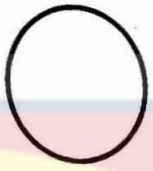
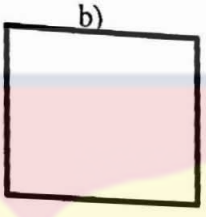
APPENDIX A: Three-tier Teaching Model for Teaching Mathematics in Context Instruction Method Lesson Note-First Lesson

Date: Period: 30 minutes Time: Class: B1 Class Size:	Subject: mathematics Strands: Numbers Sub-Strand 3: Fractions
Indicator: pupils will be able to recognize the fraction (i.e., half) of any given quantity by the end of the lesson.	

Phase/Duration	Exemplars/Learner Activities	Resources
Phase 1: (Enculturation) 30 Minutes	Activity 1 Teacher puts pupils into small groups of four or six. Teacher breaks three sticks into two such that only one is exactly half and ask pupils to name/describe the fractions in each case.  Activity 2. Teacher puts pupils in small group of four or six.	Sticks Pictures of objects

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	Teacher then gives pupils worksheets containing some objects for them to shade half of each of them a)  b)  c)  Activity 3 Teacher asks pupils to consider how tourists from Europe or America might identify halves in their home countries. This is to find out how pupils could identify halves in a way that would enable them to communicate halves to tourists to understand.	

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APPENDIX B: Three-tier Teaching Model for Teaching Mathematics in Context Instruction Method Lesson Note-Second Lesson

Date: Period: 60minutes Time: Class: B1 Class Size:		Subject: mathematics Strands: Numbers Sub-Strands 3: Fractions
Indicator: pupils will be able to recognize the fraction (i.e., half) of any given quantity by the end of the lesson.		
Phase/Duration	Exemplars/Learner Activities	Resources
Transition and acculturation	Activity 1 Teacher review pupil's previous knowledge on how we obtain halves. Teacher also asks pupils how we obtain halves from other cultures. This is to help pupils to come out with the idea of half as chemu pɛ (i.e., Division into two equal parts) as a prerequisite for the school concept of halves. Teacher guides pupils to conclude that halves from the international sense means equal halves (i.e., chemu pɛ). Teacher then explains to pupils that Ghana is part of the whole world so while we do what we do in our communities, we have to also learn what is done in the whole world.	

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	Activity 2 Teacher puts pupils into small groups of four or six. Teacher gives worksheets containing some artifacts for pupils to shade half of each of them based on chemu pɛ. a)  b) 	Worksheet
	Activity 3 Teacher brings back the sticks which were used to introduce the lesson earlier and asks pupils in their various groups to look again at the three sticks and identify which one represents half from the international perspective.  (a) (b) (c)	Sticks

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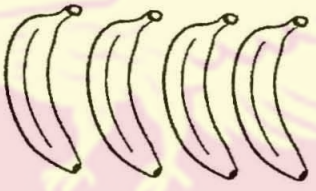
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Activity 4

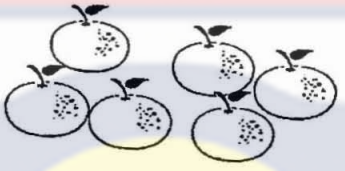
Teacher puts pupils into small groups of four or six.

Teacher gives pupils a worksheet containing group of Artifacts and ask pupils to identify half of it using a circle-to-circle half of them.

a)

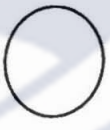


b)



Activity 5

Teacher gives pupils worksheets containing some plane shapes and asks them to shade half of each of them based on the international perspective.

a)  b) 

Activity 4

Teacher gives pupils a worksheet containing a line of 6cm and asks pupils to mark half of it. _____

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Activity 6

Teacher shows a worksheets containing containing some plane shapes and asks pupils whether the schaded portion for each is half.

a) 

b) 

Pupils are to conclude that the shaded portions for each of the above shapes are not halves.

Activity 7

Teacher asks pupils to represent half of any object sybolically.

Teacher then guides pupils to represent fractions using symbols say half of any object as $\frac{1}{2}$ where **2** is the number of equal portion of divisions and **1** is the portion taken out of the two equal portions.

Activity 8

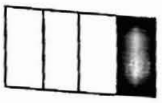
Teacher asks pupils to use symbols to represent the fractions of each of the shaded portions in the diagrams below

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a) b)





Closure

Teacher asks pupils to tell him/her how to make halves from the international perspectives and how to represent it.

Pupils conclude that halves from the international sense means equal halves (i.e., chemu pɛ) and is represented symbolically as $\frac{1}{2}$.

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APPENDIX C: Conventional Instruction Method Lesson Note-First Lesson

Date: Period: 30 minutes Time: Class: B1 Class Size:	Subject: mathematics Strands: Numbers Sub-Strand 3: Fractions
Indicator: pupils will be able to recognize the fraction (i.e., half) of any given quantity by the end of the lesson.	

Phase/Duration	Exemplars/Learner Activities	Resources
Main 30-Minutes time limit	Activity 1: The teacher uses orange to describe the fraction half as the one part that results from dividing a whole (orange) into two equal parts (NaCCA, 2019). Activity 2: The teacher uses pictorial illustrations on the board to explain the fraction half as the one portion that results from dividing a whole (orange) into two equal parts (NaCCA, 2019).  One whole one-half	Oranges

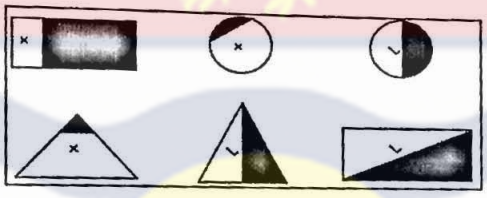
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APPENDIX D: Conventional Instruction Method Lesson Note-Second Lesson

Date: Period: 60 minutes Time: Class: B1 Class Size:	Subject: mathematics Strands: Number Sub-Strand 3: Fractions

Indicator: pupils will be able to recognize the fraction (i.e., half) of any given quantity by the end of the lesson.

Phase/Duration	Exemplars	Resources
Main 60 Minutes	Activity 1: As shown below, the teacher uses illustrative examples to assist pupils in classifying fractional pictures into those that are halves and those that are not halves (NaCCA, 2019).  The teacher concludes that the images divided into two halves are the halves of the given images. Activity 2 The teacher represents half of any object symbolically as 1/2, where 2 is the number of equal portion divisions and 1 is the part taken out of the two equal parts on the board, and instructs pupils to copy it. Activity 3 Teacher asks pupils to draw a diagram to show a pictorial illustration of a. ½ c. 1/3 b. ¼	Piece of cards

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APPENDIX E: Pupils' Identification of Fractions Worksheet (PRETEST)

INSTRUCTIONS

Answer **all** questions. This has nothing to do with your end of term scores.

Duration: 45 Minutes

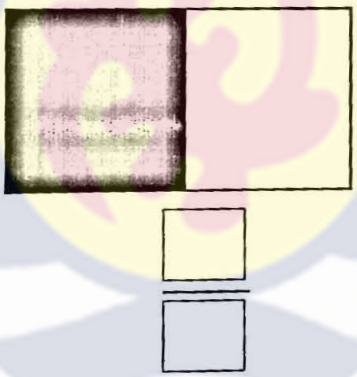
DETAILS OF RESPONDENT

1. School context.....
2. Class.....
3. Sex .....
4. Age.....

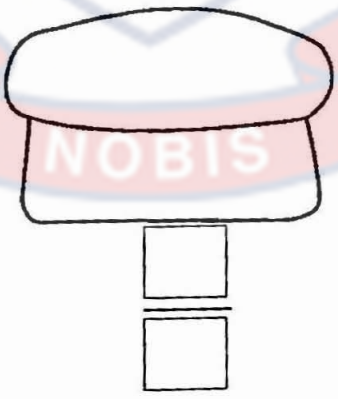
Identification Code ☐

Questions:

1. Write the fraction of the shaded portion in the diagrams below



2. Colour half of the picture below and write the fraction in the space provided below it.

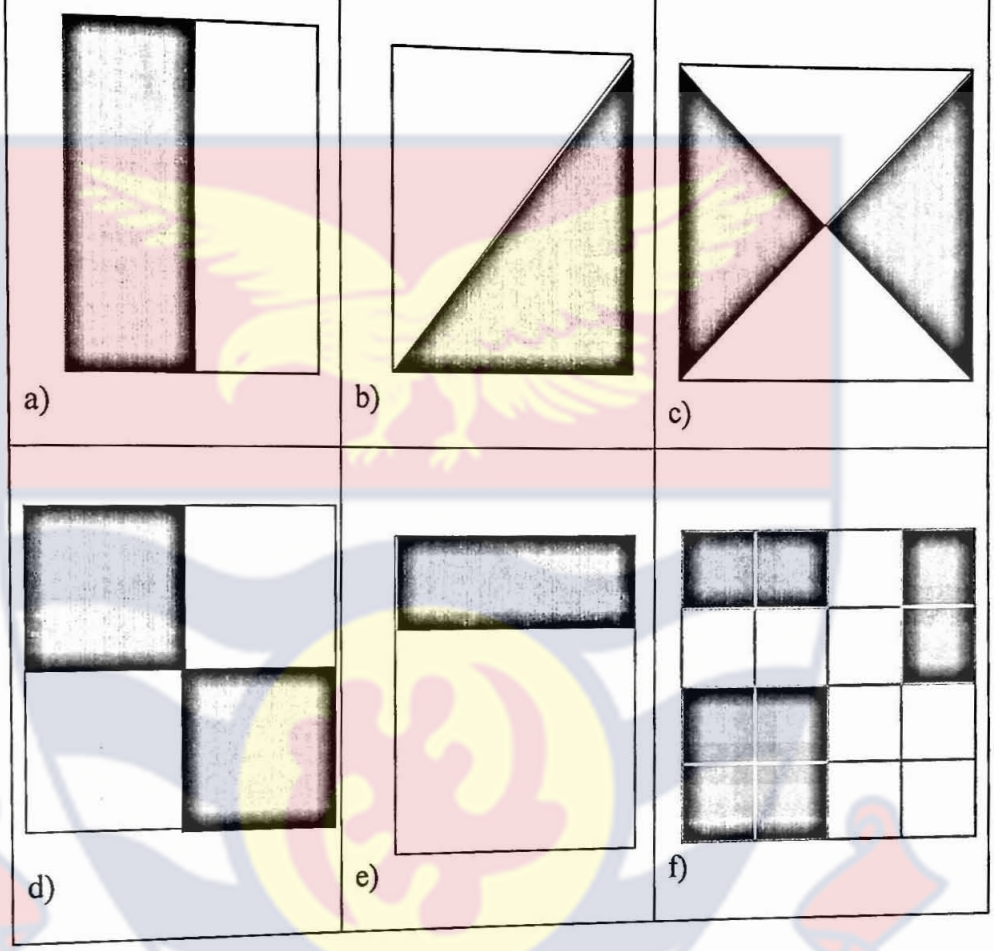


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3.

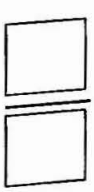
Circle each of the diagrams which showed half of the shaded parts or portions.



4. Write the fraction of the shaded portion in each of the diagrams below:

a)

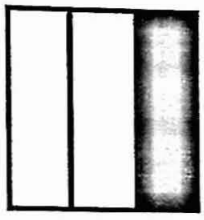




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b)





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APPENDIX F: Pupils' Identification of Fractions Worksheet (POSTTEST)

INSTRUCTIONS

Answer **all** questions. This has nothing to do with your end of term scores.

Duration: 45 Minutes

DETAILS OF RESPONDENT

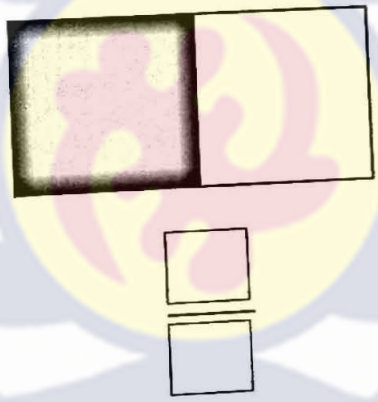
1. School context.....
2. Class.....
3. Sex .....
4. Age.....

Identification Code

Questions:

1. Write the fraction of the shaded portion in each of the diagrams below

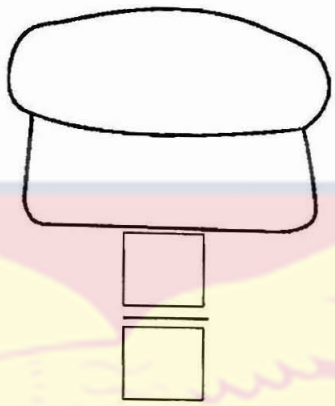
a)



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2. Colour half of the picture below and write the fraction in the space provided below it.



3.

Circle each of the diagrams which showed half of the shaded parts or portions.



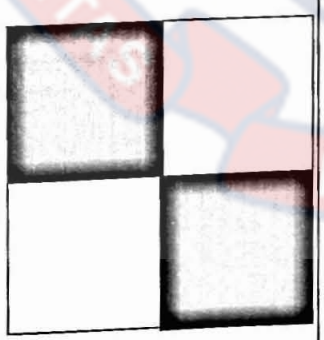
a)



b)



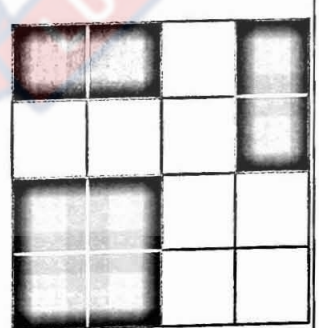
c)



d)



e)

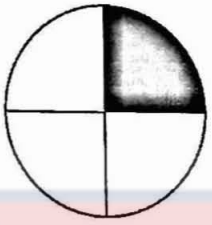


f)

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4. Write the fraction of the shaded portion in each of the diagrams below

a) 



b) 



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APPENDIX G: Invitation for a Day Workshop on the Use of the Three-tier Teaching Model for Teaching Mathematics in Context

Department of Mathematics & ICT Education, UCC
University Post Office

28th January, 2021

TO WHOM IT MAY CONCERN

Dear Sir/Madam.

INVITATION FOR ONE DAY WORKSHOP

I write to invite you for a day workshop at institute of Education, UCC on creative teaching techniques in teaching mathematics.

This workshop intends to give mathematics teachers insight into the implementation of the three-tier teaching model for teaching mathematics in context pedagogy.

Participants will be given snacks, and lunch during the workshop. Participants will also be given T & T after the workshop.

Counting on your usual cooperation

Yours faithfully,



Daniel Gbormittah (PI)

Cc

Participating Teachers

Heads of schools

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APPENDIX H: A Day Workshop on the Use of Three-tier Teaching Model for Teaching Mathematics in Context

8:30 am-9:00am		Activity	Facilitator
9:00am-9:15am		Open prayer, welcoming of participants	Researcher & Main Supervisor
Section 1	9:15am-10:15am	Three-tier teaching model for teaching mathematics in Context What is it? Why do we have to use it in teaching mathematics? Need to appreciate teaching in context	Main Supervisor and Researcher
	10:15am-10: 30am	Snack Break	
Section 2	10: 30am-12:00pm	Demonstration for the use of the three-tier teaching model for teaching mathematics in context in teaching fractions	Main Supervisor and Researcher
Section 3	12:00pm-2:30pm	Hands on activities on three-tier teaching model for teaching mathematics in context in teaching fractions	Main Supervisor and Researcher
	2:30pm- 3:00pm	Lunch Break	
	3:10 pm	Closing Prayer	

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APPENDIX I: Ethical Clearance

UNIVERSITY OF CAPE COAST
INSTITUTIONAL REVIEW BOARD SECRETARIAT
TEL: 0558093143 / 0508878309
E-MAIL: irb@ucc.edu.gh
OUR REF: UCC/IRB/A/2016/820
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0009096

9TH OCTOBER, 2020

Mr Daniel Gbormittah
Department of Mathematics and ICT Education
University of Cape Coast

Dear Mr Gbormittah,

ETHICAL CLEARANCE – ID (UCCIRB/CES/2020/74)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted **Provisional Approval** for the implementation of your research titled **The Effect of Three-Tier Teaching Model for Teaching Mathematics in Context on Primary School Pupils' Performance in Fractions: Cases of Cape Coast Metropolis and Mfantsiman Municipality.** This approval is valid from 9th October, 2020 to 8th October, 2021. You may apply for a renewal subject to submission of all the required documents that will be prescribed by the UCCIRB.

Please note that any modification to the project must be submitted to the UCCIRB for review and approval before its implementation. You are required to submit periodic review of the protocol to the Board and a final full review to the UCCIRB on completion of the research. The UCCIRB may observe or cause to be observed procedures and records of the research during and after implementation.

You are also required to report all serious adverse events related to this study to the UCCIRB within seven days verbally and fourteen days in writing.

Always quote the protocol identification number in all future correspondence with us in relation to this protocol.

Yours faithfully,

Samuel Asiedu Owusu, PhD
UCCIRB Administrator

ADMINISTRATOR
INSTITUTIONAL REVIEW BOARD
UNIVERSITY OF CAPE COAST

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University of Cape Coast https://ir.ucc.edu.gh/xmlui

APPENDIX J: Introductory Letter from Department of Mathematics and ICT Education, UCC

UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF MATHEMATICS AND I.C.T EDUCATION

Telephone: 0332096951
Telex: 2552, UCC, GH
Telegrams & Cables: University, Cape Coast
Email: dmicte@ucc.edu.gh

University Post Office
Cape Coast, Ghana

Your Ref:

Our Ref: DMICTE/P.3/V.1/0100

Date: 28th October, 2020

TO WHOM IT MAY CONCERN

Dear Sir / Madam,

RESEARCH VISIT

I write to introduce Daniel Gbormittah, with registration number ET/DME/18/0006 a PhD (Mathematics Education) student of the Department of Mathematics and ICT Education, College of Education Studies, University of Cape Coast.

As part of the requirement for the award of a doctorate degree, he is required to undertake a research on the topic "THE EFFECT OF THREE-TIER TEACHING MODEL FOR TEACHING MATHEMATICS IN CONTEXT ON PRIMARY SCHOOL PUPILS' PERFORMANCE IN FRACTIONS: CASES OF CAPE COAST METROPOLIS AND MFANTSIMAN MUNICIPALITY".

I would be grateful if you could give him the necessary assistance he may need.

Thanks for your usual support.

Yours faithfully,

Dr. (Mrs.) Christina Boateng
HEAD

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APPENDIX K: Permission to Conduct Research-Cape Coast Metropolitan Director

GHANA EDUCATION SERVICE

In case of reply the Number and date of this Letter should be quoted

REPUBLIC OF GHANA

METROPOLITAN EDUCATION DIRECTORATE
P. O. BOX 164
CAPE COAST

Tel: 03321-32514/0243852197
Email: capecoastmeo@yahoo.com
My Ref. No GES/MD.Vol 5.86

15th December, 2020

HEADS OF SCHOOLS CONCERNED
CAPE COAST

RE-PERMISSION TO CONDUCT RESEARCH IN SELECTED BASIC SCHOOLS – CAPE COAST METROPOLIS

This is to inform you that Management of the Metro Education Directorate has granted permission t Mr. Daniel Gbormittah, a Ph. D student of the Department. of Mathematics & Statistics. of th University of Cape Coast. to conduct research in some selected basic schools in the Cape Coast Metropolis.

The study seeks to find out the Effect of Three-Tier Teaching Model for teaching Mathematics in Context on Primary School Pupils' Performance in Fractions. The study will be conducted on Primary One Pupils in Ten (10) selected schools when schools resume in January 2021.

Please. note that while we entreat you to accord him the needed courtesies and acceptance he requires the study should not unduly interfere with teaching and learning.

We count on your usual maximum cooperation.

Thank you.

DORCAS BRENDA ASARE (MS)
METRO DIRECTOR OF EDUCATION
CAPE COAST

cc
Mr. Daniel Gbormittah. Dept. of Mathematics & Statistics, UCC. Cape Coast

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University of Cape Coast https://ir.ucc.edu.gh/xmlui

APPENDIX L: Permission to Conduct Research-Mfantsiman Municipality Director

GHANA EDUCATION SERVICE

In case of reply the Number and date of this Letter should be quoted

Ref. No.: GES/SP.278/TJ/109
Your Ref.:.....
TEL: 042 94351 / 028 9670606
Email: mfdges@yahoo.com

REPUBLIC OF GHANA

Mfantseman Municipal Directorate,
Post Office Box 83,
SALTPOND.

11TH JANUARY, 2021

RE: PERMISSION TO CARRY OUT EDUCATIONAL RESEARCH IN BASIC SCHOOLS IN THE MFANTSEMAN MUNICIPALITY

With reference to your letter dated 3rd December, 2020 requesting for permission to carry out educational research in Basic Schools in the Mfantseman Municipality, I write to inform you that, you have been granted permission to carry out the research in our Basic Schools.

By copy of this letter, heads of Basic Schools in the Municipality concerned are requested to offer him any assistance he may need for his Research Work.

Please note that all information to be provided by the schools is for academic work only.

You are hereby advised that your activity should not interfere with teaching and learning in the schools.

We wish you a successful exercise.

(DANIEL COBBOLD)
MUNICIPAL DIRECTOR OF EDUCATION
MFANTSEMAN

DISTRIBUTION
ALL HEADS OF BASIC SCHOOLS,
MFANTSEMAN MUNICIPALITY.

CC: Daniel Gbormittah,
Dept. of Mathematics & ICT Education,
University of Cape Coast,
Cape Coast.

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APPENDIX M: Marking Scheme for Pupils' Identification of Fractions Worksheet (PRETEST and Posttest)

Marking Scheme

Questions:

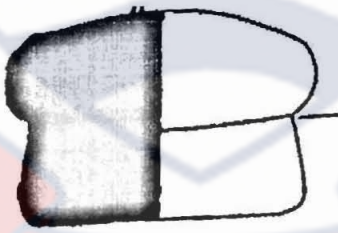
1. Write the fraction of the shaded portion in the diagrams below



1 — 2marks

2

2.Colour half of the picture below and write the fraction in the space provided below it.



2marks

1 — 2marks

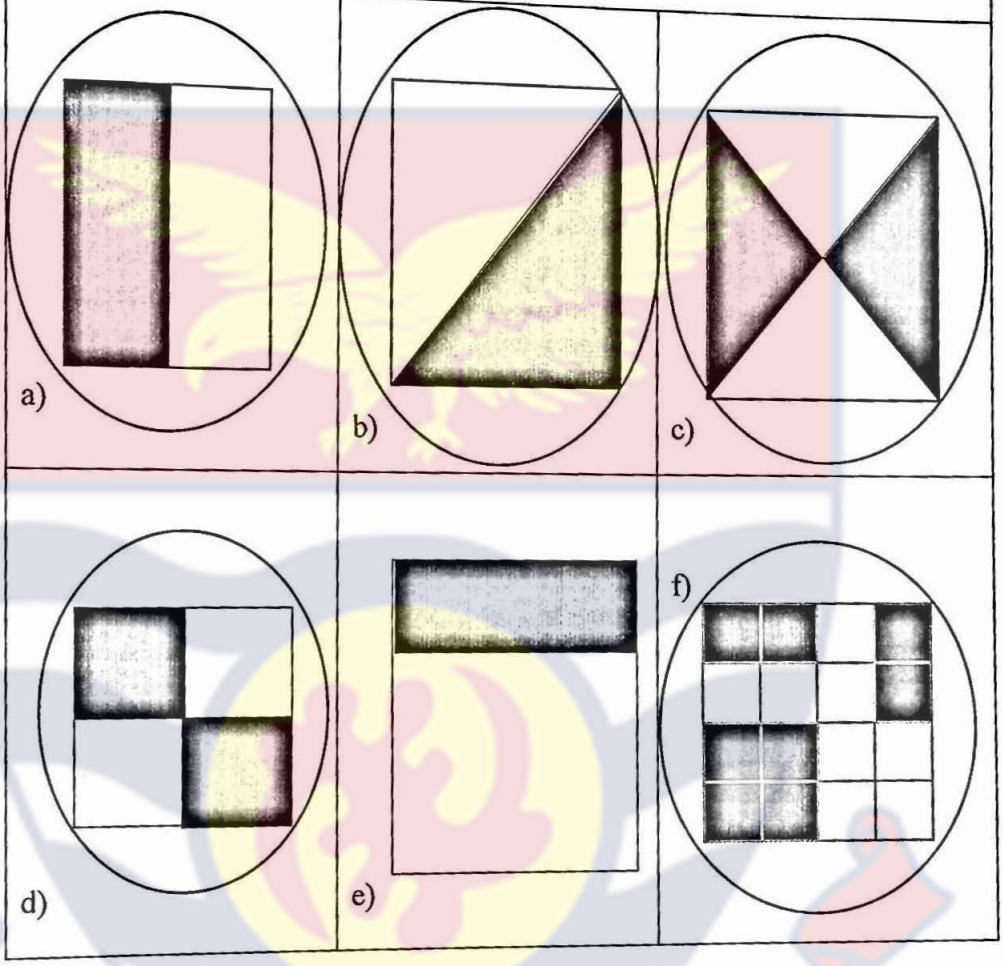
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3.

Circle each of the diagrams which showed half of the shaded parts or portions.



NB: You lose 2 marks if you select item 3e but gain 2marks if you don't select item 3e

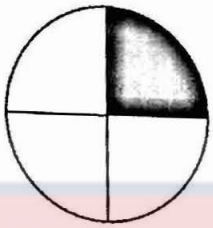
2 marks for each of the correct response for item 3(i.e., 2×6=12 marks)

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4. Write the fraction of the shaded portion in each of the diagrams below:

a)



$\frac{1}{4}$ — 2marks

b)



$\frac{1}{3}$ — 2marks

Total Marks = 22

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APPENDIX N: SPSS Output for Assumption Testing of Pretest Normality

One-sample Kolmogorov-Smirnov Test

		Control Pretest	Experimental Pretest
N		430	430
Normal Parameters[a]	Mean	4.13	3.75
	Std. Deviation	4.05	3.64
Most Extreme Differences	Absolute	0.344	0.431
	Positive	0.124	0.225
	Negative	-0.344	-0.431
Kolmogorov-Smirnov Z		0.816	0.807
Asymp. Sig.(2-tailed)		0.046	0.045
a. Test distribution is Normal			

n≥30

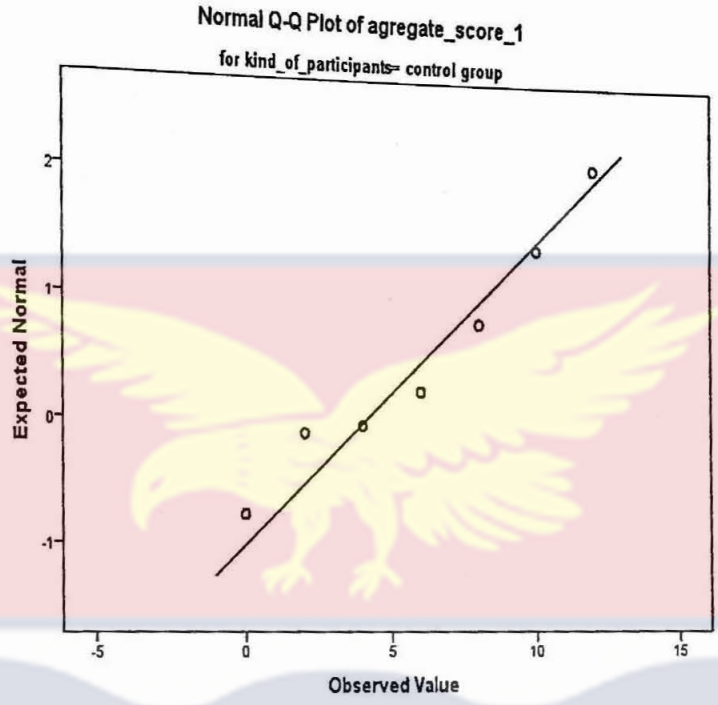
Levene's Test of Equality of Error Variance

	F	df1	df2	Sig.
Control pretest	0.14	1	428	0.14
Experimental pretest	1.20	1	428	0.16

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

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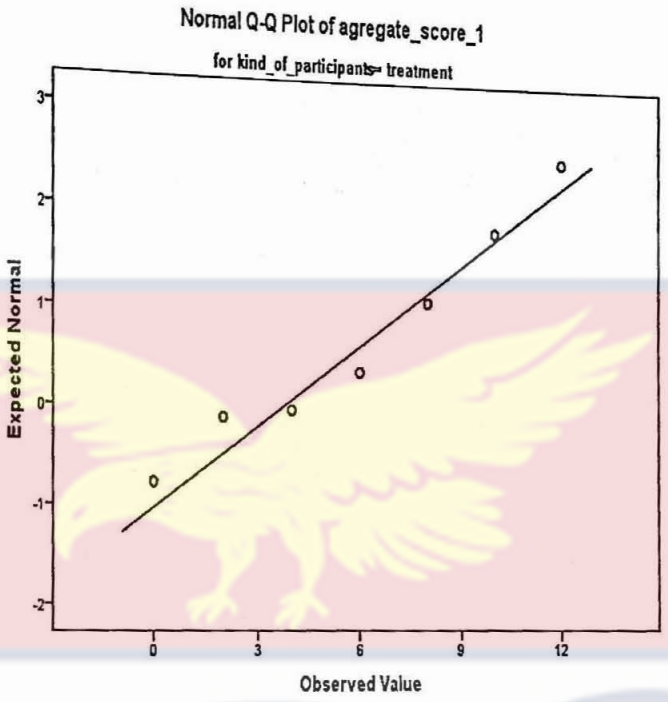
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a. Design: Intercept +group

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APPENDIX O: Tukey HSD Post-hoc Test for Pupils' Performance in Identification of Fractions for the Contexts of Schools in the Pretest

School contexts	School contexts	Mean Difference	Sig.
BA achieving schools	A achieving schools	-1.629*	0.00
	AA achieving schools	-1.613*	0.00
A achieving schools	BA achieving schools	1.629*	0.00
	AA achieving schools	0.017	1.00
AA achieving schools	BA achieving schools	1.613*	0.00
	A achieving schools	-0.017	1.00

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APPENDIX P: Tukey HSD Post-hoc Test for Pupils' Performance in Identification of Fractions for the Contexts of Schools in the Pretest from the Control Group

Context I	Context J	Mean Difference	Sig
BA achieving schools	A achieving schools	-0.83263	0.17
	AA achieving schools	-1.33571*	0.02
A achieving schools	BA achieving schools	0.83263*	0.17
	AA achieving schools	-0.50309	0.54
AA achieving schools	BA achieving schools	1.33571*	0.02
	A achieving schools	0.50309	0.54

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APPENDIX Q: Tukey HSD Post-hoc Test for Pupils' Performance in Identification of Fractions for the Contexts of Schools in the Pretest from the Experimental Group

Context I	Context J	Mean Difference	Sig
Below Average achieving schools	Average achieving schools	-1.63052*	0.00
	Above Average achieving schools	-1.69593*	0.00
Average achieving schools	Below Average achieving schools	1.63052	0.00
	Above Average achieving schools	-0.06541	0.99
Above Average achieving schools	Below Average achieving schools	1.69593*	0.00
	Average achieving schools	0.06541	0.99

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APPENDIX R: SPSS Output for Assumption Testing of Posttest Normality

One-sample Kolmogorov-Smirnov Test

		Control Post	Experimental Post
N		430	430
Normal Parameters[a]	Mean	11.40	19.60
	Std. Deviation	1.84	1.91
Most Extreme Differences	Absolute	0.225	0.271
	Positive	0.077	0.057
	Negative	-0.225	-0.271
Kolmogorov-Smirnov Z		1.418	1.438
Asymp. Sig.(2-tailed)		0.17	0.15

a. Test distribution is Normal

n≥30

Levene's Test of Equality of Error Variance

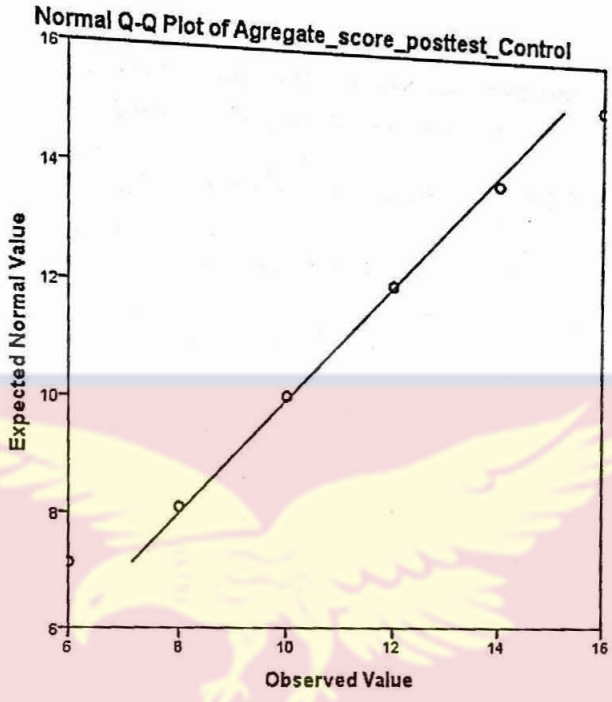
	F	df1	df2	Sig.
Control posttest	2.14	1	428	0.22
Experimental posttest	2.52	1	428	0.27

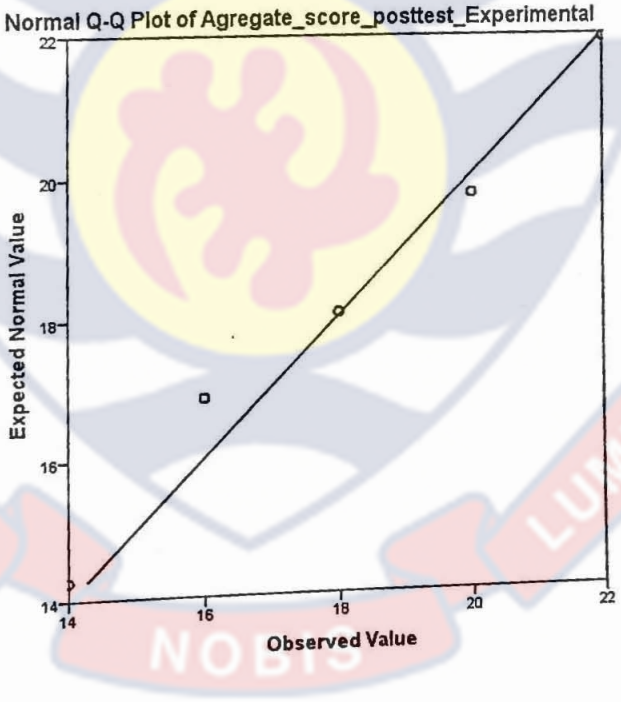
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept +group post

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APPENDIX S: Tukey HSD Post-hoc Test for Pupils' Performance in Identification of Fractions for the Contexts of Schools in the Posttest

School contexts	School contexts	Mean Difference	Sig.
BA achieving schools	A achieving schools	-0.685	0.15
	AA achieving schools	-1.533*	0.00
A achieving schools	BA achieving schools	0.685	0.15
	AA achieving schools	-0.848	0.06
AA achieving schools	BA achieving schools	1.533*	0.00
	A achieving schools	0.848	0.06

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APPENDIX T: Tukey HSD Post-hoc Test for Pupils' Performance in Identification of Fractions for the Contexts of Schools in the Posttest from the Control Group

Context I	Context J	Mean Difference	Sig
BA achieving schools	A achieving schools	-0.92646*	0.00
	AA achieving schools	-0.93571*	0.00
A achieving schools	BA achieving schools	0.92646*	0.00
	AA achieving schools	-0.00926	1.00
AA achieving schools	BA achieving schools	0.93571*	0.00
	A achieving schools	0.00926	1.00

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APPENDIX U: Tukey HSD Post-hoc Test for Pupils' Performance in Identification of Fractions for the Contexts of Schools in the Posttest from the Experimental Group

Context I	Context J	Mean Difference	Sig
BA achieving schools	A achieving schools	-0.86191*	0.00
	AA achieving schools	-1.29014*	0.00
A achieving schools	BA achieving schools	0.86191*	0.00
	AA achieving schools	-0.42823	0.12
AA achieving schools	BA achieving schools	1.29014*	0.00
	A achieving schools	0.42823	0.12

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APPENDIX V: Semi-Structured Interview Guide for Teachers

Teachers' Perceptions of the Applicability of the Model in Teaching and Learning Fractions

Questions:

1. Tell me your general impressions about the three-tier teaching model for teaching mathematics in context approach you used in teaching your pupils?
2. Why did your pupils (i.e., those in the experimental group) did better than those in the control group who were taught conventionally?
3. What problems did you face in using the three-tier teaching model for teaching mathematics in context approach?
4. Tell me how you can overcome the problems you encounter in 3 above?
5. Will you recommend the three-tier teaching model for teaching mathematics in context to be use by other teachers? If yes why?

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APPENDIX W: Paired Samples T-test for the Control Group

Paired Samples Test								
	Paired Differences							
				95% confidence Interval of the difference				
	M	SD	SD. Error Mean	Lower	Upper	T	Df	Sig. (2-tailed)
Pair1Pretest Control & post control	-7.316	4.28	0.207	-7.722	-6.910	-35.10	429	0.00

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APPENDIX X: Paired Samples T-test for the Experimental Group

Paired Samples Test								
	Paired Differences					T	Df	Sig. (2-tailed)
				95% confidence Interval of the difference				
	M	SD	SD. Error Mean	Lower	Upper			
Pair1Pretest treat & posttest	-15.85	4.18	0.201	-16.247	-15.455	-78.684	429	0.00

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APPENDIX Y: Calculation of Effect Size

a) Eta squared value for independent sample t-test $(n^2) = \frac{t^2}{t^2+N1+N2-2}$

t = t-calculated

N1 = sample size for the first group

N2 = sample size for the second group

b) Eta squared value for paired sample t-test $(n^2) = \frac{t^2}{t^2+N-1}$

t = t-calculated

N = sample size for each paired sample

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APPENDIX Z: Item Difficulty Index for both Pretest and Posttest

Items	Item Difficulty Index	
	Pretest	Posttest
1	0.52	1.00
2	0.05	0.87
3a	0.52	1.00
3b	0.49	1.00
3c	0.00	0.47
3d	0.00	0.45
3e	0.51	0.77
3f	0.00	0.11
4a	0.19	0.67
4b	0.04	0.58

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