DO NUMBERS MAKE SENSE: AN INVESTIGATION ON HOW FOUNDATION PHASE LEARNERS ENGAGE WITH MULTIPLICATIVE THINKING IN MOTHEO DISTRICT, SOUTH AFRICA

NEO HENDRICK SESENG

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Supervisor: Professor N.N. FEZA

BLOEMFONTEIN

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STATEMENT OF INDEPENDENT WORK

I, Neo Hendrick Seseng, confirm that the work for the following study was solely undertaken by myself and that no help was provided from sources other than those allowed. All sections that quote sources or describe an argument developed by another author, including secondary literature used, have been referenced, to show that this material has been adopted to support my dissertation.

Signed: ______________ Date: 1 May 2022

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DEDICATIONS

I want to commit this research to my late mom Matshediso Augustinah Seseng, who did not get a chance to bond with me enough, and teach me a lot of things about life.

My late grandmother(s) Madisebo Selloane Florinah Sesing & Nongantoni Cecelia Solane who have been my support structure and pillar of strength. Despite the fact that they both did not go far with their education, they have managed to plant a seed within me from a very tender age that schooling is very vital to success.

May their exquisite spirits rest as one.

ABSTRACT

The study investigated how the multiplicative thinking of Grade 3 learners develops and how ensuring inclusivity of all learners during the number learning process enhances learning in mathematics Grade 3. This study used a qualitative methodology to explore these two complex phenomena: multiplicative thinking and gender-sensitive pedagogy for teaching and learning mathematics in early grades. Interviews and classroom observations are employed as tools for data collection, and data was analysed qualitatively. The participants were 30 Grade 3 learners and three educators at three schools, of which two were in a township, and one in a suburban area. The findings of the study are that learners in the early grades need to be proficient in their home language, to help facilitate meaning and development of abstraction of number concepts; procedural teaching still dominates teaching and learning in mathematics practice of early grades; use of manipulatives mediate meaningfulness in mathematical ideas; multiplicative thinking of learners is impeded by procedural knowledge; COVID-19 has transformed homes with a low socioeconomic background to supportive learning environments; and that inequalities still disrupt the possibility of quality teaching and learning, through a lack of resources (physical and human). This study recommends improving foundation phase teacher training, enhancing mother tongue instruction, making more meaningful use of concrete manipulatives to encourage fluent conceptual understanding, and nurturing mother tongue use for mathematics to promote learners' language proficiency. The results of the study also call for a full implementation of gender-sensitive pedagogy in classrooms, to accommodate all genders and diverse teaching methods during instruction of mathematics from the early grades. There is a need for inter-sectoral and inter-departmental fora to address issues of early childhood education, focussing on developing and establishing solid knowledge of mathematics from an early age.

KEYWORDS: Classroom; Development; Early childhood; Foundation phase; Learners; Mathematics content, Multiplicative thinking, Numbers concepts; School setting.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANA	Annual National Assessment
CAPS	Curriculum Assessment Policy Statement
DBE	Department of Basic Education
LOLT	Language of learning and teaching
NAEP	National Assessment of Education Progress
TIMSS	Trends in International Mathematics and Science Study

DESCRIPTION OF KEY TERMS

Multiplicative thinking	The ability to adapt one's thinking to the concepts, procedures, and representations of multiplication and division as they are encountered in a wide variety of settings (Nunes, Bryant, Barros & Sylva, 2011).
Learner	Someone who is currently acquiring knowledge about a specific topic or how to perform a specific task.
Foundation phase	It has been determined that Grades R through 3 comprise the initial phase of formal education, which is characterized by the formation of morals, manners, and the most essential learning processes (DBE, 2011).
Early childhood	A period of human development that typically spans the toddler years and, on sometimes, continues for some time afterward as well.
Development	A process that results in the expansion, development, improvement, or addition of components that are physical, economic, environmental, social, or demographic in nature.
Number	A numerical value that can be written as a word, a symbol, or a figure and that stands for a certain quantity; it is employed in counting and mathematical calculations.
Mathematics content	Defined as the numerical or quantitative entities, descriptions, properties, relationships, operations and events included in the learning of mathematics (www.definitions.net/definition/mathematical +concepts, 2020).
School setting	The setting where children can receive educational services, the primary focus of which is the education of the people receiving those services. (https://www.lawinsider.com/dictionary/educationiy).
Classroom	A learning space in which children and adults learn.
Teacher	An individual who shares their knowledge with learners, to ensure that those learners acquire competence, virtues and shared knowledge in a formal teaching and learning setting.

Education	The act of receiving or imparting methodical instruction, as well as the time spent cultivating the abilities of reasoning and judgment, and generally preparing oneself or others intellectually for the responsibilities of adult life.
Gender	Throughout human history we have known, and many societies have seen, and continue to see, gender as lying on a spectrum, and not limited to just two possibilities (Dreyer, 2007).
Gender identity	The intuitive sensation that an individual has of being either male or female (or both). Some individuals have a gender identification that does not correspond to their physical anatomy or their expected duties in society (Benjamin, Twala & Reygan, 2018).
Curriculum	In the field of education, the term "curriculum" refers to the comprehensive package of learning opportunities provided to pupils throughout their time in school. Quite frequently, this term is used to refer to a certain planned sequence of instructional activities (DBE, 2011; 2014).

CHAPTER 1: OVERVIEW OF THE STUDY

1.1 INTRODUCTION

This section of the research will provide a comprehensive overview. It will represent the proposed study's context and express the goal and objectives of the proposed investigation. It will also provide the research questions and speculate on the study's potential importance for system and practice. The proposed study ideas and procedures, as well as ethical considerations related to data gathering, will be discussed.

1.2 BACKGROUND TO THE STUDY

Multiplicative thinking ensures that learners are able to work out numbers, rational numbers, ratios, proportions and percentages. Lamon (2005) adds that these topics are not just significant in the later stages of education, and that multiplicative reasoning in the early years is regarded as being important (Brown *et al.,* 2010). These topics are difficult to teach, because they require sufficient time, and thorough preparation is needed to develop it sufficiently in learners. A study that was conducted in the United Kingdom found that most learners in secondary education are unwilling to participate in mathematics problem-solving (Brown *et al.*, 2010).

In South Africa, learners in primary-level education continue to attain low grades in mathematics – especially children in the state education system (Fleisch & Kregenow, 2013). This challenge has seen limited change with regard to arithmetic tasks, where most learners still seek out concrete counting methods until they reach upper primary grades (Schollar, 2008). Several studies focusing on South African children, in particular those in Grade 5, report that TIMSS (Trends in International Mathematics and Science Study) shows that foundation phase learners' experiences are not preparing them to deal with numbers and multiplicative thinking in their counting activities (Venkat & Askew, 2012; Reddy *et al.,* 2015).

Numerous research has been conducted to study the significance of multiplicative thinking in the field of mathematics (Siemon, Bleckly & Neal, 2012; Siemon, Breed, Dole, Izard & Virgona, 2006a). The ability to conceive in terms of multiples is essential for the growth of a number of fundamental mathematical ideas, such as algebraic reasoning (Brown & Quinn, 2006), place value, proportional reasoning, rates and ratios, metric measurement, and statistical sampling (Mulligan & Watson, 1998; Siemon et al, 2006b). In addition, a study that was conducted by Siegler and colleagues (2012) suggests that a comprehension of division as well as the application of fractions are good predictors of subsequent mathematical ability. According to the findings of the study, fractions are a subfield of mathematics that require one to think in a multiplicative manner.

1.3 PROBLEM STATEMENT

Learners are continuing to get low mathematics marks, from primary to secondary school level. This issue of lack of relevant teaching aids and well-equipped classrooms for mathematics purpose has led to learners failing mathematics, and persist to be resistant in accepting mathematics as a primary knowledge builder and developing love for the subject (Feza, 2014; Tlou & Feza, 2017; Clements & Sarama, 2016). Several studies report that teaching mathematics requires sufficient time for planning and thorough preparation to ensure that, during content delivery, learners understand the intent of the lesson, and that no learner is left behind after lesson presentation (Govender, 2019; Khalid *et al.*, 2018; Clements & Sarama, 2016; Ehsan, Mahmood, Khan, Khan & Chou, 2018; Barmby, Harries, Higgins & Suggage, 2009; Feza, 2012a).

The challenge or gap that was identified is that there are not many studies in the context of South African early childhood education that have attempted to gain an understanding of the multiplicative thinking of Grade 3 learners by making use of the number concept in the process of learning mathematics. This was determined to be the case after it was found that there are a limited number of such studies.

Various researchers have proven that poor mathematics outcomes are the result of failing to focus on learners' thinking processes when they understand mathematics during learning; of learners' poor foundation phase mathematics background; as well as the neglecting attending to gender diversity. (Feza, 2012b; 2014; 2016; Ekdahl, Venkat & Runesson, 2016).

The literature reports that unintentional attendance to gender diversity of learning affects the development of female learners' aptitude for mathematics (Fennema, Carpenter, Jacobs, Franke & Levi, 1998; Evans, 1998; Weaver-Hightower, 2003).

Neglecting gender diversity in the classroom setting has resulted in female learners feeling isolated and less important during teaching and learning. It is fundamental that teachers are sufficiently prepared to exhibit gender sensitivity, so that they have the ability to practice and advance gender correspondence in the classroom setting, more adequately and consistently. If students are treated with care and respect, they stand a chance of experiencing successful learning. Mathematics can develop or destroy a learner's self-esteem and confidence, particularly if esteem and confidence was not well nourished from the time of early childhood education (Kachulo, 2018; Taylor & Karlin,1998; Warin & Adrian, 2015).

Clements and Sarama (2019) report that children up to six months of age appear to be sensitive to numbers, and that children are also sensitive to dice displaying larger numbers, although learners' understanding and prior knowledge of dealing with number concepts while learning mathematics are often ignored or neglected as a quantifier in educational practices. Multiplicative thinking should be extensively studied, as it plays a critical role in cognitive development.

Clements and Samara (2016) indicate that, in the second half of the twentieth century, educators developed several models of counting and subtilizing. Although debates on mathematics education are ongoing, mathematics educators are expected to assist learners in the lower grades to develop number sense very early on, using appropriate models of teaching or content delivery on specific mathematical content, which can stimulate learners to learn.

1.4 PURPOSE OF THE STUDY

This study sought to understand the thinking processes of foundation phase learners in Grade 3 as they engage with and learn multiplicative thinking under number operations. Furthermore, the study sought to understand how teaching and learning accommodates gender differences and similarities in nurturing learning.

1.5 RESEARCH QUESTION, AIM AND OBJECTIVES

1.5.1 Research questions

The main research problems were formulated to understand the development and conceptualisation of multiplicative structures involved in engagement with numbers by Grade 3 learners, and how gender-sensitive instruction can enhance learning during instruction. The study formulated three questions to gain the insight it sought to achieve, namely,

Question 1: To what extent do Grade 3 learners understand the language of factors, multiples the concept of equal groups and multiplicative arrays?

Question 2: How do learners use multiplicative arrays to coherent their thoughtful of the multiplicative condition and similar ideas, such as the converse relationship and the commutative property?

Question 3: How does instruction of multiplicative thinking include learners of all genders, to diversify the classroom?

1.5.2 Research objectives

Primary objective

The primary objective of this study was to understand the thinking processes of foundation phase learners in the Grade 3 as they engage and learn multiplicative thinking under number operations.

Secondary objective

The secondary objective of this study was to establish and analyse how teaching and learning accommodate gender differences and similarities while nurturing learning.

1.5.3 Delineation of the study

Only participants from the Department of Basic Education (DBE) were included; the Department of Higher Education was not included in this study. This was not a comparative study between learners at schools and students in the higher education sector.

1.5.4 Significance of the study

This study is set to investigate and understand the thinking process of foundation phase learners in Grade 3 when engaging with and learn multiplication under number operations. Furthermore, seeks to understand how teaching and learning of mathematics accommodate gender differences and similarities in nurturing learning. The findings of this study will make recommendation for other researchers on the aspects which still needs to be researched in the area of ECD mathematics. Further make contributions to the department of education by suggesting possible way ti stimulate multiplicative thinking and gender sensitivity amongst foundation phase learners and educators.

1.6 THEORETICAL FRAMEWORK

According to Torraco (1995), a theoretical framework is a tool that helps researchers zero in on specific variables while also establishing the specific framework that the research will utilize or apply in order to analyse and understand the data that is to be collected in the future. It allows the research to grasp ideas and variables according to the definitions that have been given, and it contributes to the building of knowledge by validating or testing theoretical assumptions. The following educational theories of learning served as the basis for this study.

1.6.1 Jean Piaget's theory of cognitive development

According to Piaget (1974), this theory offers a robust framework for comprehending the many modes of behaviour and modes of thought that are exhibited by children at various stages of their development. Piaget theorizes that children are born with pre-programmed behaviours, which he refers to as "reflexes." These behaviours are already in operation at the time of birth. Reflexes like these help children adjust to their surroundings, and while they can be readily and swiftly replaced by newly acquired or manufactured systems, children are born with them.

The theory of Piaget defines two processes that are used by humans in an attempt to adapt, which are referred to as i) assimilation and (ii) accommodation. Piaget was a Swiss developmental psychologist. The process of making use of or making changes to one's environment in order to fit new information into previously established cognitive structures is known as assimilation. The process of altering one's cognitive architecture in order to make room for new information gleaned from one's surroundings is referred to as accommodation. Throughout an individual's entire life, both processes are utilised simultaneously and in alternating fashion (Huitt & Hummel, 2003; McLeod, 2018).

1.6.2 Jerome S. Bruner's theory of discovery learning

Bruner's theory is associated with constructivist teaching principles; it emphasizes that students learn best when they are engaged in active, social learning processes that assist students in forming or developing new ideas based on their existing knowledge. Bruner's theory was developed in the 1950s and has since been associated with constructivist teaching principles (Clabaugh, 2009). Schunk (2008) and Maderin and Preckel (2009) state that discovery learning can be structured to involve either limited or extensive direct learning.

These two theories were chosen as the study's theoretical framework, because of their relevance to the study. They complement the research aims and objective and provided clear direction to the whole dissertation. Piaget's cognitive development theory and Bruner's theory of Discovery learning links with each other as they both believes that learners move from a tangible, an action-oriented stages of learning to a symbolic and abstract stage of learning. For learners to all these stages mentioned above learners needs to have the ability to build new knowledge upon their previously learned knowledge. These frameworks will guide the research on developing relevant data collection tools and selecting the relevant research design for the study.

1.7 RESEARCH DESIGN

The research design is arranged into methodology; study design; population and sampling; trustworthiness or quality assurance of data, data analysis methods, and Mechanism to ensure the quality of the study.

1.7.1 Methodology (qualitative research)

In this study, the qualitative research method was used, because qualitative research creates knowledge claims from constructivist perspectives (Creswell, 2013). Doing so entails aspects such as socially and historically constructed meanings, as well as diverse meanings from individual experiences (Creswell, 2013). The researcher used qualitative research to develop patterns, develop theory and establish advocacy regarding relevant issues (Creswell, 2013). The use of case studies falls under qualitative research methodology; other methods are grounded theory studies, phenomenology, ethnographies and narratives (Creswell, 2013). This methodology was suitable for this study, as I worked with learners to investigate how they engaged in understanding multiplicative thinking while learning in a formal school setting. The data I gathered was used to develop themes (Creswell, 2013), which answered the questions in relation to the what, why and how of the research problem.

1.7.2 Study population and participants

The targeted population of this study was Grade 3 learners at three schools in Motheo District; both suburban and township schools were involved. The sampling procedure that was used for this study was probability sampling. The sample size was 30 learners and three classes, because sampling in qualitative research typically follows random sampling procedures (Creswell, 2015), and the size of the sample differs according to the purpose of the study. A pilot study was conducted to test the suitability of the sample and the usefulness of the self-constructed questionnaire.

According to Mertens (2015, p. 434),

> *a researcher needs to decide whether to (a) use a measurement instrument that is commercially available or one developed by other researchers;*
>
> *(b) adapt an existing instrument from the reviewed literature, or (c) create a new one to meet the needs of the proposed research.*

In this context, a self-developed clinical interviews questionnaire was used. The rationale was to assess issues in a holistic manner across different social contexts.

1.7.3 Data collection

To investigate learners' ways of attending to multiplicative problems, I designed a structured (diagnostic) test (clinical interviews) for learners, and conducted follow up unstructured interviews, to understand their responses. I also used a class observation tool to observe the gender-sensitivity of teaching and learning. The clinical interviews comprised only structured questions, and prompts that related to the research topic, though it also made provision for unanticipated topics raised by participants. The interviews were conducted when it was convenient for the learners, and as agreed with the school management team and the subject educators, which were governed by their work schedules (Smith, 1995; Creswell, 2013).

1.7.4 Trustworthiness or quality assurance of data

Reliability is essential when it comes to qualitative research (Shenton, 2004), though, in qualitative research the equivalent term is trustworthiness (Guba, 1981). Trustworthiness can be assessed through a criterion comprising four concepts, namely, credibility, transferability, dependability and confirmability, as described by Shenton (2004) and Schurink (2009).

To ensure trustworthiness, the researcher ensured that questions asked during the interviews were related to issues relating to multiplicative thinking, multiplicative arrays, the concept of equal groups, and the language of factors and multiples, and teaching and learning in early childhood development. Intensive interviews were used for the study. The researcher asked participants the same questions, and a classroom observation tool was used to assess connections between learners and educators during the teaching and learning of mathematics.

There was an assurance given to the that the anonymity of their responses would be sustained.

1.7.5 Data analysis methods

Data was analysed using the thematic approach analysis. The initial stage of the analysis involved the collection of data and the grouping of themes that emerged. The next stage involved scanning the transcripts in search for themes, patterns or trends. After the data had been assessed, it was grouped into segments or categorised (Creswell, 2013; Denzin & Lincoln, 2018).

It is good practice to ensure satisfactory data storage. The data was stored safely, to protect participants' confidentiality and anonymity. For example, the digital audio recording of the interviews was stored electronically in a password-protected file (Babbie & Mouton, 2001a; Creswell, 2013; Denzin & Lincoln, 2018).

Care should be taken to control bias, such as selection bias and bias when collecting or analysing data. The following processes were followed to ensure satisfactory reliability. The researcher and a peer researcher and the supervisor participated in the development of the themes by reading the transcribed transcripts of the interviews, in order to establish inter-coder consensus (Denzin & Lincoln, 2018; Miles, Huberman & Saldaňa, 2014; Elmar, 2015). This means that, once the initial analysis had been completed, the researcher generated themes independently, then had a meeting with the supervisor for guidance, to reach agreement on the themes and sub-themes.

1.8 ETHICAL CONSIDERATIONS

Written permission was sought from the district departmental officials working at the research office as well as from the district director within the basic education sector and the head of the department of the Free State Department of Education. Refer to Appendix A for particulars of the letters that were sent to their offices.

The following is a list of additional ethical issues that have been highlighted by previous research and that have been adhered to throughout the study: a) Obtaining informed consent from potential research participants; b) reducing the risk of harm to participants; c) preserving the anonymity and confidentiality of participants; d) avoiding the use of deceptive practices; and e) providing participants with the option to opt out of participating in the research (Babbie & Mouton, 2001b; Creswell, 2013; Denzin & Lincoln, 2018). The participants were sent a letter of information, which is provided in Appendix B.

1.9 STRENGTHS AND WEAKNESSES OF THE STUDY

The strength of the study is that interviews were conducted during school hours at the times agreed upon by the researcher, school management, participants and educators. Furthermore, the researcher was directly involved in the teaching and learning process for observation purposes. The interviews lasted between 30 and 45 minutes each.

The research is original and sought to address the gap in the learning of mathematics of Grade 3 learners, and the direct implications of multiplicative thinking and reasoning in a formal learning setting. A limitation of the study is limited generalisability, since it is not possible to generalise research findings in the absence of random sampling and because the sample is so small (Brink & Wood, 1998).

1.10 MOTIVATION FOR THE STUDY

The researcher is an educator and identifies as a passionate member of the education sector, who is working hard to develop foundation phase learners' understanding and conceptualisation of mathematics knowledge in the school setting, which will result in increasing mathematics performance in the particular education setting, and in the community. As a result, the major motivation for the study was the need to make a positive contribution to the body of knowledge and the profession.

The learners in a space where the researcher is currently teaching still perform below expectation with regards to the quality of mathematics results as expected which has led to the researcher's development of question about how teaching and learning resources are being utilised in a foundation phase schooling setting and what challenges the educators within that space experienced in terms of the quality content deliverance of mathematics in the foundation phase. I was intrigued to figure out how the reason for science learning was established in the groundwork stage.

1.11 STRUCTURE OF THE THESIS

This Master's degree dissertation will be presented over five chapters. Chapter 1 presented an introduction, to set the scene and provide an overview of the research. Chapter 2 will comprise a literature review, and Chapter 3 will explain the methodology and research design that was applied. Chapter 4 will present the findings of the study, while Chapter 5 will involve a discussion and conclusion of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This section of the study offers insight on how to write a good quality literature review (Boote & Belle, 2005; Cronin, Ryan & Coughlan, 2008; Torraco, 2016; Randolph, 2009). According to these sources, a good literature review gathers and draws together a volume of literature on a specific subject, summarises and synthesises it and does a critical analysis of the research topic.

The literature reviewed for this study outlined the theoretical framework guiding the study and the context of mathematics, specifically multiplicative thinking of Grade 3 learners, and assessed the development of gender-sensitivity pedagogy for these learners while they were learning mathematics. Furthermore, the literature review in this chapter will analyse recurring themes reported in the sourced literature. These themes are a brief overview of early mathematics education; low mathematical literacy/poor aptitude and comprehension; poor future prospects of passing/low pass rates; limited upward social mobility; challenges related to English as the language of teaching and learning (LOLT); passing without competence through the progression policy; confrontations which are relating to the quality of content teaching; literacy levels of parents; lack of educational stimulation at home; and comparison of data and statistics in terms of the following: gender, residential areas (urban or rural), and performance in mathematics by learners in government and private schools.

2.2. HISTORICAL CONTEXT ON MATHEMATICS IN EARLY CHILDHOOD

Numerous studies on the teaching and learning of mathematics in early childhood that have recently been published indicate that this area of mathematics research has developed progressively. The importance of mathematic learning in early childhood is reflected by the specific vested parties, working groups and probe for a committed to mathematics education (Björklund, Van den Heuvel-Panhuizen & Kullberg, 2020). Mathematics experiences in an early childhood setting should concentrate on (a) numbers (including whole number, operations, and relations) and (b) geometry, spatial relations and measurements, with more mathematics learning time being devoted to numbers than other topics (Booth, 1984; Barmby *et al.*, 2009). As stated in National

Research Council (2009), “Mathematical process goals should be intergraded in these content areas”. Comparisons of achievement of developed and developing countries have been done for mathematics, science and literacy, because it has been found that countries have unique systems, educational facilities, policies and teaching methods that fit their curricula. Learners in early grades are exposed to practical work, such as playing with building blocks, mathematics charts and other, related resources that accommodate different types of learners in a class. One would hope that all educators are experts in their fields More than a decade's worth of research investigations into mathematics in high performing countries have come to the conclusion that, in order to increase mathematics achievement in the United States, the mathematics curriculum needs to become significantly more focused and coherent (Evans, 1998; Park & Nunes, 2001; Barmby et al., 2009; Askew et al., 2018).

Research on the early years of mathematics learning and teaching in South Africa uncovered a number of challenges, including variable practitioner/educator mathematics knowledge, practitioners' beliefs about how children learn mathematics that indicate discrepancies in understanding of children's innate abilities, and the role of socioeconomic status in the quality of children's development. In addition, the research highlighted the role that socioeconomic status plays in the quality of children's development (Feza, 2012b). Hence, this study investigated the understanding of foundation phase learners’ perspectives and conceptualisation of mathematics content numbers, and the prevalence of this approach to multiplicative thinking. The study also investigated gender-sensitivity pedagogy at primary schools as it relates to the learning experiences of foundation phase learners, specifically those in Grade 3.

2.2.1. Multiplicative reasoning

Multiplicative reasoning ensures that learners are able to work out numbers, rational numbers, ratios, proportions and percentages (Lamon, 2005). Not only are these topics of significance on the later stages of education, but they are difficult to teach, because they require sufficient time and thorough preparation in order to develop it sufficiently in learners. Multiplication starts with the need to gather different quantities of items/objects using rehashed addition, while considering potential misinterpretations – the process is subjectively unique to addictive thinking (Lamon, 2005, Vergnaud, 1994). In mathematics perspective, multiplication of numbers and rational numbers might be viewed as moderately straight forward; nevertheless, it can be demonstrated by numerous discernible classes of situations and its outcomes are not always of a greater number (Greer, 1992). Hence, a crucial calculation of multiplication is important when expanded dominion of positive multiplication is a floating point (Vergnaud,1994). Situations and concepts that involve multiplication, division, fractions, ratios and proportions, and the ability to engage in multiplicative reasoning, requires an unmistakable theoretical comprehension and full information on arithmetic cycles, as well as the ability to build connections amongst the situations and ideas. Thinking mathematically includes the ability to embrace number concepts internally, through the most common way of furnishing issues, circumstances and connecting materials with proper language and images that address ideas.

Early intervention in multiplicative reasoning is vital. A study conducted in the United Kingdom in 2010 found that most learners in secondary education are unwilling to participate in mathematics problem-solving, hence, the importance of developing multiplicative reasoning in the early years (Brown *et al.,* 2010). Learners at the primary level of education – especially children in the state education system – continue to attain poor grades in mathematics (Fleisch & Kregenow, 2013). This challenge emerges as limited progression in arithmetic tasks, and most learners seeking out concrete counting methods until they reach upper primary grades (Schollar, 2008).

It is important to investigate every aspect involved in this topic, and not overlook important details that may be major contributors to challenges and solutions related to multiplicative reasoning. Learners' levels of thinking are among the contributors to their learning potential – the individual learners' presentation can't be easily observed without the educator's ability to identify learners' thinking processes. Teachers in this way, need to recognize the significance of identifying the genuine reasoning levels of their learners, as well as the learners' potential levels, to pitch guidance at the right level (Vygotsky,1978).

Studies referencing the TIMSS of South African children, in particular that of learners in Grade 5, found that foundation phase learners' experiences are not preparing them to deal with numbers and multiplicative thinking in their counting activities (Venkat & Askew, 2012; Reddy *et al.,* 2015). The significance of multiplicative thinking in mathematics was investigated by various studies in Australia (Siemon *et al.,* 2012;

Siemon *et al.*, 2006b). Multiplicative rational is imperative for the improvement of mathematics conceptions, comprising algebraic thinking (Brown & Quinn, 2006), place value, proportional reasoning, rates and ratios, measurement, and statistical sampling (Mulligan & Watson, 1998; (Siemon, 2006a). Furthermore, a study by Siegler *et al.* (2012) advocates for understanding division and the use of fractions as predictors of later mathematical achievement. The study also describes fractions as a branch of mathematics that relies on multiplicative thinking. Several studies have noted that the use of 'solid' multiplicative thinking cannot be applied useful by a majority of the learners (Clark & Kamii, 1996; Siemon *et al.,* 2006a). These studies found that 52% of Grade 5 learners were not solid multiplicative thinkers, while 40% of learners in Grades 7 and 8 performed below the standards set by the curriculum. A study conducted by Sophian and Madrid (2003), in turn, found that most children enter school with informal knowledge that supports both counting and additive thinking, hence, the need to reconceptualise the way they understand numbers, so that they can understand the multiplicative relationship (Wright, 2011).

The literature reported in this section presents a vantage point for the ways in which multiplicative reasoning can be accomplished in accordance with the foundation phase guidelines outlined in the South African curriculum and Assessment Policy Statement (CAPS) document. The CAPS document suggests that the three proportions – multiplication, sharing and grouping –are categories of simple proportions (DBE, 2011). The CAPS, furthermore, contains illustrations of division situations encompassing the need to round up/down, based on making sense of the context in place. For example, Grade 1 learners are expected to solve problems such as the following (DBE, 2011):

> *Stella sells apples in bags of three apples each. She has 14 apples. How many bags of three apples each can she make up?*
>
> *Ben wants to take 15 eggs to his grandmother. How many egg boxes that can take six eggs each does he need to pack all the eggs?*

In the CAPS, division is mostly dealt with as a separate branch of multiplication, and it is omitted totally, in the sense that models including double number lines, arrays or ratio tables are used as captions that connect both operations.

2.2.2. Exclusion from education in South Africa

South Africa has two education system streams. Historically, white schools or so-called former Model C schools accommodates the wealthiest 20–25% of learners (Fleisch, 2008; Kader, 2012; Spaull, 2013); some of these schools are private schools (Kallaway, 2009; Kader, 2012; Spaull, 2013). The other stream consists of previously disadvantaged schools or township schools, which accommodate the poorest 75–80% of learners (Spaull, 2013); these schools are state-funded and fee-paying public schools (Kallaway, 2009; Kader, 2012; Spaull, 2013).

Schools in South Africa were previously racially segregated (Kader, 2012; Mampane & Bouwer, 2011; Xaba & Malindi, 2010). Parity is lacking, as the schools divided learners according to language, socioeconomic status and geographic location (Kader, 2012; Xaba & Malindi, 2010; Spaull, 2013). Previously disadvantaged schools are mostly situated in poverty-stricken areas (Mampane & Bouwer, 2011; Xaba & Malindi, 2010). During the apartheid era, these schools were characterised by inferior education and resources endorsed by the Bantu Education Act (Hartley, 2006; Spaull, 2013; Munje & Maarman, 2016). Township schools in disadvantaged areas are characterised by a lack of resources, poverty and poor infrastructure, and significant infrastructural backlogs (Bush & Heystek, 2003; Xaba & Malindi, 2010; Mampane & Bouwer, 2011; Kader, 2012). Other infrastructure challenges include inadequate facilities, such as poor sanitation facilities, lack of waste management, dirty and dilapidating facilities, and damaged and too few desks (Motala & Pampalis, 2001; Kamper, 2008; Bumgarner, 2010; Xaba & Malindi, 2010).

Learners at previously disadvantaged schools are mostly from working-class and poor backgrounds, while well-resourced suburban schools mostly serve learners from the middle classes (Fleisch, 2008; Kallaway, 2009; Kader, 2012). Previously disadvantaged schools are associated with violence and instability (Chisholm & Valley, 1996; Bloch & Solomos, 2009; Mampane & Bouwer, 2011; Kader, 2012), and some experience gang violence, drug abuse, and vandalism (Chisholm & Valley, 1996; Kader, 2012). Learners tend to migrate from township schools to better resourced schools (Bloch & Solomos, 2009; Kader, 2012). Most disadvantaged schools are described as dysfunctional, with only a few of them producing excellent results or university entries (Kader, 2012; Spaull, 2013). However, it is important to note that studies suggest that there is no static standard that outlines being functional or dysfunctional, rather, that there is a continuum on which schools may range from dysfunctional to function (Kader, 2012).

In general, these formerly disadvantaged schools are believed to perpetuate the disparity and exclusion birthed in apartheid South Africa (Fataar, 2008; Bloch & Solomos, 2009; Kader, 2012) – they are described as continuously deteriorating and in need of interventions to solve their problems (Bayat, Louw & Rena, 2014; Pretorius 2014; Munje & Maarman, 2016). Since the advent of democracy, there have been efforts to bring about useful reforms (Munje & Maarman, 2016). Despite great strides being made to effect improvements, much more work still needs to be done (Kader, 2012; Spaull, 2013). The main predicament is ensuring that policies are translated to ensure that previously deprived communities can enjoy the practical benefits of democracy (Maarman, 2009; Munje & Maarman, 2016).

2.2.3. Challenges fronting the South African schooling system

The continuing difficulty in the education system in South Africa (Spaull, 2013; Maddock & Maroun, 2018) has led the education system to it being considered the worst education system of all middle-income countries (Spaull, 2013). The system is overwhelmed by economic, social and administrative inequalities (Carnoy *et al.,* 2008; Clarke, Reynolds & Harris, 2004; Badat, 2009; Modisaotsile, 2012; Spaull, 2013; Munje & Maarman, 2016). These challenges are the result of geographic location and lack of access to resources and funding (Spaull, 2013). The system is also plagued by poverty, inefficiency, unfairness, underperformance and the violation of human rights (Clarke *et al.*, 2004; Modisaotsile, 2012; Spaull, 2013; Munje & Maarman, 2016). Schools have poor infrastructure and the system is plagued by significant infrastructural backlogs (Xaba & Malindi, 2010; Kader, 2012).

The studies that were reviewed reveal that significant inequalities still remain in the system, despite considerable improvement and attempts to transform the education system (Crouch & Mabogoane, 2001; Chisholm, Motala & Vally, 2004; Clarke *et al*., 2004; Reschovsky, 2006; Van der Berg, Burger, Burger, Louw & Yu, 2006; Taylor, Fleisch & Schindler, 2008; Taylor *et al*., 2012; Munje & Maarman, 2016). The overall implementation of interventions is constrained by such unequal conditions (Carnoy *et al.*, 2008; Kader, 2012; Spaull, 2013).

A further significant obstacle in the South African education system is conflicting social, theoretical and ideological frameworks (Badat, 2009). Naicker, Grant and Pillay (2016) claim that there have been too many changes in the legislation that regulate schooling. Despite significant policy changes, improvement in education outcomes is still insignificant (Carnoy *et al*., 2008.). Another challenge facing the education system is that teacher unions tend to overlook the educational interests of the learners, and the professional development of educators (Van der Berg, Taylor, Gustafsson, Spaull & Armstrong, 2011).

These challenges are then differentiated in two parts, namely; internal and external challenges facing the South African education system. Both internal and external challenges will be discussed in detail in the paragraphs below.

2.2.4. Internal factors fronting the South African education system

2.2.4.1. Challenges related to the quality of education

Challenges facing the South African education system extend to the quality of education in the country, which remains poor and unsatisfactory (Kader, 2012; Modisaotsile, 2012; Spaull, 2013; Zoch, 2017). For example, 50% of learners who enrol for Grade 1 do not reach Grade 12; only 40% of learners pass Grade 12, and only 12% of them get academic results that allow them to enter university (Kader, 2012; Spaull, 2013). Zoch (2017) argues that the quality of education provided by schools in poor neighbourhoods has to be drastically improved. Similarly, Modisaotsile (2012) states that an overall improvement of the quality of education is needed, in order to ensure that the system functions optimally. Improving education will give poor learners equal opportunities, as it has been found that even learners from the poorest neighbourhoods can improve their performance if they are given the chance to attend well-resourced and affluent schools (Zoch, 2017).

There is a difference in the academic performance of learners from poorly resourced township schools and those in well-resourced and affluent suburban schools, which is also due to significant differences based on the circumstances in the cohort of Grade 6 to 12 learners (Zoch, 2017).

2.2.4.2. Challenges relating to the curriculum

South Africa is challenged by a curriculum that is inefficient in its structure and design (Chisholm *et al*., 2003; Kader, 2012; Spaull, 2013). Through the years since the end of apartheid, South Africa's curriculum has undergone several changes (Carnoy *et al.*, 2008; Rammala, 2009; Kader, 2012). Some of these changes involved a shift to outcomes-based education, and then to the CAPS – these seemingly haphazard changes have been criticised for causing major setbacks and confusion (Rammala, 2009; Mabodoko, 2017; Maddock & Maroun, 2018). The curriculum is still deemed as being implemented poorly (Bottery, 2004; Spaull, 2013). South Africa is challenged by a lack of alignment between the curriculum and the assessment of the various policies; curriculum offerings are limited, and challenges relating to curriculum requirements are not being met optimally (Chisholm et al., 2003; Xaba & Malindi, 2010; Kader, 2012).

The selection and effective use of appropriate mathematics resources requires careful consideration and planning on the part of teachers (Drews, 2007). The ordinary procedure of manipulatives does not literally mean that it will bear the favourable effects, such as stimulating considerate and increasing understanding of mathematics concepts, will be accomplished.

Voluminous resources used in the foundation phase classroom spaces assist the learners to easily develop and enable learner's ability to work well with mathematics, resources such as counters; numbers chart and number line are playing a vital rule in learner's comprehension of mathematics concepts. According Kader's research he highlighted that the use of the resources plays a vital role in a child comprehension of mathematics. Nonetheless, it is not always tranquil for early youngsters to attach solid objects, such as blocks, beans, and sticks, to mathematics concepts, as Kader (2012) explains:

> *Imagine that there are white blocks, each of them having a length of one unit, and orange blocks, each having a length of ten units, on the same scale, and that the addition problem, 6+7, is given to a child to solve with these blocks. The child has to collect six white blocks, and again seven white blocks. Once the blocks are collected, they can be put together. When the length of the collected white blocks equals that of an orange block, the ten white blocks are replaced by one orange block. The teacher's intention with this activity is to*

teach the concepts of addition and place value using concrete materials. However, for young learners, the activity might be a simple colouring exercise, replacing blocks according to their colour. Young learners might not be aware why they are exchanging the ten white blocks for the single orange block, while still following the directions correctly step-by-step. In this situation, the activity becomes simply procedural, which is a commonly perceived problem with manipulatives.

The above-mentioned resources have been proven to be the most effective tools in supporting the development of young children's mathematical learning and number concepts development through problem-solving in various context like division; multiplication; subtraction and addition. Nonetheless, it has also been proven by Van De Walle, Karp and Bay-Williams (2010) that making use of these resources may not be optimal. Possessions are occasionally ineffectively used during the teaching and learning may guide learners 'on what to and how to use those resources (Van de Walle *et al*., 2010). This instruction style does not endorse understanding so much as rote learning, and Van de Walle *et al.* (2010) restraints against "the consistent allurement by teachers to take out the materials and telling learners' accurately the best way to utilize them". Though these learners need the instruction from teachers in using resources, too much directing by teachers can damage learners' ability This recommends that there is a huge difference between learners who are being directed by the teacher and learners who are being influenced by the teacher. Hence, where that students take with assets actually relies generally upon the educator. The accentuation ought to be on idea improvement, as opposed to process or repetition memorisation (Abramovitz, 2012).

The correct use of the resources within the classroom setting also create an opportunity for manipulatives to be very easy to learners (Boggan, Harper & Whitmire, 2010). Conversely, it is not always easy to "grasp" mathematics concepts in solid materials (Thompson, 1994:3).

The specific abstract mathematics ideas are represented by resources, thus purposely designed to represent them. these resources/materials can be used as models by both educators and learners; they hold a vital visual and tactical appeal, hence, they are originally designed for hands-on manipulation (Drews, 2007). Drews makes sense of that Dienes blocks and Cuisenaire number poles are instruments that assist learners with perceiving connections in the base-10 number framework and can be used to demonstrate the base-10 spot esteem framework, similar to the connection somewhere in the range of 100 and 10 tens. These numerical resources uphold learners to figure out decay, as a methodology toward calculations that include the pulling together of numbers (Drews, 2007).

2.2.4.3. Challenges with English as LOLT

Studies across the world establish that moving from an individual home language to a second additional language has an unpleasant impact on learners learning. According to these studies, the outcomes are impaired once learners not adequately prepared in their own home languages, which poses a serious challenge for such learners to comprehend the second additional language. (Wetere, 2009:3; Unesco, 2012:2; Madiba, 2013:4). In the context of South Africa, most suburban schools use English language as the medium of instruction during teaching and learning LOLTs.

Setati (2005; 2008) indicates clearly the role of mother tongue instruction in making sense of mathematics ideas. Setati’s work provides a deep understanding of classroom practices in relation to expectations of language use for teaching and learning mathematics. She demonstrates that code switching (a speaker alternating between two or more languages) occurs as the need arises, although this practice it is not part of language policy. Code switching has its benefits and disadvantages. On the one hand, it helps learners to understand the teacher’s explanation, while, on the hand, it denies learners the opportunity to become more articulate or better skilled in all the languages in use. These findings provide vital insight into understanding the thinking processes of learners when it comes to their mathematics or conceptual understanding. It demonstrates that home language becomes a tool for sense-making of mathematics ideas (Setati, 2008).

learners are viewed as specialists of their own lives, and ought to have the option to track down their own means to take part in significance making processes, both at home and at school. The problem challenging the young learners of English who is from a lower financial climate is that added substance bilingualism implies more than individual learner home language; nonetheless, In most cases, the English language will be used rather than the first language. This results in what is known as subtractive bilingualism, which is detrimental to the development of a young child's language skills.

The addition of jargon can also lend a lavishness and intricacy to mind, and bilingualism can help to nurture the development of more complex thought. Even very young children are able to reason intelligently beyond the restrictions of a single correct word and consider multiple points of view (Tella, Indoshi & Othuon, 2010). Whatever the case may be, this type of scholarly turn of events, which is intervened through more than one language and culture, is discovered in first class bilingualism as added substance bilingualism (Gathumbi, 2013; Kanga and Indoshi, 2012). In these kinds of households, children are often encouraged to develop high levels of theoretical ability in both English and their first language. Children who come from families with lower incomes, on the other hand, are more likely to have parents who struggle with a variety of issues, such as a lack of formal education, the poor economic health of their native language, and a lack of time because they must work long hours away from their children. This can make it difficult for these parents to adequately care for their children (Toukomaa, 2000:215; Tella *et al.*, 2010).

It's possible that their original language will not get enough respect in the traditional educational system or the workplace. Standard bilingualism, also known as subtractive bilingualism or semilingualism, will typically result in the development of (Toukomaa, 2000:215). The child might have picked up some essential relational abilities in English, which is either their second or additional language, but they struggle with their mental and academic language aptitude (Cummins, 1979). This is the situation of the young second or extra language learner. Lansdown (2005) explains that a culture of paying attention to young children when talking is not generally the norm for adults. Language is a social ability for correspondence in the school and classroom setting (Adler, 2000). Challenges with language incorporates learners' home dialects and their connection to the LOLT; it is likewise an asset that students use to respond to questions and examine work with one another in class.

Barbu and Beal (2010) acknowledge that language is important for learning, and suggest that the difficulty experienced by learners in solving mathematics problems might lie in the complexity of the language in which mathematics problems are given. The study conducted by Barbu and Beal (2010) shows that learners' performance in mathematics is linked to their ability to understand language adequately. Their comprehension of English language enables learners to successfully grasp the required competence in solving mathematics problems. These researchers also agree that learners' performance in non-linguistic mathematical problems is better (Barbu & Beal, 2010:13-14). This is an indication that language is vital, as it improves understanding. Most learners in the early childhood stage or foundation phase education find it easy to process when given language-free calculations, yet find it difficult to do similar calculations with language (Killen, 2000; Barbu & Beal, 2010). Killen (2000:25) adds that mathematics has its own distinct language, and learners need a deeper and thorough understanding of that language to figure out mathematics. Hence, English second language learners have a twofold weight of learning the LOLT as well as the language of mathematics. Absence of clearness, or misconception of images, prevents learners from connecting their current mathematics information and the new information to be learnt, and this will in general lead to negative outcomes for their progress in mathematics (Siyepu & Ralarala, 2014).

Siyepu and Ralarala (2014) express concerns about university undergraduates who concentrate more on English than their subsequent language, yet battle and neglect to grasp mathematics language. This issue is exacerbated by a few student educators and instructors (particularly those that undergo foundation phase education training). Few of these educators are proficient in the language of teaching and learning (English) and they have had limited exposure to teaching mathematics in English. Assuming that student teachers for whom English is a subsequent language struggle to comprehend mathematics language at tertiary level, how much more will they encounter difficulties to teaching the subject? "Learning the language of another discipline is a part of learning the new discipline; the language and learning can't be isolated" (Schleppegrell, 2007:140). When learners start attending school, they have already acquired some knowledge from their home and societal environments, which they use to develop their insight into the world. It is, therefore, expected of educators to use and expand on that language and information, and guide learners towards new and more logical and specialised understandings, by monitoring the difficulties that accompany the reasonable difficulties of learning (Schleppegrell, 2007:140).

Educators should refrain from assuming that using words frequently mean that learners will have the ability to understand it even, these words are not explained by educators to learners (Killen, 2000:25). Schleppegrell (2007:143) agrees that learners understanding frequently used mathematics-related words, such as more, less, and more, is not enough – learners must be taught the language patterns related to these words and be encouraged to understand how these patterns build up mathematics concepts.

Learners cannot learn mathematical language automatically with being taught by the educators/initiators of knowledge (Killen, 2000:25). Moreover, the capability to work with language only is not satisfactory in mathematics. “Mathematics pulls on numerous semiotic (meaning creating) classifications to construct knowledge: symbols, oral language, written language, and visual representations” – such as concrete, semi concrete and abstract materials (Schleppegrell, 2007:141). Educators should, consequently, apply various methods that work well with language to enable effective teaching and learning of mathematics language, mathematical problem-solving techniques, and so on.

Several challenges impact the South African education system in relation to language, among which the proficiency of teachers and learners in a LOLT (Nel & Müller, 2010; Van der Berg *et al.*, 2011). In essence, English as a LOLT poses challenges in many schools; it impacts academic performance, as learners do not comprehend what they read and write (Nel & Müller, 2010).

Howie’s (2003) findings on aspects that affected South African learners’ mathematics performance in TIMSS 1999 advise that socioeconomic status had less influence than home language and class size. The minute the LOLT is different from the home language, it has a major effect on South African learners’ mathematics performance (Howie, 2003) – learners accomplish better results if the LOLT is the same as the language used at home. South Africa is a multilingual nation; thus, this variable should be recognised by and by to serve learners. A focal concern communicated by the research is that learners who are learning in a second or additional language can be silenced in more ways than one.

Conversely, there may be different perspectives in terms of social and cultural as well as how mother tongue is viewed within those perspective in relation to the second additional language, English, however, the conclusion is that the LOLT is regarded as the influential language. Thus, the ‘best interests’ practice of English can turn into a matter of successful understanding, contestation and discussion between parents, children and teachers.

The modern methodology to improve multilingualism ideologies is embraced by the school curriculum to achieve additive bilingualism as a language attainment (Kimathi, 2017; Christiansen, Bertram & Mukeredzi, 2018). The assumption is that learners can unexpectedly and progressively be transfers of various literacy skills from their home language literacy knowledge, to learn English as first additional language, and can later use these languages for future learning (Kimathi,2017; Bertram & Mukeredzi, 2018)

2.2.4.4. Challenges impacting educators in the phases for early childhood, and other phases

South Africa faces the challenge of a severe shortage of well-trained educators to teach mathematics at the foundation phase (Chisholm *et al*., 2003; Christie, 2010; Kader, 2012). Exacerbating this shortage is the trend of between 18 000 and 22 000 educators quitting the teaching profession every year (Modisaotsile, 2012). They leave the profession due to various reasons – sometimes they are forced to leave, and sometimes they leave voluntarily (Bloch & Solomos, 2009; Kader, 2012; Modisaotsile, 2012). The perception of Kader (2012), Marais (2016) and Modisaotsile (2012) in their respective research is that this brain drain is contributing towards excessive teacher workload and overcrowding of classrooms.

The literature reviewed argues that some of the key challenges impacting educators are the following: (a) Teachers have a poor work ethic, which is characterised by apathy or lack of effort (Van der Berg *et al.,* 2011; Leepo, 2015); (b) Absenteeism by teachers (Mashaba & Maile, 2008); (c) The unsatisfactory conduct of educators at schools (Dikgale, 2012); (d) Poor quality of relationships between educators and learners (Leithwood, 2010; Mabodoko, 2017); (e) The opposing outcome of educators' undesirable reinforcement in classroom management (Mabodoko, 2017); (f) Strikes organised by teacher unions, which are detrimental to teaching and learning (Van der Berg *et al*., 2011); and (g) Educators lacking the necessary qualifications (Reschovsky, 2006; Christie, 2008; 2010; Kader, 2012). Hard-working educators are demotivated, as the salary system does not differentiate them from underperforming educators (Reschovsky, 2006; Christie, 2008; 2010; Kader, 2012).

2.2.4.4.1. Lack of professional support for educators and learners

There is a lack of professional support for educators and learners. There is a need for greater logistical support during the teaching and learning process. Better professional support will stimulate better academic performance and better-coping skills to meet academic demands (Hartley, 2006; Munje & Maarman, 2016).

Various strategies that have been put in place since to support educators since 2000 which professional development in from of being allowed to further their studies through Advanced Certificate in Education (ACE), this programme is for teachers who have a National Professional Diploma in Education (NPDE). These implementations were conceived with the intention of providing equal chances to all educators and enabling them to broaden their knowledge base on the topics that they already instruct, as well as for educators who are specialized in a new content area or phase of instruction. The Department of Basic Education viewed this programme as a potential opportunity for teachers to improve their skills in literacy and mathematics education and obtain extra qualifications by participation in the programme.

2.2.4.4.2. Teaching and learning of mathematics in foundation phase classes

The accessibility and efficient use of mathematics resources should go hand in hand with a competent teacher's grasp of how and when these resources should be used, because different mathematical materials serve a variety of goals at a variety of times and in a variety of grades (Mtetwa, 2005:255). As an illustration, calculating can be done with flared cards, the major purpose of which is to aid in the acquisition of place value (DBE, 2011:247). Another illustration that can be found in this body of work is that of number lines and number tracks. This is owing to the fact that foundation phase teachers employ these tools most frequently within the context of their mathematics lessons. (Lannone, 2006). Lannone (2006) finds that this is a problem and discusses that the use of number tracks alone restricts learners' ability to understand numbers and exposes the number system as being made up of only cardinal numbers. As a result, this practice of educators persuades learners in the foundation phase to have no ability to leave space for fractions and irrational numbers. Lannone also finds that the use of number tracks alone exposes the number system as being made up of only cardinal numbers. On the other hand, number lines help students better understand the number system by exposing them to a variety of numerical representations, which in turn facilitates the acquisition of new knowledge. It is imperative that all classes in the foundation phase have access to number lines and make use of them so that students can develop a deeper comprehension of numerical concepts beginning in the early grades.

The process of teaching and learning is negatively impacted by a number of factors in most classrooms in South Africa. Consequently, there is minimal teaching in some classrooms (Chisholm et al., 2003; Xaba & Malindi, 2010; Kader, 2012; Marais, 2016). An important underrated factor c to this negative impact is a lack of structure in the classroom. Learning largely depends on teaching.

An educator who has not received adequate training to teach the foundation phase learners will experience challenges in carrying out the expected duties with the foundation phase classes, this will be evident from their classroom management skills; inadequate lesson preparation, and lack of establishment of a conducive teaching and learning spaces (Kuhne & Schemer, 2013).

According to findings by Kuhne, Lombard, Moodley, O'Carrol, Kuhne, Comrie and Hickman (2013) only educators who have undertaken foundation phase teaching training at tertiary institutions should in those classroom. Such educators are perceived to be experts in their field, as they have specialised knowledge that enables them to understand the importance of creating a conducive classroom setting for teaching and learning; such educators understand the kind of knowledge they need to bring into the classroom; have their specialised way of presenting lessons that makes use of relevant materials during teaching and learning; they have the ability to summarise and use relevant teaching approaches to assess the lesson as a whole; the educator is guided by objectives and knows the skills to be developed, and can motivate the learners, and allow for both group and individual practice. This pattern assists learners to be mentally prepared for any new information that is to be imparted to them.

2.2.4.4.3. Learner support materials and textbooks

The majority of schools of the South African school system lack sufficient learning resources and materials (Motala & Pampallis, 2001; Chisholm *et al.,* 2003; Christie, 2010; Xaba & Malindi, 2010; Mampane & Bouwer, 2011; Kader, 2012; Modisaotsile, 2012). Some of the textbooks in use are not the prescribed ones, and they contain little and irrelevant information (Kallaway, 2009; Kader, 2012). In many schools, learners are forced to copy notes from the board and each other, as there are no textbooks (Christie, 2010; Kader, 2012). In some schools, basic facilities and supplies, such as toilets and classrooms, are insufficient (Reschovsky, 2006).

The majority of non-fee-paying schools in the South African school system experiences shortages of learning resources and materials (Motala & Pampallis, 2001; Chisholm et al., 2003; Christie, 2010; Xaba & Malindi, 2010; Mampane & Bouwer, 2011; Kader, 2012; Modisaotsile, 2012). Some of the textbooks in use are not the prescribed ones, and they contain little and irrelevant information (Kallaway, 2009; Kader, 2012). In many schools, learners are forced to copy notes from the board and each other, as there are no textbooks (Christie, 2010; Kader, 2012). In some schools, basic facilities and supplies, such as toilets and classrooms, are insufficient (Reschovsky, 2006).

In mathematics classes, learners have access to a wide variety of teaching materials and resources, all of which can be categorized according to one of the following three subheadings, according to Adler (2000): (i) Materials used in mathematics classes (ii) Objects used in mathematics (iii) Everyday objects used in mathematics Materials for school mathematics are resources that are designed expressly for use in school mathematics. Examples of materials for school mathematics include chalkboards, computers, and textbooks. Mathematical objects are resources that arise in the environment of learning, such as number lines and Dienes blocks, and are referred to as "objects of mathematics." Money and the tops of bottles are examples of everyday things that have no direct relevance to mathematical instruction in the classroom.

Having to use the above-mentioned resources for mathematics in the classroom setting requires educators to be experts in the field, as these resources use demand standard practice for many years by primary school teachers, especially in the foundation phase (Drews, 2007:19) According to Lesser and Pearl (2008:2), materials found in foundation phase classrooms are easy to work with and enjoyable for both teaching and learning purposes, while Drews (2007:19) emphasises that these resources are not just concrete materials, but range from semi-concrete to abstract materials. Drew further highlights that the effective use of these material can result in learners improving their ability to develop constructive learning experiences and enable opportunities for learners to make connections in mathematics classes.

Furberg and Arnseth (2009:157) indicate that, in sociocultural theory, resources are frequently referred to as "mediational methods or cultural instruments". [Case in point:] According to Bornman and Rose (2010:82), mathematics resources are visual tools that assist students in comprehending what is being instructed or demanded of them. They emphasise that teachers can utilise real items, photos, or drawings as visual tools to assist learners in solving mathematical problems. These resources can also be employed by the teachers themselves (Bornman & Rose, 2010:82). Crafter states (2012: 34) that:

> *resource is a concept that refers to the way in which the individual is simultaneously a seeker and provider of meaning. The classical definition of a resource suggests that it is any object which one resorts to for aid or support.*

2.2.5. External challenges

This section of the literature review will focus on the external challenges faced by the South African education system, particularly by foundation phase education, and which includes learners' limited upward social mobility, and a lack of education stimulation at home, problems with the literacy of parents, and how using resources impacts on teaching and learning. This section will also assess the extent of the impact of these challenges on the education system, as well as the instruction of multiplicative thinking in the early grade(s) in mathematics. The foundation phase is the primary point of concentration because it serves as the primary foundation for the entire educational system and is the area or stage where gaps in mathematical knowledge first begin to appear. In order for "learners' future schooling to have acquired a solid foundation of basic understanding and skills throughout the main subject areas by the early grades," it is of the utmost importance for them to have done so by the early grades (Mukeredzi, Bertram & Christiansen, 2018). Learners who are functioning below the needed average may be putting themselves at risk for future failure in their educational careers, and they may fall more and further behind their classmates as they stay in school (Mullis, 2011:13; Mukeredzi et al., 2018). This emphasises that the difficulties should be addressed as soon as possible in order to improve the learners' chances of having success in the future.

2.2.5.1. Low mathematical literacy/poor aptitude and comprehension

This part of the literature study will discuss challenges related to inadequate mathematical literacy, aptitude and comprehension, as among the consequences or harm caused by neglecting the curriculum in the early childhood phase of education. Low mathematical literacy, and poor aptitude and comprehension are among the internal factors of the education curriculum system that can result in poor learner performance in mathematics. Various factors contribute to the high underperformance rate in the South African context, among which the inability of learners to apply their knowledge, and their failure to comprehend, as evidenced by TIMMS 2011 (cited by Mukeredzi et al., 2018; Lamon, 2009).

This failure becomes an obstacle to learning, which makes further education more difficult. According to Kozulin (2003), conceptual comprehension is defined as the incorporation of higher mental processes, and he claims that in order for educators to be able to create these processes in learners, they should integrate learners' cultural resources into their teaching. These cultural tools are a combination of what learners bring to the classroom with them and the new concept that is being learned.

There are many compelling arguments in support of placing a strong emphasis on evaluating and enhancing mathematical performance (Wallace Foundation, 2013). The quality of the learner's performance in mathematics and science is a good indicator of the quality of the human capital pool. The quality of the learner's performance in mathematics and science is a good indicator of the quality of the human capital pool. Mathematics is a crucial factor in determining whether or not students will be successful as adults and citizens (Ndlovu, 2011:420). According to Mbugua, Kibert, Muthaa, and Nkonke;(2012;87), mathematics is considered to be the cornerstone of a nation's scientific and technological knowledge. This knowledge is highly important for the development of social and economic statuses inside the country. In light of these points of view, mathematics becomes one of the most essential learning areas within the context of the school, as required by the policy and curriculum statement that is universally included in the curriculum around the globe (Mbugua et al., 2012:87). At the moment, South Africa is required to import a significant portion of the scientific and technological competence that is crucial for the country's continued economic progress (Makgato & Mji, 2006). The United States is suffering from a severe shortage of mathematics educators who are suitably qualified. The current educational system is incapable of producing sufficient numbers of students with the necessary skills to enter this field of study (Makgato & Mji, 2006:254). The South African Department of Basic Education (DBE) devised the Annual National Assessment (ANA) in order to address these problems and to contribute to the improvement of the quality of basic education (DBE, 2014). The ANA is comprised of standardized tests that are designed to measure and enhance the performance of learners in mathematics and in their native language from grades 1 to 6 and from grade 9 onward (DBE, 2014:14). In the same way as the results of the systemic evaluation are used, the results of the ANA "are used to report on the policy goals of access, equity, and quality as indicators of the 'health' of the education system and target a more diagnostic interpretation of learner achievement" (DBE, 2014:14). However, the fact that they are monitored and graded by the learners' own teachers and lack external verification decreases the value of the examinations. Spaull (2013:3) says that these assessments are not crucial for improving the value of education in South Africa.

Table 2.1 displays the average mark that learners in South Africa achieved on the ANA examination during the years 2012 and 2014.

Table 2.1: ANA learner average mark 2012–2014

Grade	MATHEMATICS AVERAGE PERCENTAGE MARK		
	2012	2013	2014
1	60	60	68
2	57	59	62
3	41	53	56

Initially the purpose of ANA as stipulated in the guidelines published in DBE 2014:19, aims at identifying challenges which learners are exposed to on their everyday schooling life. The above table represent learner's annual performance in mathematics and Home Language. The table has been used to analyse learners 2013 results of the assessment and enable the department of basic education to have data which they will use in reporting on the Diagnostic Report and performance analysis.

2.2.5.2. Poor future prospects of passing/low pass rates

In South Africa, academic performance is characterised by unsatisfactory results and poor academic achievement (Bloch & Solomos, 2009; Carnoy *et al.*, 2008; Hartley, 2006; Kader, 2012; Maddock & Maroun, 2018; Munje & Maarman, 2016; Spaull, 2013; Pretorius, 2014). Learners in the South African school system encounter a high frequency of repeated failure in mathematics, or having to repeat a grade (Kader, 2012). Sometimes, they repeat one grade more than once (Kader, 2012; Munje & Maarman, 2016; Spaull, 2013). In general, the system is deemed to lack alternatives for dealing with such large numbers of unsatisfactory mathematics results (Kader, 2012).

There is consensus in the reviewed literature that academic performance is impacted by aspects such as the following: a) Lack of parental involvement (Dikgale, 2012; Modisaotsile, 2012; Mampane & Bouwer, 2011; Ngcongo, 2016; Rammala, 2009) ; b) Constant curriculum reforms (Chisholm, 2003; Carnoy *et al.*, 2008.; Kader, 2012; Ngcongo, 2016; Rammala, 2009; Spaull, 2013); c) Lack of discipline at schools (Adu, 2009; Clarke, 2007; Ngcongo, 2016); d) Overcrowded classes (Clarke, 2007; Kader, 2012; Maddock & Maroun, 2018; Ngcongo, 2016; Rammala, 2009) and e) Absenteeismby both educators and learners (Mushwana, 2000; Ngcongo, 2016; Mashaba & Maile 2008; Van der Berg *et al.*, 2011). The literature also refers to exceptional circumstances that have a negative effect on academic performance: a) Child-headed families (Ngcongo, 2016; Sayed *et al.*, 2007); b) Teenage pregnancy (Modisaotsile, 2012; Ngcongo, 2016); c) violence in schools (Bloch & Solomos, 2009; Ngcongo, 2016); d) exceptional circumstances (Mabodoko, 2017; Ngcongo, 2016); e) Questionable assessment methods (Ngcongo, 2016; Spaull, 2013) and f) Corporal punishment (Ngcongo, 2016). In order to counteract the effects of these circumstances, it is essential to intervene by having a process of early detection, diagnosis and prevention (Spaull, 2013), without which the deficits will become insurmountable (Spaull, 2013).

2.2.5.3. Limited upward social mobility

Literature on this topic focuses on the child's movement from a lower position to a higher position, that is, the kind of knowledge that a child acquires from birth to early childhood, and how it impacts effective acquisition of knowledge throughout the child's life. The relevance of this section of the study is based on the research aim and one of the objectives, which is to understand how foundation phase learners, specifically those in the third grade, understand the development and conceptualisation of multiplicative structures in engaging with numbers.

After consulting recent literature on upward social mobility, I conclude that the long-term effect(s) can be seen in learner's' lives, whether psychological and emotional or financial, due to their experiences in early childhood. The DBE,2013; 2014, together with the South African government, are attempting to improve the education system, and to provide quality education that accommodate every citizen. They analyse the education system and make changes to uplift previously disadvantaged learners, and focused on the implication of stability for social justice and how does low-mobility learning environment may signal or reduce a learner's potential to achieve best results and success, more especially for those from previously disadvantaged background.

The numeracy workbooks are one of several departmental system-wide interventions is aimed at improving learner performance and the effectiveness of teaching strategy to be employed by educators during teaching and learning process. The introduction of the workbooks was also a way of affording learners the opportunity to learn and acquire the mathematics knowledge, skills and concepts that will enable them to move on to further grades successfully (DBE, 2013). Thus, a key function of numeracy workbooks is to ensure that learners, through using the workbooks, gain the required knowledge and independence, and that learners are provided with relevant mathematics-related activities that will enable them to practise effectively what they have learned in class at home. Fleisch *et al.* (2011), agree that numeracy workbooks are useful in the South African education system, while Downling (1996) considers it to be a government strategy to improve learning.

2.2.5.4. Passing without competence due to the progression policy

The legislation of progression implies that learners are progressed to the next grade even if they have not achieved the necessary minimum requirements (Kader, 2012; Munje & Maarman, 2016; Stott, Dreyer & Venter, 2015). Progression implies that learners are automatically promoted regardless of their academic performance – even those learners who lack the necessary content knowledge in mathematics and other compulsory subjects– for the purpose of retaining them in the education system (Munje & Maarman, 2016). In some instances, retention is used synonymously with progression (Munje & Maarman, 2016). The policy aims to limit learners from repeating a grade more than once within each of the four phases of basic education from the beginning to the end of the school process (Stott *et al*., 2015). The policy first came into being in 1998, when the Department of Education decided to progress learners until Grade 9, and again from Grades 10 to 12 (Stott *et al*., 2015).

In 2014, the first cohort of progressed learners reached Grade 12 (Stott *et al*., 2015). Sometimes, after being progressed, there is an initial improvement in academic performance (Van der Berg *et al.*, 2011). One of the perceived social benefits and the moral behind the policy are to grant learners in the lowest quintile schools an opportunity to finish their schooling (Stott *et al.*, 2015). In 2008, 80% of Grade 10 learners in such schools were projected to have experienced difficulties with regard to their prospects of reaching Grade 12 two years later, by 2010 (Stott *et al.*, 2015).

Stott *et al*., 2015 outline the common characteristics of progressed learners as the following: (a) They are unable to cope with school; (b) They do not complete their class work and homework; (c) They are unmotivated to keep up with work; (d) They lack discipline and exhibit undesirable behaviour in the classroom; and (e) They are not well equipped for teaching and learning.

Aspects perceived to be additional problems in environments in which learners are progressed are the following: (a) Educators refuse to teach in classrooms that have progressed learners; (b) Educators threaten to resign due to pressure, which is perceived to be exacerbated by progressed learners; (c) Educators actually resign; (d) Educators are forced to deal with pressure by the education department related to progressed learners; (e) Educators are demoralised; (f) Educators feel overwhelmed and experience burn-out; (g) Schools experience a shortage of resources; and (h)

Sometimes, educators disregard policy stipulations. One of the major challenges is that, sometimes, educators act as gatekeepers and prevent learners from being progressed, especially to Grade 12. Another problem is that automatic promotion is not at always implemented in all schools. Political, social and emotional pressure is brought to bear by staff to prevent automatic promoting from taking place.

There are contradictory views on the process of progression – some educators support it, and others are against it (Kader, 2012; Munje & Maarman, 2016; Stott *et al.*, 2015). The following are some of the key arguments of allies of progression. Progressing learners helps to reduce the high rate of learner dropout (Kader, 2012; Munje & Maarman, 2016; Stott *et al.*, 2015), because the more knowledge learners acquire, the less the risk of them exiting the next grade (Kader, 2012; Munje & Maarman, 2016; Stott *et al*., 2015). The justification is that learners who repeat two grades are almost 100% likely to drop out (Kader, 2012). There is a belief that progressing learners allows learners to remain in their age-range cohort (Kader, 2012; Munje & Maarman, 2016; Stott *et al*., 2015). There is also the belief among the allies of progression that it does more good than harm for teaching and learning (Kader, 2012; Munje & Maarman, 2016). The belief is also that progression does not necessarily create self-concept problems (Kader, 2012). Progression is viewed as contributing positively to the educational development of all learners (Munje & Maarman, 2016). Progression is regarded as helping to reduce the high failure rates that are socioeconomic in nature, because failure impacts mostly learners from low socioeconomic backgrounds (Kader, 2012). Progression is considered to assist at-risk and deprived learners to acquire more knowledge and give them a chance to catch up and master the necessary basics (Kader, 2012; Munje & Maarman, 2016).

The following are some of the key arguments of opponents of progression. It is believed that progression lowers the general pass rate in all grades (Spaull, 2013; Stott *et al*., 2015). For example, progression is believed to have decreased the pass rate in 2014 by 2.6%, compared to 2013 (Stott *et al.*, 2015). Progression is considered to be detrimental to normal school functioning (Stott *et al*., 2015), and does not offer a cure for other school-related problems that learners encounter (Munje & Maarman, 2016). There are claims that some learners do not put enough effort in their standard of performance because they are lazy and lack discipline (Kader, 2012), and there is criticism that the policy imposes many restrictions on both learners and educators in low-socioeconomic areas (Munje & Maarman, 2016). The policy of progression is criticised because it leads to learners experiencing low motivation, stigma and language challenges (Kader, 2012). Another challenge related to the policy is that there is not sufficient first-hand analysis that helps policymakers to fully comprehend the low level of academic performance at South African schools, or how to implement strategies to improve performance (Carnoy *et al*., 2008).

One of the significant objections to progression is that learners who are progress continue to face challenges (Hartley, 2006; Kader, 2012). Sometimes, these continuing challenges are the result of needed support structures not being in place (Alexander, Entwisle & Dauber, 2003; Kader, 2012; Munje & Maarman, 2016).

People who oppose progression point out that South Africa has very different classroom conditions than developed countries that also practice progression (Stott *et al*., 2015). South Africa lacks strong systems for providing remedial action (Stott *et al*., 2015). Opponents of progression, that is, most educators and the public, suggest that promotion should only be done on the basis of merit (Stott et al., 2015; Alexander *et al*., 2003.

2.2.5.5. Challenges related to the quality of content teaching

The systemic tests and using of ANA is aimed at measuring learners' performance in the subject like home language and mathematics, has positioned pressure on teachers to reflect on their teaching approaches and look for means to ensure that all their learners are being taught effectively (Centre for Excellence in Teaching, 1999:29). One of the reasons South African education still faced with poor quality content deliver is because educators are pointed out to have sufficient time for planning and classroom preparation; some still have challenges with the content they are teaching; hile other struggle s to be effective within their special field and lack classroom management skills (Van de Walle et al., 2010:23; Karp & Bay-Williams, 2010:26).

Mtetwa (2005:255) state that it is the responsibility of individual educators to ensure that quality of teaching and learning is achieved within the Basic education sector.

In terms of teaching, it's critical to recognize that people with varying degrees of mathematical ability talk, use, and comprehend terminology differently, and that teachers frequently employ terms that can only be comprehended by learners who have progressed to the third or fourth Van Hiele level (Wirszup, 1976). As a result, when teachers communicate with lower-level learners, their intentions may be utterly misinterpreted.

The concern of what educators learn from developmental programs in not only research relate issue, but has increasingly becoming a national concern. Over the past three decades, government has invested a lot of money for teacher development programs as well as teachers' qualification advancements opportunities. However, findings from Meyer & Abel, 2015; Murris & Verbeek, 2014 disclose that learners' achievement is entirely dependent on educator's ability to carry out teaching duties effectively in the classroom ensuring that no learner is left behind. This may be because form part of formal learning and teacher have contribution on how learners learn (Verbeek,2014).

South Africa faces the challenge of poor teacher training, which leads to poor teaching by underqualified or unqualified educators (Anderson, Case & Lam, 2001; Clarke, 2007; Carnoy *et al*., 2008.; Hoadley, 2012; Modisaotsile, 2012; Munje & Maarman, 2016; Maddock & Maroun, 2018; Reschovsky, 2006; Spaull, 2013; Yamauchi, 2011). This is an aspect of the education system that was inherited from the apartheid dispensation (Carnoy *et al*., 2008; Spaull, 2013). During apartheid, the system was characterised by racial segregation, an inferior curriculum for Black schools, and separate administration, supervision and funding (Carnoy *et al.*, 2008; Spaull, 2013). Post 1994, during the end of apartheid, over 150 separate teacher colleges were reduced to 50, of those, 27 were merged into the Department of Higher Education (Carnoy *et al*., 2008.). Teacher training in South Africa does not adequately prepare educators to deal optimally with the challenges and obstacles they encounter in their classrooms, nor does it does fully develop their professional capacity to teach effectively (Clarke, 2007; Marais, 2016; Van der Berg *et al*., 2011). In general, therefore, there is a need to develop better institutional support and provide ongoing professional training, in order to help teachers' deal with the challenges they face (Clarke, 2007; Marais, 2016).

2.2.5.6. Problems relating to the literacy of parents

This section of the literature review will focus on the part of close relative in the lives of their children during the development of foundation phase mathematics learning, and assess the impact of parent literacy in positioning positive child development. Parents are valued by the education system and schools as the agents of primary knowledge of their children. Active parenting includes sharing responsibility between families, schools and communities, which facilitates the process of learning during the early childhood development stage (Visser, Juan & Feza, 2015). The partnership of parents and schools is emphasised by legislation such as South African Schools Act (Act 90 of 1996) (Republic of South Africa, 1996).

There are sense of duty and accountabilities that parents are set or are expected to fulfil to ensure active, good quality education for their children. Parents are likely to cooperate and keep up certain values and standards in guiding the child’s positive growth to maturity (Senosi (2004:20). Weigel, Martin and Bennert (2006) affirmed that is the prime task of parents and families to initiate education of their children and, later, to transfer the task to schools, where most learner then continue education in a formal setting and in more advanced ways that they did with their parents and families. Therefore, Senosi (2004:20), Aaronson (1996), Weigel, Martin and Bennert (2006) add by saying that “the education of children is in the first place the task of his parents and secondly that of his educators.”

Weigel, Martin and Bennert (2006) defines education as the assistance given to children so that they can become adults. Gunter (1984, in Senosi, 2004:21) education is the foundation to childhood development, from birth with dependence on the information provided by elders and to old age with complete self-resilience as the ultimate aim. It may sound simple to practice parental involvement in the lives of children while they are still in the early grades, but it requires a lot of time and attention (Senosi, 2004). However, there are contextual factors which may hinder successful parental involvement in children’s education Gender inclusivity

This part of the literature study was informed by one of the main research questions: How does the instruction of multiplicative thinking include learners of all gender diversifying in the classroom? In responding to this question, I investigated the gender inclusion policy of schools, and the impact of gender inclusivity on children’s development. The primary objective of the study is to understand the thinking of learners in the foundation phase as they engage in and learn multiplicative thinking. The secondary objective is concerned with the way teaching and learning of multiplicative thinking while engaging in mathematics accommodates gender differences and similarities while nurturing learning.

Research has found evidence of innate, biological gender differences in mathematical ability. This has fueled debates about understanding gender-sensitive pedagogy and has led to an underrepresentation of women in the majority of fields related to STEM (science, technology, engineering, and mathematics) (Kersey et al., 2019a; Kersey et al., 2019b). There are many facets to the role that gender plays in the teaching of mathematics (Fennema et al, 1998; Maccoby & Jacklin, 1974). Over the period of the last few decades, there have been numerous accounts detailing gender variations in relation to mathematical skill. Despite differences in socioeconomic status and sexual orientation, a number of research studies have pointed to mathematics as a topic that serves as a barrier for students (Walkerdine, 1998; Weaver-Hightower, 2003). A historic gender difference in favor of males in regards to mathematics achievement has been brought to light by a number of studies (Aunola, Leskinen, Lekkanen & Nurmi, 2004; Githua & Mwangi, 2003; Marsh, Martin & Cheng, 2008). According to the findings of other researchers (Lindberg, Hyde, Petersen, and Linn, 2010), the gender gap in mathematics is not statistically significant. Despite this, Robinson and Lubienski (2011) discovered that, over the course of the past forty years, girls have earned somewhat higher grades in mathematics than boys have. These findings are consistent with those of Brown and Kanyongo (2010) and Evans (1998), who observed gender disparity in terms of student-teacher interaction in the various types of play that were fostered, the varying use of praise and gender-specific messages, and the stereotypical messages that were evident in children's literature or play materials. Brown and Kanyongo (2010) and Evans (1998) also found that these gender disparities persisted even after controlling for the different types of play that were fostered.

Cronin (2005), Pinker (2002), and Summers (2005) argue that men and women exhibit somewhat different cognitive profiles when they are presented with complex tasks that can be solved by multiple strategies, but that both sexes demonstrate equal performance on tasks that tap into the core foundations of mathematical thinking. Cronin (2005), Pinker (2002), and Summers (2005) argue that this difference in cognitive profiles is due to the fact that men and women are more likely In addition, the ability to acquire advanced mathematics at the college level is equally distributed across men and women. In spite of the fact that mathematical aptitude is very necessary for learners to make progress in the sciences, it appears that both men and women are capable of understanding scientific concepts.

2.2.5.7. Lack of educational stimulation at home

South African learners encounter an absence of conducive and supportive conditions for education in their homes (Modisaotsile, 2012; Mampane & Bouwer, 2011). Some homes are not conducive because there is little family love and encouragement (Rammala, 2009). In general, an unconducive home environment does not assist a learner who is unmotivated and disorganized in their academic activities (Modisaotsile, 2012). Sometimes gender roles within the home such as being forced to do chores directly and indirectly may influence the ability to do school work (Sayed *et al.*, 2007; Rammala, 2009).

The reviewed literature suggests that some learners experience low self-esteem or stigma because of their home environments; some may experience emotional problems, such as anxiety (Rammala, 2009). Most families are characterised by disrupted family structures and family values (Chisholm & Valley, 1996; Kader, 2012). Some families are not families with a typical structure, but are child-headed families (Sayed *et al.*, 2007; Rammala, 2009). Some children have parents whose attitudes towards education are not positive (Modisaotsile, 2012; Mampane & Bouwer, 2011). Some parents are not well informed about policies (Modisaotsile, 2012; Mampane & Bouwer, 2011). Some parents do not have sufficient literacy skills as they left early (Anderson *et al*., 2001; Hoadley, 2012; Modisaotsile, 2012; Mampane & Bouwer, 2011; Munje & Maarman, 2016; Rammala, 2009; Spaull, 2013; Yamauchi, 2011). In some cases, circumstances beyond the control of the parents, such as having to work long hours (Modisaotsile, 2012), prevent parents of being involved in their children's lives. Some parents are unemployed (Rammala, 2009); some face financial difficulties (Dikgale, 2012). The implication is that some parents are too tired for or uninterested in educational activities (Modisaotsile, 2012).

The term "early childhood development" encompasses the process by which children, between the ages of 0 and 8, progress emotionally, physically, and cognitively. Realizing the right to early childhood development requires the state to adopt a national strategy that is rights-based, multi-sectional, coordinated, integrated, and has adequate resources to ensure universal access to the full complement of prescribed early childhood development services. These services should include early childhood stimulation and education provided at home, through the community, at school, and at site-based locations (Martin, 2012). According to Visser et al. (2015), it is highly vital to establish an environment that is both friendly to learning and productive for learning because this kind of environment will lead to the highest academic accomplishment possible for learners. They go on to say that such an environment is not limited to the confines of a classroom or school, but also encompasses the home, and that "it is from these contexts that learners draw resources and strength for their learning" (both tangible and intangible). During the course of the investigation that Vissel et al. conducted into the various factors that may contribute to the development of multiplicative thinking in early childhood, it was discovered that the environment of the learner, both at school and at home, plays a significant role in the learner's ability to perform mathematical tasks.

From research conducted by Duncan *et al.* (2007), Jordan, Kaplan, Loccuniak and Ramineni (2007) and Storch and Whitehurst (2002), it is evident that the home environment plays an important part in children's early development. These studies report that children with a positive home environment are the most motivated, develop strong academic skills and are these children are the strongest predictors of academic competencies and school success later. According to these researchers, children who start school having lacked stimulation in their home environments are faced with challenges such as inadequate vocabulary (poor language skills), low literacy (letter knowledge), and poor numerical skills (e.g. number knowledge).

2.3. COMPARISON OF DATA AND STATISTICS IN TERMS OF THE FOLLOWING

2.3.1. Gender

This part of the literature review sought to investigate the differences in mathematics performance of male and female students

It is evident from various studies that academic excellence in mathematics is derived from and linked with self-efficiency and gender inclusion (Randhawa *et al.*, 1993). Similarly, students' interest in mathematics is associated with a strong preference for mathematics content, which translates into sustained commitment over time and better performance (Koller *et al*., 2001; Hidi & Renninger, 2006; Lee, 2014; Jansen *et al.*, 2016) in both childhood and adolescence (Lepper *et al*., 2005; Aunola *et al.*, 2006; Denissen *et al.*, 2007; Viljaranta *et al*., 2009).

Various studies have established that women are underrepresented in STEM programmes and that, even in classrooms, male students are given preference in mathematics. It has been perceived that male students have greater capabilities for better results in mathematics than female students and this contributes significantly to the broad attitudes towards mathematics of learners from the early grades, and career choices related to mathematics in post-secondary education (Colbeck, C. L., Cabrera, A. F., & Terenzini, P. T. 2001; Ceci & Williams, 2011; Sadler *et al.*, 2012; Kanny *et al.*, 2014).

2.3.2. Residential area (urban or rural)

This part of the literature review compared the impact of residential area on performance of mathematics, by comparing urban and rural areas. Both urban and rural development are perceived important in the South African education system, hence, it is very important to have a look at both effective policies to ensure its sustainable and social development (Mabena, N., Mokgosi, P. M., & Ramapelana, S. S 2021). Education is the most important aspect in societal development, and school play a major role in ensuring the success of development. For this development to be accomplished students need to be willing to learn, have good skills and have to be proactive with an appropriate mind. In addition, students need to be active in co-curriculum activities.

The learning environment plays a major role in learning, and the area where students live can negatively affect their academic performance. Reasons for variations in achievement include geographic location, resources, availability of technology and the quality of the teachers (Sa'ad, T. U., Adamu, A., & Sadiq, A. M. 2014).

Studies conducted both nationally and internationally have analysed and reported on the mathematical and numeracy skills of students in both rural and urban settings. The SACMEQ II study examined the academic performance of South African learners enrolled in the sixth grade in relation to the location of the school that they attended. The usage of markers such as "city," "small town," and "availability of amenities and facilities" were then utilized in order to classify individuals into the appropriate categories. (Moloi & Strauss, 2005) There were concerningly large gaps in achievement across the board, with students from learners who attended schools in remote locations having the lowest averages (Moloi & Strauss, 2005). In addition, the survey found that a sizeable majority of rural students achieved at levels equivalent to pre-numeracy (11.8 percent) and emergent numeracy (59.6 percent). These levels correspond to the comparable levels of Grade 2 or lower and Grade 3, respectively, according to the CAPS evaluation standards. Learners in urban (city) schools, on the other hand, demonstrated better performance, with slightly more than 17 percent of them performing at level 6, which is the equal of Grade 7 in terms of pragmatic problem-solving (Moloi & Strauss, 2005).

Using data from the Program for International Student Assessment (PISA) in the year 2000, Sa'ad, T. U., Adamu, A., & Sadiq, A. M. 2014; Moloi & Strauss, 2005 conducted an investigation of cross-national differences in the mathematical achievement of 15-year-olds living in rural areas of 24 industrialized nations. In 14 of the 24 countries, the average mathematics score in rural areas was significantly lower than the average mathematics score in urban and medium-sized communities. Nevertheless, the patterns were difficult. The majority of the time, a linear relationship was found to exist between the size of the community and the average mathematical score. However, in several nations, pupils from towns of a medium size had the highest average score, followed by those from urban areas, and finally those from rural areas.

2.3.3. International perspective of ECD

It is evident from the international perspective that competence at all levels starts at early childhood, or early education schooling, and it is more important than ever in dealing with learners in the 21st century. In recent years, especially after a long neglecting of ECD an international system change took place in education, and there was a global standards movement with a shift in policy focus in educational research and measurement of early childhood education (Gruber, 2006).

Mathematics in the early childhood or foundation is now becoming the primary research focus. Gruber (2006) resists that one of the explanation for lower rural performance is due to low socioeconomic status of rural learners. Constant with other studies, the United States of America (USA) disclosed a minimal raw rural achievement gap, which had been wiped out just after the socioeconomic status was controlled. Once socioeconomic status was well managed, rural location anticipated mathematics scores in only 4 of 24 countries. Sparsely populated area was only a statistically significant negative predictor of mathematics achievement in Russia, regardless of socioeconomic position. However, the NAEP revealed a significant discrepancy in the United States (National Assessment of Education Progress). According to Braswell et al. (2001) in The Nation's Report Card: Mathematics 2000, the NAEP performed a national mathematics examination of fourth, eighth, and twelfth grade students in the United States. In participating states and jurisdictions, results from the fourth and eighth grades were also collected. Fourth graders in urban fringe/large town schools performed better than their rural/small town peers. Unlike NAEP, which focused on learner performance in mathematics in an industrialised country, namely the United States, this study was conducted in South Africa and sought to investigate learner performance in a developing country, as well as investigate equity factors as possible predictors of future numeracy performance of rural and urban school learners.

Learners in South African are significantly below their peers in other countries regarding expected levels of literacy (Spaull, 2013; Kader, 2012). Most South African learners cannot cannot read, write and calculate at grade estimated norms for mathematics, reading, and writing (Fleisch, 2008; Kader, 2012; Modisaotsile, 2012; Spaull, 2013) They perform a lot worse (Fleisch, 2008; Kader, 2012; Modisaotsile, 2012; Spaull, 2013). The performance of South African learners in mathematics and science is ranked low and deemed unacceptable (Kader, 2012; Tachie & Chireshe, 2013). Black township schools in particular, face serious challenges with regard to imparting numeracy and literacy skills, because they remain dysfunctional (Spaull, 2013).

Nevertheless, there are exceptions. A small percentage of schools produce good results that provide university entry (Kader, 2012; Naicker *et al.*, 2016; Spaull, 2013). However, the academic performance of well-resourced and under-resourced schools remain uneven, which has created a segregated schooling system (Naicker *et al*., 2016). This segregation and poor quality schooling provided by both primary and secondary schools limits access opportunities to further education and training (Spaull, 2013). This impacts poorer learners disproportionately, who are the main group of learners whose academic performance is poor (Spaull, 2013) – this, in turn traps, them in a cycle of intergenerational poverty (Spaull, 2013).

2.3.4. Mathematics performance in government and private schools

This section of the review of the literature will focus mostly on making a comparison of the mathematical abilities of students who attend either urban (former Model C schools) or rural (government schools). Since the 1970s, the idea that pupils in private schools receive a more beneficial education than those in public schools has been a widely held misconception in the United States (Fisher, 2008; see also the analysis by Berliner, 1993). This notion originated from the fact that learners who attended public schools were more likely to have lower results on standardized tests than those who attended private schools (Nation's Report Card, 2007). This belief is supported further by a number of studies (Anderson & Resnick, 1997; Bryk, Lee & Holland, 1993; Choy, 1997; Kemerer, Martinez, Godwin & Ausbrooks, 1997), from which I drew the conclusion that learners in rural public schools, similar to their urban counterparts, are taught in English and are expected to learn to read using similar books, which makes it difficult for them to understand the content very well. In addition, students in urban public schools This outcome is made even worse by the fact that students attending rural public schools (which were researched for the purpose of this study) are expected to read novels that largely reflect urban content and context. Learners who come from rural areas are less likely to read because they find little value in the content of books that is related to the urban lifestyle, and as a result, they are less likely to read. However, recent research challenges this assumption by providing strong evidence that students in public elementary schools are making greater gains in mathematics assessments than their peers in private schools, particularly in the early grades. This is especially true when comparing students in the same grade level who attend public and private schools (Lubienski, Lubienski & Crane, 2008; Reardon, Cheadle & Robinson, 2009). Researchers are looking at data that has just become accessible to investigate the mathematical performance of students attending public and private schools. Several studies have been conducted to study early grade students' mathematical and English literacy levels, as well as their literacy levels in other academic areas.

2.4. MATHEMATICS PROBLEM SOLVING AND COMPREHENSION

According to Nel & Müller, 2010; Killen,2005;25; Kemerer, Martinez, Godwin & Ausbrooks, 1997, it is very important for every learner must have the ability to read mathematics and develop all the necessary skills in enabling learners to understand and master mathematical concepts like, Multiplication; Addition; numbers and mathematical reasoning. The huge number of learners in South Africa are unable to read, write, or perform mathematical calculations at the level anticipated for their grade, and many of them are functionally illiterate and innumerate. Developing competence at all levels of schooling starts early in learner's lives, and, in the 21st century, it is vital that young learners understand the content of the mathematics they are learning. However, little attention has been paid to early childhood – that is, teaching young children basic mathematics before they enter the formal foundation phase – and learners with low mathematical literacy. This failure, generally, contributes to learners developing negative attitudes towards learning mathematics, and results in low mathematical aptitude or comprehension.

A few research studies education mathematic in the ECD and Multiplicative thinking emphasise the need to transform early childhood mathematics teaching into providing the opportunity for all children to become actively involved in their learning, so that they can acquire mathematics literacy and skills. These studies conclude that learners perform better when they are actively involved in the teaching and learning process. Furthermore, it has been reported that children from disadvantaged backgrounds show lower levels of mathematics achievement than those from middle-class and higher status backgrounds (Ginsburg & Russell, 1981; Hughes, 1986; Jurdan, Huttenlocher & Levine, 1994; Starkey & Klein, 2000; Starkey, Klein & Wakeley, 2004; Clements & Sarama, 2007). It has been emphasised by Starkey and Klein (2000) and Starkey et al. (2004) that mathematical learning in early childhood necessitates children to use numerous unambiguous mathematical reasoning process, known as "big ideas". If learners cannot develop their reasoning process during learning, or find it difficult to deal with concepts that connect multiple concepts, procedures or problems, it means that they have poor mathematical comprehension and lack the required learning aptitude, which may result in poor attainment in the subject area.

This is the case even if South Africa is a country. Learners do not all receive an education of the same caliber from their respective schools. Mbugua et al. (2013) conducted an investigation into schools that have a poor socio-economic status in order to identify what resources are available for them to utilize to teach mathematics, as well as how they use the existing resources in order to teach number concepts and to improve understanding. According to Spaull (2013:4), disadvantaged learners are confronted with an ever-widening knowledge gap between what they should know and what they really know. According to Mbugua et al. (2012: 90), the educational background of learners' parents and guardians can make a major contribution to the learners' success in school and to the reduction of this gap. They came to the conclusion that the majority of students' parents did not have schooling beyond the secondary level. Due to the poor level of education that many parents possess, it can be challenging for them to assist their children with many school-related tasks, including homework, assignments, and projects (Mbugua et al., 2012). As a direct consequence of this, the gap gets wider over time, which causes students to fall further behind in their coursework and makes it more difficult for them to keep up in secondary school.

In spite of the fact that these issues have been discovered, Ndlovu (2011:420) contends that very little is being done to investigate the factors that contribute to the high rates of success attained by students attending top-performing or well-resourced schools. Another potential source of confusion is the method by which the educational system evaluates the effectiveness of a school (Ndlovu, 2011:420). Mbugua et al. (2012:87) carried out research in Kenya's secondary schools with the goal of identifying potential factors that influence students' mathematical abilities and how well they perform. They discovered that the learners' entry marks from primary to secondary school offer no causes for their low performance in mathematics. These marks range from 200 to 400 out of a maximum of 500, and they concluded that these marks reveal nothing about the learners' arithmetic struggles. If the usefulness of a school is evaluated not in terms of the quality of education that is being offered, but rather in terms of the percentage of students who pass tests in mathematics and science, this might lead to further issues (Ndlovu, 2011:420). According to Ndlovu (2011:420), there has been tension brought about by this sort of measuring, and it inhibits students from studying mathematics at more advanced levels.

Mbugua et al. (2012:87) came to the conclusion that the amount of work that mathematics teachers have to do may also have an effect on the quality of instruction. They discovered that some of the instructors utilized what is known as the lecture approach to instruct their students. This is likely due to the fact that the lecture method requires little preparation time and enables instructors to cover a significant amount of material. However, because it does not encourage learners to actively participate in the process of learning, the lecture method is not always beneficial (Mbugua et al., 2012:87).

Mathematics is not just about implementation of sets of activities or following processes that the teacher explains, but rather producing approaches for solving problems, relating those approaches to help resolve problems and checking to see whether if learners' responses make sense. As Van de Walle, Karp, and Bay-Williams (2014), say, "mathematics in the classroom should closely model how mathematics is done and used in the real world".

2.5. SUMMARY

This chapter provided a comprehensive demonstration of the relevant literature to the study topic. It began by providing some context for the study and then moved on to address some of the factors that lead to the underachievement of students in mathematics. In addition to this, it presented a general description of what other scholars have documented regarding the efficient use of resources in the foundation phase of mathematics. These resources include individuals, materials, culture, and time. The chapter looked at how children learn number concepts by using multiplicative thinking, and it discussed how gender awareness is promoted and accommodated during the teaching and learning of mathematics in the foundation phase. The chapter also discussed the use of resources to teach number concepts, and it went into great detail about how these resources improve learners' understanding of number concepts.

The next chapter will concentrate on the approach that was used in the study in greater depth.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. INTRODUCTION

This chapter will explain in-depth the methodology employed by the study, and its design. Give a brief overview of other research methodologies and why they are not suitable for this current study. The study was informed by a qualitative inquiry, because of the ability and strength of qualitative research for gaining understanding. The chapter will outline the research design, paradigm, the selection of the participants – the population and sample – and how data was collected, transcribed, and analysed.

3.2. RESEARCH DESIGN

The research design that was employed is a phenomenological design, because the main focus of the design was on how learners develop multiplicative reasoning in mathematics using the number concept, which makes it more relevant to what the phenomenological design under the qualitative enquiry is aimed at. A phenomenological design examines human experience through the descriptions provided by the people involved. These experiences are called lived experiences. The goal of phenomenological design is to describe the meaning that experiences hold for each subject, and is used for studies about which there is little knowledge (Donalek, 2004). This type of design allowed this study to investigate how learners engage in understanding multiplicative thinking while learning mathematics in a formal school setting.

There are different notions about what the appropriate size of a sample should be for a phenomenological approach. Some sources suggest that here needs to be a least six participants (Sandelowski, 1995; Smith, 1995; Morse, 2000; Dworkin, 2012). This study targeted three schools in the Motheo District in the Free State province. The plan was to work with learners in both township and urban schools, to investigate how multiplicative thinking is promoted at township and suburban schools.

This study falls under a hermeneutic phenomenology or a phenomenological approach (Annells,1996; Ricoeur, 1976). By using a phenomenological approach in this study, the researcher could investigate the personal meaning of experiences of Grade 3 learners (Annells,1996). A phenomenological approach was deemed appropriate because this study explored personal meaning associated with a phenomenon (Annells, 1996). The study explored, in an in-depth manner, multiplicative thinking in early childhood mathematics education in the third grade (Myers, 2013). A phenomenological approach assesses the particular context of a participant or how that participant is situated within their world (Myers, 2013).

3.2.1. Paradigm

The study is given direction through the utilization of a paradigm. According to Patton (1999), a paradigm is a worldview, or a perspective that is typically employed to simplify the complexities of the real world. As a result, an interpretivist theoretical framework serves as the context for our investigation. A framework that has been driven by a set of feelings and views about the universe and how it should be explored and understood is referred to as a paradigm (Guba, 1990).

Denzin and Lincoln (2001) present an exhaustive explanation for each of the following three categories of beliefs, which they model as questions:

The question of ontology seeks to answer what kind of being the human being is. The study of ontology seeks to answer the question, "What is real?"

Concerning the study of epistemology, the question is posed, "What is the relationship between the inquirer and the known?" "The study of epistemology refers to the discipline of philosophy that investigates the nature of knowledge as well as the procedures that are used to obtain and verify information" (Gall; Borg & Gall, 1996).

Methodology seeks to answer the question, "How do we know the world, or how may we enhance our understanding of it?" In its most basic form, this research paradigm is concerned with the singular characteristics of a given circumstance and how those characteristics contribute to the overarching goal of achieving background depth (Myers, 1997).

The researcher made an effort to get himself into the mind-set of the participants in the study so that he could understand how the participants deal with the pressure of having external form and structure imposed on them.

This was done so that the phenomenon that was being studied would not be compromised. The researcher intended to directly involve the learners in the discussion once more in order to reflect their perspectives (Cohen, Manion & Morrison, 2011:17).

Patton (1999) suggests that a normative paradigm is quantitative and works towards precision by focusing on things that can be counted. However, the concern of the researcher was beyond the figures or numbers. This study could have been shaped by a normative paradigm; however, the researcher's concern was beyond the figures or numbers. If the researcher had done so, it would have restricted their ability to interact with the participants and to take into account factors such as human behaviour, which cannot be divorced from the meanings that are ascribed to it by humans. This is in contrast to the meanings that are ascribed to physical objects (Guba & Lincoln, 1994).

3.2.2. Methodology and approaches

Methodology is the logical and theoretical investigation of the procedures that are helpful to the study, or it is the theoretical examination of the collection of methods and principles that are linked with a certain area of expertise. In most cases, it incorporates ideas like paradigm, theoretical model, phases, and quantitative or qualitative methods. (Mertens, 2015; Tashakkori & Teddlie, 2010). (Mertens, 2015; Tashakkori & Teddlie, 2010). Research methodology is described as the principle or modus operandi that navigates the research process (Mertens, 2015). Research design is outlined as a procedure of developing an experimental test to either confirm or refute a claim or hypothesis (Gall, Gall, & Borg, 2007; Mertens, 2015). Subsequently, these hypotheses or claims can be tested against prior studies (Mertens, 2015). The research methodology or research design that is used in a study is determined by the objectives and aims of that study. (Mertens, 2015; Tashakkori & Teddlie, 2010). Practical implications, such as the advantages and disadvantages of methodology approaches need to be thoroughly considered, and include aspects such as budget implications and time implications (Mertens, 2015; Tashakkori & Teddlie, 2010). Before I proceed with the methodology selected for this study, the main three methodologies in research are discussed, and their relevance or irrelevance to this research design highlighted.

3.2.2.1. Quantitative enquiry/method

According to several sources, quantitative research enquiry involves any data that can be measured or calculated in numerical terms (Creswell, 2012; Mertens, 2015; Tashakkori & Teddlie, 2010). It makes an allowance of statistical categorization, coding and synthesis. This can either be in the form of statistics and represented with tables, graphs and graphics (Creswell, 2012; Mertens, 2015). Mertens (2015) argues that there are two major types of quantitative research. The first type assesses or describes a phenomenon involved in a quantitative study. The second type assesses comparisons, corrections or casual relationships. In this study, this research method was not used to avoid considering broader themes and relationships with regard to research, because the quantitative method can be limiting in its pursuit of concrete, statistical relationships.

Quantitative research is a study approach that focuses on quantifying the collecting and analysis of data. This type of research can be broken down into two categories: (Bryman, 2012). It is influenced by empiricist and positivist philosophical schools of thought, and it takes a deductive approach that places an emphasis on putting theories to the test (Bryman, 2012). This method of study is linked with the natural, applied, formal, and social sciences. It encourages the objective, empirical investigation of observable phenomena, with the goal of testing and comprehending the links between phenomena. This is accomplished by the utilization of a wide array of quantitative methods and procedures, which are a direct result of its widespread application as a research strategy across a wide range of academic fields (Babbie, 2010; Muijs, 2004; Given, 2004).

The purpose of quantitative research is to develop and apply new mathematical models, ideas, and hypotheses that are related to observable phenomena. Quantitative research is predicated on the process of amount since it offers the essential connection between empirical observation and the mathematical interpretation of quantitative connections. As a result, the process of quantity is at the heart of quantitative research. Any type of data that is expressed in a numerical format, such as statistics and percentages, is considered to be quantitative (Given, 2008).

The researcher conducts an analysis of the data with the assistance of statistics, and he or she has high hopes that the calculations will lead to a result that is objective and can be applied to a wider population. The purpose of qualitative research, on the other hand, is to conduct in-depth investigations into particular experiences with the aim of describing and investigating meaning through written narratives, visual-based data, or text-based data by developing themes that are unique to a particular group of participants (Glesne, 2011).

In the field of social science, areas such as psychology, economics, demography, sociology, marketing, community health, health and human development, gender studies, and political science make extensive use of quantitative inquiry, whereas anthropology and history make less frequent use of this methodology. Research in the mathematical sciences, such as physics, is also considered "quantitative" according to the meaning of the term, despite the fact that the context in which the term is used is different. The term "observed techniques" is used in the social sciences, and it refers to approaches that have their roots not only in theoretical positivism but also in the history of statistics.

3.2.2.2. Qualitative enquiry

Qualitative research methods create knowledge claims from constructivist perspectives, which entails aspects such as socially and historically constructed meaning and diverse meanings from individual experiences (Creswell, 2013). Qualitative research is useful for developing patterns, developing theories or establishing advocacy towards issues (Creswell, 2013). The use of case studies falls under qualitative research methodologies, as do grounded theory studies, phenomenology, ethnographies and narratives (Creswell, 2013). This study will use the qualitative research method because of its detailed description of participants' feelings, opinions and experiences (Denzin, 1989). It recognised that every individual who was part of this research played an integral role in this study in terms of the outcomes/findings.

In contrast to quantitative research, qualitative studies put more of an emphasis on inductive rather than deductive reasoning. The researcher makes an effort to explain things using the components of the observations that raise questions. In contrast to quantitative research, in which the researcher remains completely detached from the phenomenon that is the subject of the investigation, qualitative research features a strong association between the observer and the data. In qualitative research, there is no starting point of truth or any existing assumptions from which the researcher can begin. This is because qualitative research focuses on the experiences of real people (Leedy & Ormrod, 2001).

This means a researcher's research outcome is not based on their own personal opinion, belief system or assumptions. Qualitative research method mainly focusses on the outcome of investigations, which means the researcher's view about most findings should be outside their emotions and perspectives.

In qualitative research, facts and data that are not quantitative are examined. Qualitative research has a lot to offer when it comes to understanding human behavior from a subjective perspective. It first gathers data and then translates it into meaning so that people can better understand the world around them. By relying on methods such as open interviews, surveys, and observation, this method allows the researcher to arrive at a specific conclusion (Creswell, 2013; Busetto, Wick & Gumbinger, 2020).

Quality research is favoured by social scientists because it allows them to study individuals in terms of their interactions, actions, and behaviour. Sutto & Austin (2015) explain this. By interacting with the source directly, this sort of inquiry reveals the connections between variables.

Researchers such as Busetto *et al.,* 2020, and Creswell (2013) concur that qualitative research requires in-depth probing to provide viable results. In order to gain a better understanding of people's thoughts and feelings, this form of exploratory study is carried out. It takes a closer look at a topic and provides useful information that can be used to inform future discussions and research. Open-ended inquiries are used to gain insight into the target audience's thoughts and actions. The results of this type of study are both descriptive and communicative, which aids researchers in understanding how people think.

Data gained through open-ended questions and analysis of the resulting information and recordings are among the many advantages of qualitative research.

For example, a small-group discussion could have allowed employees to describe their personal resistance, leading to an adjusted strategy. Qualitative research employs a variety of approaches (Sutto & Austin (2015). To put it simply: Qualitative methods can help a researcher discover or uncover the problem, and help them find solutions to it.

This is only one of the many advantages of using this method. It can be used in a variety of ways during study.

3.2.2.3. Mixed methods

Mixed methods research is an emerging research methodology that promotes the systematic integration, or mixing, of qualitative and quantitative data within a single study or long-term research project. The core idea is that combining quantitative and qualitative data gathering and analysis results in a more comprehensive and synergistic use of data. Mixed method research began in the social sciences and has lately grown into the health and medical sciences, covering fields such as nursing, family medicine, social work, mental health, and others, according to Creswell and Plano Clark (2011).

Mixed methods research incorporates components of qualitative and quantitative research procedures (e.g., use of qualitative and quantitative viewpoints, data collecting, analysis, and inference techniques) with the general aims of attaining breadth and depth of understanding and corroboration.

Mixed methods research is the younger sibling of multimethod research, in which either various qualitative or quantitative approaches are integrated.

As a product, a mixed methods design has several major characteristics that should be taken into account during the design process. This study emphasizes the following major design 'dimensions': mixed goal, theoretical drive, time, site of integration, typological use, and degree of complexity. When creating a mixed methods design, several secondary dimensions should also be considered (Burke Johnson & Christensen, 2017).

Mixed methods designs can be grouped into a mixed methods typology or taxonomy based on these dimensions. Various typologies of mixed methods designs have been offered in the literature (for a summary, see Creswell & Plano Clark, 2011:69–72). Clinical interviews and classroom observations were employed in this qualitative investigation. A qualitative study is by its very nature interactive, and this one had to be conducted through interaction with Grade 3 students. For classroom observation reasons, only educators directly involved in teaching Grade 3 at the selected schools were invited (Cohen et al., 2011:224).

In conclusion, qualitative research is based on specific evidence rather than broad study. A case study, for example, can be used in qualitative research to highlight a phenomenon. Rather than collecting statistics, data is collected based on the meanings of participants. Cross-case comparisons are common in qualitative research. It is a versatile multi-method approach that allows for numerous combinations of methodologies such as participant observation, in-depth interview, and artefact collection (McMillan & Schumacher, 1993:374).

The fact that quantitative and qualitative research approaches are not only compatible, but also complimentary, supports requests for more mixed methods research projects to be conducted (Johnson & Onwuegbuzie, 2004; Mingers, & Brocklesby,1997; Sale, Lohfeld & Brazil, 2002; Tashakkori & Teddlie, 2010).

3.3. SAMPLE

The method of sampling that was utilized for the purpose of conducting this research was known as a purposeful sampling, and participation was chosen based on their availability and limited target of participants which will not be disadvantaged in terms of geographical area and distance from and to school. This indicates that not every single person in the population had a shot at getting chosen for the study. The purpose of this form of sampling is to provide results that are typical of the entire population, and as such, it is most commonly utilized in qualitative research. According to Babbie (2010:52), a sample consists of a selection of the general population or a relatively small group of people who are participating in the research. Selecting units that are representative of the phenomenon under investigation is the first step in a standard case sample procedure (McMillan, 2001:378). The researcher wants to get the required information in a trustworthy method, but they don't want to involve the entire community, so they use this technique for sampling. The goal of sampling is to do this. The approach of purposeful sampling that was utilized was based on the presumption that the researcher wants to find, comprehend, and gain insight and, as a result, has to pick a sample from which the most information could be acquired in order to achieve these goals.

The targeted population of the study was learners in Grade 3 at urban and suburban schools. Three classes were observed by means of the classroom observation tool that was developed for the study. The study took place in the Motheo District of the Free State, South Africa.

The participants were 30 male and female learners from three different schools. In trying to achieve a gender balance, 15 female and 15 male learners were selected – 10 learners from each participating school. The number of 30 participants and three educators was considered to be an adequate and moderate sample size that is in line with recommendations for the qualitative enquiry method (Creswell, 2015). The number of participants will differ for different studies, depending on the aims, objectives and purpose of a study.

3.4. INSTRUMENTATION FOR DATA COLLECTION

In this study, data was collected through clinical interviews, classroom observation and a face to face (as follow up unstructured interviews). Learners completed the questionnaires and were engaged through interviews during the data collection process. The classroom observation tools were completed by the researcher during the classroom interactions, during which the instruction of multiplicative thinking in mathematics was observed to determine if it promoted gender inclusivity in the respective classrooms. During the data collection process, no clinical interview questionnaires were discarded because they were incomplete or poorly answered, as the researcher was present during each step of the process.

3.4.1. Pilot study

A preliminary test, or pilot study, was carried out before the main research project was carried out. A pilot study is a smaller-scale replica of a full-scale study, often known as a test run, that is conducted before the full study is carried out. It is possible to use it as a form of preliminary testing for research tools such as questionnaires or interview schedules (Polit, Beck & Hungler, 2001; Van Teijlingen & Hundley, 2001).

The pilot study for this investigation was conducted during the final week of the second term, just before the break for the winter holidays. The researcher conducted the pilot study at two of the approved schools located within Motheo District, which is located in the southern section of Free State. One of the schools was located in an urban area, and the other was located in a suburban area. This was at the period that the researcher was at home (Botshabelo and Bloemfontein), and the two schools were chosen on purpose because of their vicinity to the researcher's residence at the time, as well as their accessibility and convenience (Yin, 2009; 2014).

Due to the fact that the two schools in the pilot project are located in different parts of the same district, it was necessary to conduct the pilot project's procedures in both of the schools in order to compare and contrast the results. In addition, the pilot study was carried out to determine whether or not the questions would be comprehensible to the participants to the extent that they would be able to supply the essential data for the study. The pilot's findings suggested that the majority of the questions were understandable to the participants and did not require any further modification; this was the case at both schools.

In the quest to verify the protocol, the researcher also tested the instrument with the promoter, who is directly involved in and passionate about mathematics learning in the phase of early childhood education and has broader knowledge of that speciality. She has published articles in journals and books on the specific context of early childhood development. The instruments were analysed and discussed thoroughly with the study promoter over about two months and some modifications were made. In analysing the results of the pilot study, the researcher found that questions were clear and needed no modification.

Furthermore, the foreword to the schedule, the estimated duration of the interviews was extended from 30 minutes to an hour. The pilot study also assisted the researcher to hone their questioning technique, and to learn how to understand the non-verbal cues of the participants.

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to hone their questioning technique, and to learn how to understand the non-verbal cues of the participants.

3.4.2. Clinical interviews

According to Kemmis, McTaggart and Nixon (2014) a clinical interview is a tool that helps a researcher to gather accurate from a study. In the case of this study, the researcher asked structured interview questions and conversed with the participants directly. In the process, the researcher assessed verbal and non-verbal communication, including facial expressions and body language, to also assist the researcher to make accurate evaluation of responses while conversing with the participants at the three purposefully selected schools in the Motheo District.

In order for clinical interviews to be used, basis of the decision was on the element to have active participation from participants, Kemmis *et al.* (2014) posit that participatory action research intends to challenge structured power relations, such as those based on social class, race, sexual orientation, gender or religion.

The selection included the primary schools. The researcher delivered a letter from the university authority (the study supervisor) to the school management in person, to request, on behalf of the researcher, the school's participation in an investigation at the school. The letter stated clearly the purpose of the interview and assured the school management that the findings would be treated confidentially and be used solely for study purposes.

The Department of Education gave permission for the research to be undertaken. The school principals, together with parents, did not have a problem with the researcher conducting the investigation. Parents' consent was important, because learners in Grade 3, according to South African law, are regarded as minors and, hence, consent by parents or guardians was needed to allow their children to participate in the study.

After obtaining permission and consent from the various relevant parties, the researcher had to adapt the proposed schedule for clinical interviews, due to Covid-19 regulations and the availability of participants

The researcher requested that learners whose parents had given consent, and who would be comfortable to discuss and answer the questions, be identified for participation. The information needed by the researcher would then be planned by leaving the schedule for management to familiarise themselves with it and make all necessary arrangement well in advanced. On the dates agreed upon, the researcher visited the schools and conducted the interviews in a classroom or office. The researcher brought with him to the interview mathematical tools for learners to play with and become comfortable during the interview, and an audio recorder, to free him to take part actively in the discussions.

The questions were open-ended, to allow participants to further explains, but the schedule was semi-structured, to manage the discussion. As much information as possible was gathered.

3.4.3. Unstructured interview (face to face)

According to Cohen et al. (2007:261–262), research data can be gathered in various ways, another method for that is the unstructured interviews (face to face) as is entail a conversation instigated by the researcher to search for applicable information. In this study, interviews helped the researcher to identify patterns and relationships between the geographic setting of the schools, and learners' mathematics knowledge and thinking. The researcher used the unstructured interviews to follow up to the responses given by participants in the clinical interview and asked both closed and open questions. The unstructured interviews focussed on those aspects of the clinical interviews which were not fully addressed during the data collection in various schools. It was possible to dig deeper into the motivation of participants and their reasons for responding as they did, and probing provided unexpected results.

The face-to-face interviews were scheduled to follow learners' clinical interview's responses. Thus, the arrangements for the interviews were confirmed at the time of the clinical interviews, the interviewer did not take for granted that the participant, who had already been interviewed during the clinical interview, knew what the study was about, so he introduced the purpose of the study again.

The consent forms which were signed by participants' parents or guardians on behalf of learners before proceeding to the actual data collection process, would then be requested by the researcher (Kvale, 2008). The interviews will then continue, with the researcher asking questions and jotting down notes and recording using tape record were applicable as participants provided valuable data. The notes jotted down together with gathered information through interviews assisted the researcher to analysis and clarify questions where the participants provided information that was not obviously relevant to the study. Sometimes, the researcher followed up on prompts or clues provided by participants (Mather et al., 2003).

3.4.4. Classroom observation

The observation tool was developed by the researcher and modified by the supervisor to match the study aims and objectives. The classroom observation tool was used to observe teachers in the classroom during teaching and learning of mathematics, how learners in a particular class engage with others. The researcher was able to identify recurring themes for the study. The tool made it possible for the researcher to measure the impact of training programmes and other interventions on teachers, and to observe challenges with the quality of content taught and, in turn, its effect on student learning, and challenges related to English as LOLT. Furthermore, observation of classroom interaction of schools in urban and suburban areas enabled the researcher to compare and understand data relating to gender, location and mathematical performance in two participating public schools and one participating suburban school. Classroom observation helped the researcher to benchmark the performance of the schools and classroom setting important areas, such as teachers' use of instructional time and educational materials, learner engagement, and use of best-practice teaching techniques. As stipulated by Atkinson (2010), classroom observation can provide school directors and mentors with informative feedback on individual teachers that could be used by educators to improve their teaching skills during the instruction of mathematics lessons and help the educators understand the learners different thinking level while learning mathematics. Frey (2018) add that classroom observation is an essential element of a comprehensive evaluation of the performance of individual teachers. To generate useful data, classroom observations must use a standardised method and be carried out by trained observers (Frey, 2018).

The observations of this study were conducted for one classroom in each participating school in Botshabelo. The researcher received consent from the class educator to observe the lesson, explained that the data gathered would be used for research purposes only, and that confidentiality was a priority for as far as research permission and ethical clearance was concerned.

According to Frey (2018) every method that can be used in research has its own strengths and weaknesses. Classroom observation, as used in this study, is one of the instruments or tools that can be used to observe the extent to which Grade 3 learners understand multiplicative arrays, the concept of equal groups, and the language of factors and multiples; how do learners use multiplicative arrays to articulate their understanding of the multiplicative situation, and related ideas, such as the inverse relationship and the commutative property. It can also be used to determine whether instruction of multiplicative thinking includes learners of all genders.

By providing detailed varied information based on the context of different schools, the sample served the data collection purpose well. The context provided by Botshabelo schools supplied a different dimension of data from the schools in Bloemfontein. To be precise, two government schools in Botshabelo were visited where the clinical interviews for learners, classroom observation and follow-up interviews were conducted. The clinical interview in this particular context consisted of 20 learners. Furthermore, classroom observations were conducted for two educators at two different schools. In Bloemfontein, a private school in an urban area was visited. In the same manner, a clinical interview, classroom observation and follow-up interviews were undertaken with ten learners, to get the overall picture of their thinking while engaging in mathematics from private school. Furthermore, classroom observation focussed on gender sensitivity while learners were being taught mathematics

3.5. ETHICAL CONSIDERATIONS

The first step taken by the researcher in ensuring that ethics for the study is considered and adhered to was to, apply for an ethical clearance certificate from the faculty of Humanities Research Committee in the Central university of Technology. This clearance allowed the researcher to approach the provincial Department of Education to obtain permission to visit schools to do research. The researcher also reached various schools principals to get their consent to conduct the study.

The Department of Education also furnished the researcher with a letter indicating to the principals that the researcher had been cleared to conduct research at their respective schools.

The following are some of the permission and consent documentation generated for the study.

a) Ethical clearance certificate was issued by the Central University of Technology Research ethics committee,
b) A letter requesting permission to undertake the study was submitted to the district director in the Free State DBE.
c) Written permission was sought from school management of the schools of the participants.
d) An information letter explained the research to the learners and addressed ethical considerations were sent to the learners.
e) A letter was also sent to the parents of participants below the age of consent, to inform them of the study and their children's possible participation.
f) The letter contained the researcher's contact details if parents had questions about their children's participation in the study.
g) The researcher distributed copies of a questionnaire to Grade 3 teachers, who volunteered to administer it.
h) Permission was requested from the Department of Education research office for the researcher to gather data at the approved schools.

The following sections will discuss non-negotiable ethical procedures that were adhered to during the study.

3.5.1. Informed consent

Participants need to provide informed consent to participate as the study (Bradburn, Sudman & Wansink, 2004; Creswell, 2012; Denzin & Lincoln, 2018**;** Mertens, 2015).

3.5.2. Anonymity, privacy and confidentiality

It is important to ensure that participants and their data are treated with anonymity, privacy and confidentiality (Mertens, 2015). No identifying information should be made available to any third party at any stage of the research (Mertens, 2015).

3.5.3. Avoiding psychological or physical harm

The participants need to be assured that there will be minimal risk to them when they choose to take part in the study (Bradburn *et al.*, 2004; Denzin & Lincoln, 2018). The human rights of the participants should not be contravened (Bradburn *et al*., 2004; Denzin & Lincoln, 2018).

3.5.4. Avoiding deception

No participant should be misled about the purpose of the study or any information related to it (Bradburn *et al.*, 2004; Denzin & Lincoln, 2018). Misleading participants to persuade them to participate is unethical.

3.5.5. Protection of data

The data of the research should not be compromised in any way. Therefore, it should be stored safely during and after the process of the research (Bradburn *et al.,* 2004).

3.5.6. The right to access the final research report

Each participant and stakeholders have the right to access the final report, as a courtesy for being part of the study and to clarify any enquiries or questions they may have (Bradburn *et al.*, 2004; Denzin & Lincoln, 2018).

3.6. DATA REDUCTION AND ANALYSIS

Once the fieldwork was complete, and transcriptions had been done of the verbal data, thematic analysis was used to analyse the data. The stage of the analysis involved assessing all the transcripts and grouping the patterns and trends of data into themes. Then, data were grouped into segments or categorized (Creswell, 2013; Denzin & Lincoln, 2018).

Often, there is a high possibility of multiple interpretations of qualitative data are possible (Gibbs 2007: 3, quoted in Cohen et al., 2011:537). Incorporating data collection with data analysis in an interactive, back-and-forth process is often how qualitative data analysis is distinguished. Research instruments such as interviews and classroom observations presented rich data.

3.6.1. Trustworthiness

Researchers must be sensitive about bias in data collection that results from any demographic differences between themselves and the sample with regard to gender, race or ethnicity, culture sexual orientation, religion, disability or socioeconomic status (Mertens, 2015).

To ensure trustworthiness, the researcher ensured that questions asked during the interviews were related to issues relating to multiplicative thinking, multiplicative arrays, the concept of equal groups, and the language of factors and multiples, and teaching and learning in early childhood development. Intensive interviews were used for the study. The researcher asked participants the same questions, and a classroom observation tool was used to assess connections between learners and educators during the teaching and learning of mathematics.

There was an assurance given to the that the anonymity of their responses would be sustained. This assurance expectation was that responses then showed a deep and broad understanding of the topic under discussion by providing participants with detailed descriptions of data shown in chapter 4. This would make it easier for the readers to acquire an understanding of the data responses and attempt to replicate the findings (McMillan & Schumacher, 1993), which increases the chance of the transferability of the findings of this study. The use classroom observation, face-to-face (follow-up) interviews and clinical interviews assisted with the triangulation and corroboration of data. Denzin (1978) and Patton (1999) contend that exhausting diverse data collection methods help to warrant the uniformity of findings and to reveal opposite aspects of the same sensation through triangulation. Triangulation also increases the integrity (trustworthiness) and validity of research findings. By combining theories, methods or observations in a research study, fundamental biases arising from the use of a single method or a single observer are overcome. Using several measures, along with the availability of audio recordings and all original interview transcripts and field notes, increased the trustworthiness of the study. Audio recording is one of the most accurate ways of recording data and proves that data was not fabricated or manipulated.

3.7. LIMITATIONS OF THE STUDY

Some interviews were conducted after school hours, which made it difficult for some learners to participate. It also meant the researcher had to return to the school to compete the clinical interviews. Due to the timing of interviews after school, participants were sometimes tired and looking forward to going home. The researcher had to apply patience to elicit accurate and honest answers from the participants despite their lack of enthusiasm. COVID-19 restrictions required the researcher and participants to adhere to strict social distancing, which prolonged some interviews.

The study findings cannot be generalised, due to different contexts, demographics and other nuances at a provincial or national levels. The inferences that are made may be similar or differ from its outcomes. Generalisability is limited, as it is difficult to generalise research findings in the absence of random sampling (Brink & Wood, 1998).

3.8. DELIMITATIONS OR BENEFITS OF THE STUDY

The research is original and sought to address gaps in Grade 3 mathematics learning and the direct implications of multiplicative thinking and reasoning in a formal learning setting.

The researcher was directly involved during the teaching and learning process for observation purposes. The research gave the researcher the opportunity to explore every aspect of the study, which enabled him to gain insight into the learners' behaviour, social beliefs and perspectives.

Through interaction with learners, the researcher obtained in-depth knowledge of different learners' views on mathematics, and other aspects of learning.

3.9. MOTIVATION FOR THE STUDY

The researcher is a passionate educator who works hard to develop foundation phase learner understanding and conceptualisation of mathematics knowledge in the community. As a result, the major motivation for this study was the researcher's need to make a positive contribution to the body of knowledge relating to early childhood mathematics education, and the education profession as a whole.

The driving factor behind the study was a realisation of the challenge learners encounter when they try to understand conceptualisation of mathematics, which goes beyond understanding methods and steps. The researcher's passion for the study was accelerated by years of experience of working with learners, and realising there may be a common factor that influences understanding and conceptualisation of mathematics.

This study attempted to not only change the attitudes of learners towards mathematics, but also to make the task of mathematics educators easier. This could be possible if learners understanding the problem and have the correct tools to improve their understanding and conceptualisation of mathematics.

3.10. CONCLUSION

This chapter included evidence on the processes that were carried out during the research. These processes included the data gathering process, the instrumentation, and the manner in which the data was analysed. Under the categories of mythologies and paradigms, explanations were provided for the specific selections made, including references to the most prominent theories and, in some instances, the individuals who originated those theories. The data that was acquired and analysed will be discussed in detail in the following chapter (Chapter 4).

CHAPTER 4: FINDINGS

INTRODUCTION

The previous chapter outlined the methodology of the study. The purpose of this study was to investigate on how Grade 3 learners engage with multiplicative thinking. As indicated in the previous chapter thematic analysis is employed to respond to the following questions:

- Question 1: To what extent do Grade 3 learners understand multiplicative arrays, the concept of equal groups, and the language of factors and multiples?
- Question 2: How do learners use multiplicative arrays to articulate their understanding of the multiplicative situation and related ideas, such as the inverse relationship and the commutative property?
- Question 3: How does instruction of multiplicative thinking include learners of all gender diversity in the classroom?

Prior to the thematic report, biographical data that was collected during the study is presented to provide some background information on participant's equity status and age.

Table 4.1: Biographical data of research participants

School	**Number of participants**	**Gender**	**Age**
School A	10	5 Male	8 Years
		5 Female	8 Years
School B	10	5 Male	9 Years
		5 Female	9 Years
School C	10	5 Male	9 Years
		5 Female	9 Years

Table 4.1 clearly indicate that Grade 3 learners are between 8 and 9 years of age across both genders. This indicates that learners begin formal schooling at the age of 6 and 7. Therefore, below is thematic report is divided according to the research questions to make sure that the researcher delivers on the objectives of the study.

4.2 THEMATIC REPORT

4.2.1 Research question 1

To what extent do Grade 3 learners understand multiplicative arrays, the concept of equal groups, and the language of factors and multiples?

This question aimed to inquire into the extent to which learners understand mathematics, specifically the basic mathematics skills of counting, the use of multiplicative arrays, their understanding of multiples, and the role of language. It was also aimed at finding out how learners in Grade 3 are being prepared for future mathematics classes through the use of number concepts. The following themes respond to the above question:

4.2.1.1. Theme 1: Basic numeracy development

Learners in Grade 3 demonstrated difficulties remembering the basic mathematics skills they had learnt in previous grades, they struggled to work fluently with numbers and basic mathematics problems. In this study, learners' responses from the follow up interviews and the clinical interviews confirm what the researcher found during the classroom observation.

Learners' lack of basic number fluency leads to poor mathematics results. Observations found that there is a need to address learners' number knowledge, and to equip them with skip counting skills, to enable them to work effectively with number bonds and to complete tasks as required by applying relevant numeracy skills. This will enable them to analyse and interpret mathematics problems accordingly. Figure 4.1 shows learners lack of mathematical number fluency

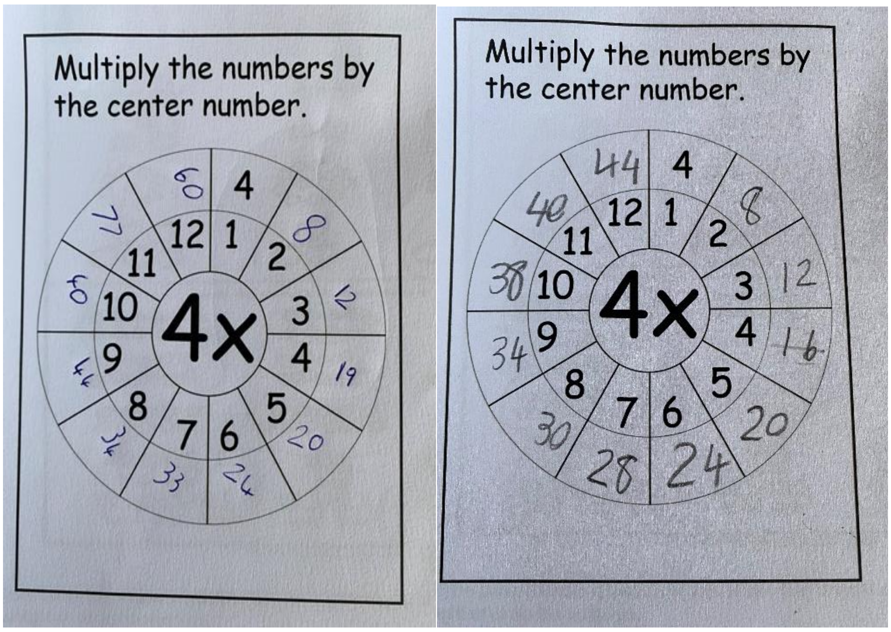


Figure 4.1: Learners lack of mathematical number fluency

Because learners lacked skip counting skills, they used counters and counted in ones to the mathematics problems. The majority of learners depended on manipulative to complete the tasks an indication that their numeracy mental capabilities are not developed. The participants used a one-to-one correspondence approach using objects for them to be able toc complete the multiplication activity. Their multiplicative thinking was not yet developed.

4.2.1.2. Theme 2: Language and manipulatives in mediation

Majority of participants demonstrated poor language comprehension, which caused challenges in developing the needed mathematical language; those Sesotho speaking learners who are expected to learn in English lacked an understanding of English as their LOLT. Furthermore,

Learners highlighted that learning aids are essential, and supported their problem-solving processes. This means that using manipulatives adds value in promoting learning however, developmental levels hypothesised by researchers like Clements and Sarama (2009) should be visited and the work of Venkat and Askew () in mediating growth in the number bonds, skip counting, cardinality and other numeracy skills. Below learners express how they are supported by this manipulatives and pictures.

Learner 3: The counters helped me to count and get answers. (Learners 1; 5; 8 and 15 reported having the same experience.)

Learner 4: When receiving the paper, I looked at pictures and their colours, recognised the things I am familiar with from home. (This matches responses from learners 2; 6; 7; 11; 22; 28 and 30.)

Learner 9: I love looking pictures because they have different colours. While learner 10 added in their response by indicating that "colours make it easy to work with". (This response matches that of learners; 12–14;16-21.)

This finding is supported by research conducted by Piaget (1974), which found that learners learn effectively through things they can see or touch. When resources are scarce it is difficult for learners to work practically, and leads to challenges in relation to their comprehension. They struggle to acquire the intended skills and it becomes very challenging for educators in the foundation phase to instil in learners what is expected of them. Resources range from skilled human resources, playing fields, furniture and other learning materials.

Language challenges in mathematics teaching and learning resonate with both learners and teachers. Below a snapshot of how learners reflect on their incomplete tasks indicate such:

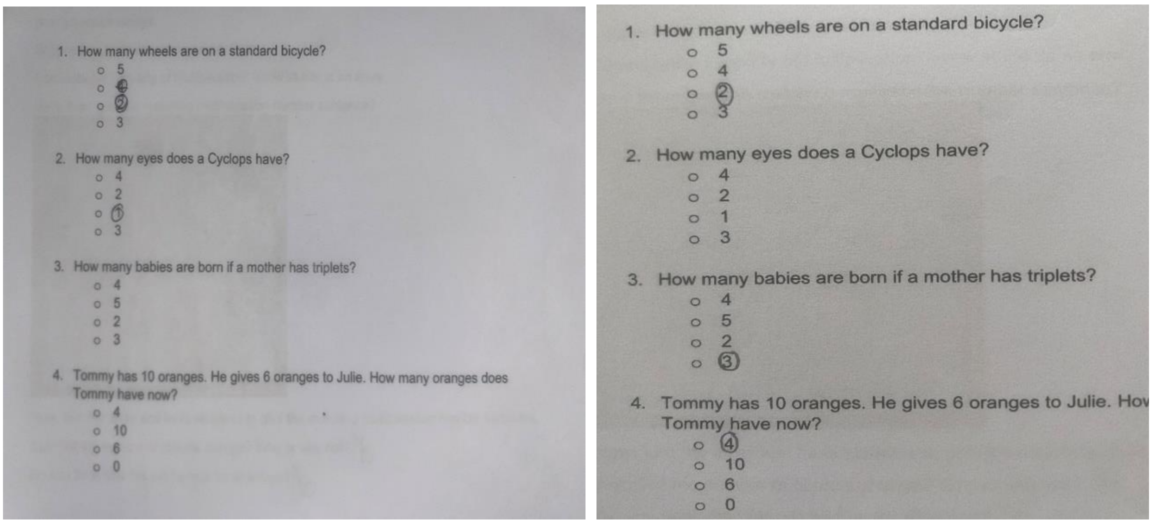
Learner 1: I am unable to finish the set activities due to my teacher not giving clear instruction and focus more on learners in the front raw while teaching and explaining. (Twenty other learners gave a similar reason.)

Learner 13: I am unable complete given task during teaching and learning due to limited time and some learners who are always talking and making noise this affect me in performing to my level best as I tend to lose focus.

4.2.1.3. Theme 3: Covid-19 complexities in learning

Furthermore, learners agreed that they were not coping with the demands of learning the mathematics content, in their response they indicated that this challenges are due to changes caused by the global COVID-19 pandemic, which had reduced the time allocated for teaching and learning, due to schools being closed. Learners also mentioned being divided into two groups to be able to adhere to the strict social distancing rules and time table adjustments to accommodates the first and second session.

Figure 4.2 shows an example of incomplete work.


1. How many wheels are on a standard bicycle?
   - 5
   - 4
   - 2
   - 3
2. How many eyes does a Cyclops have?
   - 4
   - 2
   - 1
   - 3
3. How many babies are born if a mother has triplets?
   - 4
   - 5
   - 2
   - 3
4. Tommy has 10 oranges. He gives 6 oranges to Julie. How many oranges does Tommy have now?
   - 4
   - 10
   - 6
   - 0

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   Tommy have now?
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   - 10
   - 6
   - 0

Figure 4.2 Incomplete work due to curtailed teaching time

Classroom observation during a task-based question showed that the majority of learners could not finish the task on time, and most took longer than expected. This is an indication that learners were struggling to conceptualise questions and work effectively. Moreover, they were slow when responding to activities, and some were afraid to ask for clarity where they needed it – when this happened, learners tended to guess the answers.

An example of a learner's response is the following

> *Learner 1: I am struggling to finish the task because I am slow and struggle to remember formulas.*
>
> *Learner 3: I did not finish the activity because I still struggle with calculations, and multiplication.*
>
> *Learner 5: I did not complete the task, because mathematics is difficult for me I have no one to assist me with even when I am at home.*
>
> *Learner 11: "Nna hake utlwisisi dipalo hantle, ke sebetsa butle ke dula ke hloka thuso"*

The above learner's responses matched with other learner responses from learner (2; 8; 10; 15; 17; 18; 23; 25–28 & 30) who also gave similar response as the above mentioned.

4.2.1.4. Theme 4: Classroom management

Classroom facilitation observed had its own shortcomings and learners confirmed it. Learners reported that educators at suburban have their full attention and focus to a specific group of learners, while other learners in the same class are neglected and left unattended. The group of neglected learners struggle to grasp certain skills of mathematics and are unable to continue with the set tasks.

> *I observed that, during teaching and learning, Educator A called on certain learners to give examples, as a reference to check whether learners were following. She spent most of her time engaging with a minority group, mostly girls and a few boys, while neglecting the majority of learners.*
>
> *In the case of Educator B, the most engaged learners sat in the front row. I observed that she looked at the books of a few of these learners to control their work. She explained to me that "these learners are smart and make it easier for me to work with them and their books are neat and easy to control".*
>
> *Educator C worked to ensure that no learner was left behind, by reaching out to all the learners in the classroom through the use of diverse examples and by providing further clarity that accommodated different kinds of learners and their different learning styles. I noticed that Educator C had the ability to take charge of the classroom. This teacher engaged all the learners and moved around to facilitate teaching and learning and posed questions to all the learners during the lesson.*

The above themes clearly indicate that learners and teachers are challenged by language in mathematics teaching and learning. Learners in Grade 3 struggle to understand teacher instructions which lead to them being unable to complete nor understand some number concepts. Secondly, learners are operating at low levels of numerosity with lack of foundational number knowledge such as skip counting, and number bonds. Therefore, they are at one-to-one correspondence level where they use object counting instead of grouping objects or using arrays for multiplication. At this level the concept of equal groups is too advance for them.

4.2.2. Research question 2

How do learners use multiplicative arrays to articulate their understanding of the multiplicative situation and related ideas, such as the inverse relationship and the commutative property?

The aim of the above question is to assess how participants made links between multiplicative arrays and calculations. The question was set to afford the researcher a chance to determine whether learners possessed the expected mathematical knowledge for their level, with specific reference to participants' abilities to select and use appropriate referents of (10, 25, 100), to apply relevant multiplication rules, and use multiplicative structures to solve mathematics problems appropriately. The questions also investigated participants' ability to communicate their responses effectively and making a link between the inverse relationship and commutative property of multiplication.

The following thematic report gives account to the analysed data

Learners were asked by the researcher if they understood the multiplication rule and they all responded by saying "Yes". However, when requested to match number sentences with arrays as in Figure below responses did not align well with their positive response as presented by the themes.

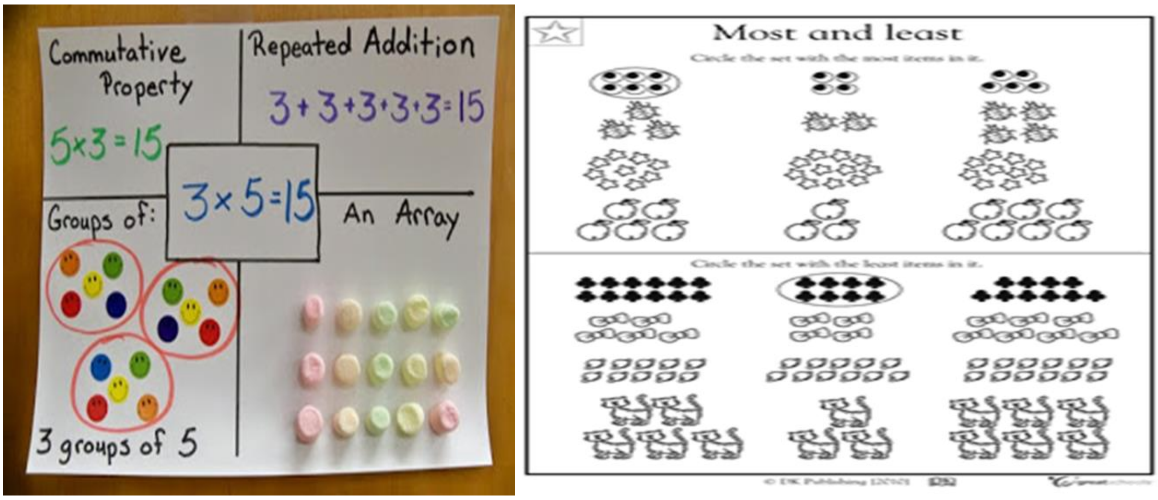

Figure 4.3: Examples of arrays given to learners

Learners' responses to this set of questions differed.

4.2.2.1 Theme 5: Foundational conceptual understanding

The findings indicated that learners in Grade 3 lacked conceptual understanding of multiplication and number knowledge, though there was evidence of counting in ones. Based on interviews with the participants and the classroom observations, I concluded that learners do not have the basic number knowledge needed for skip counting, as they could not see that there were three groups of numbers. They could not recognise small numbers, subtilizing, composing and decomposing. All these mentioned skills and knowledge are developed early in the learning of numbers prior formal schooling.

The findings indicate that 57% of the learners participating in the study – the majority of the sample – struggled with recognising equal groups of objects. Some of the participants were still struggling to count in threes, twos and fives they continue to count in one. This was revealed by learners' responses when they engaged with the task-based interviews, in which 17 participants really struggled to use advance counting methods. This indicates that they still did not understand the difference between addition, subtraction, multiplication and division. The findings also reveal that some participants could not count from one to fifty.

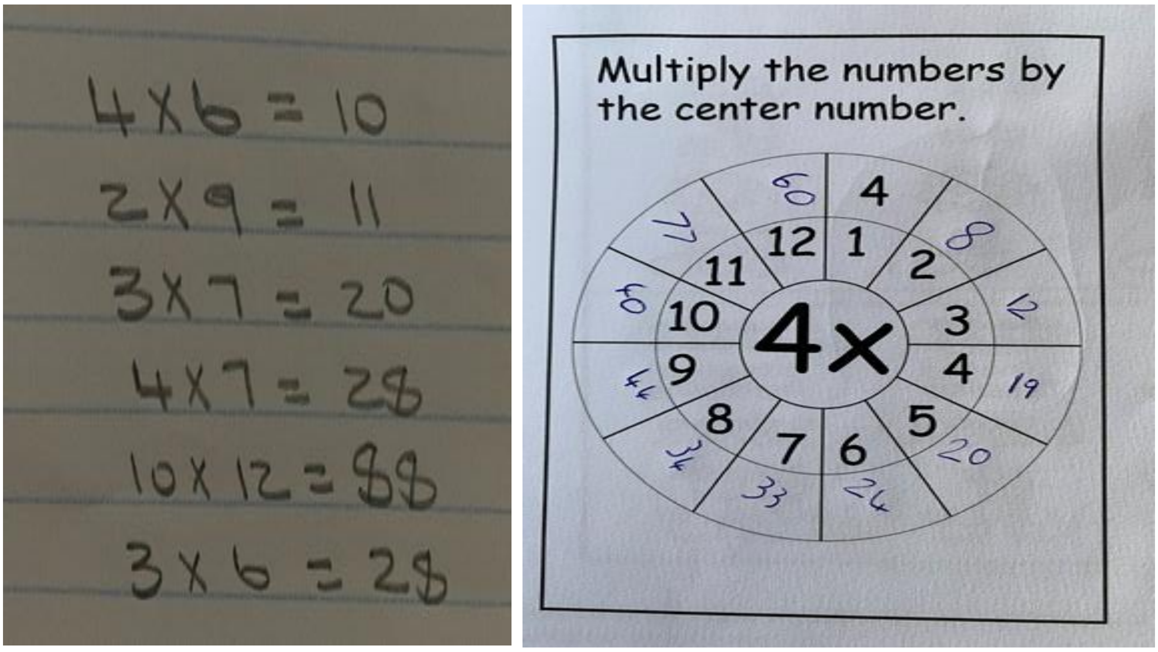

Figure 4.4: Disconnections of number relationship (from additive to multiplication)

From these learners' responses it is evident that the majority of participating learners in Grade 3 still struggled to use multiple arrays to build number facts in a meaningful way. This finding indicates that the majority of learners were not yet fluent in working with numbers, and lacked the ability to think flexibly, accurately and efficiently while working with numbers. The participants' responses and the classroom observation exposed that some participants lacked understanding of the relationships between numbers and could not manipulate numbers; furthermore, they were unable to apply various strategies to solve mathematics problems.

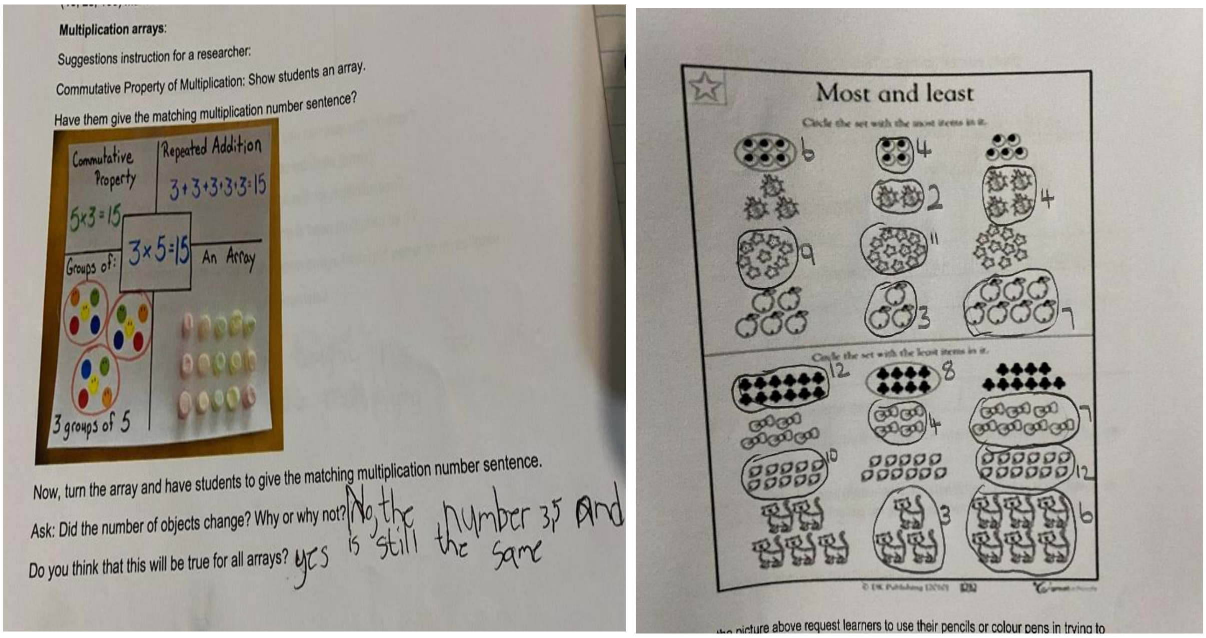

Figure 4.5: Disconnection of commutative property of multiplication

The analysis of the learners' responses indicates that all participating learners possessed mathematical knowledge, specifically, they have mastered the skills of working with numbers, but not all of them have in-depth understanding of the commutative property of multiplication. This was shown by learners' responses in the clinical interviews, observed in the classroom observations and exhibited in the face-to-face interaction the researcher had with individual learners during data collection.

The findings reveal that not all learners in Grade 3 are able to analyse and communicate clearly aspects of mathematics. Hence, the concept of multiplicative thinking is the main research topic of the study. Findings also imply that some learners in all the foundation phase grades (Grades 1–3) lack numeracy skills appropriate for their level, as evidenced by Grade 3 learners' lack of preparedness. These shortcomings may relate to the progression and mark-adjustment policy, with specific reference to mathematics and languages.

The findings indicate that 65% – the majority of the participating learners – still struggle to connect each property and calculation method reflected in mathematics through using relevant explanations and justifications. This finding was drawn from the clinical interview responses and confirmed by the classroom observations. The majority of learners in Grade 3 lacked background knowledge of the basic number properties, hence, they showed little understanding of commutative property when dealing with multiplication during the clinical interviews and the teaching and learning of number systems in class. During face-to-face follow-up interviews, some participants indicated that they were unfamiliar with each of the properties, hence they struggled to remember the questions and could not use relevant calculation methods.

> *Learner 1: In my last year my teacher focused a lot on counting and we couldn't get the opportunity to learn all mathematics content which was supposed to be covered in the second grade due to the spread of COVID-19 pandemic. (Similar responses were given by nine other participants.)*

> *Learner 5: My teacher in Grade 2 always gave us workbooks to do at home, then use the maths period to teach us about shapes and gives counters to work out answers without explaining further on what is expected from us.*

The findings indicate that the participants lack understanding and could not demonstrate recognising mathematics number system, relationships and functions. The findings indicate that few learners in the study passed mathematics with proper competence hence most of the learners participated in the study faced challenges in remember basic mathematics skills which they have passed from previous grades, which later affects the mathematics performance of learners in the following grades.

In the clinical interview question about multiplication and reasoning, which asked participants if the number of the objects changes when the arrays are facing down, 11 participants responded No (36.67% of total participants), which means that they agreed with the statement that the number of the object does not change. Their reasons were that number 3 and 5 still did not change, even when the array faced down. They also responded with "No" to the last question, Do you think that this will be true for all arrays?, which implies that they, furthermore, did not agree that this will remain the same for all the arrays. An example of their responses is represented in Figure 4.6.

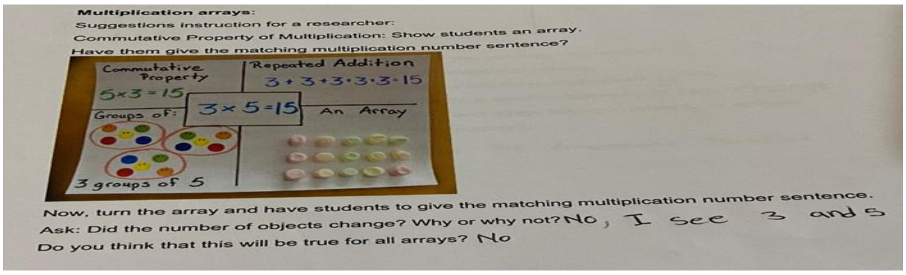

Figure 4.6: Mixed group of multiplication arrays (A)

Though seven learners who participated in the study replied “No” to the first question, their responses match that of the 11 participants reported on above, which implies that they believe the number of the object does not change. Their reasons are similar to that of other learners participated in the study represented above, though their response to the last question differs, as they responded “Yes”, which implies that they agreed with that it will be true for all the arrays. An example of this response is represented in Figure 4.7.

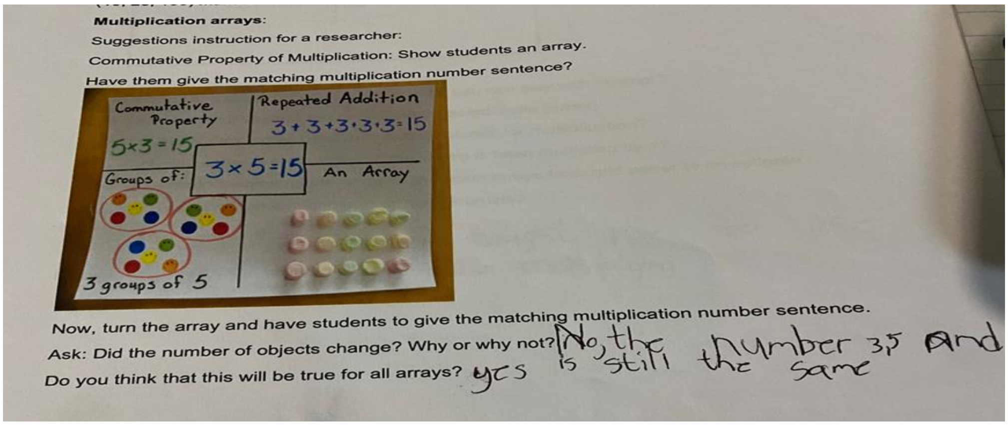

Figure 4.7: Mixed group of multiplication arrays (B)

Eight participants responded with “Yes” to the first question, which implies that the number of the object changes when the array faces down; a similar reason was given, that the numbers are no longer clear. They replied “Yes” to the last question, by which they agree that it will be the same for all the arrays. An example of this response is given in Figure 4.8.

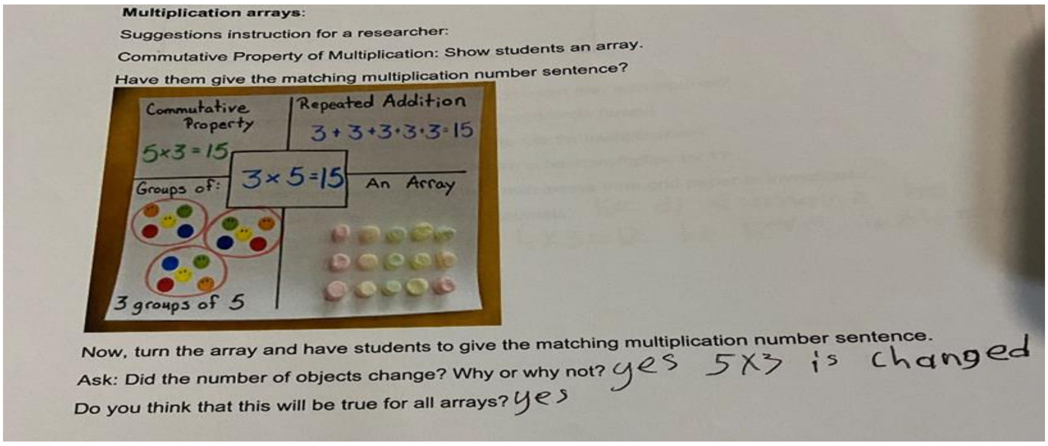

Figure 4.8: Matching multiplication number groups (A)

Four learners responded “Yes” to the first question, which is similar to that of the eight participant reported on above, and gave the same reasons, but they gave a different response to the last question. They responded “No”, which implies that they disagree that this will stay true for all the arrays. Their last response matches that of the 11 participants’ response to the last question. An example of their response is presented in Figure 4.9.

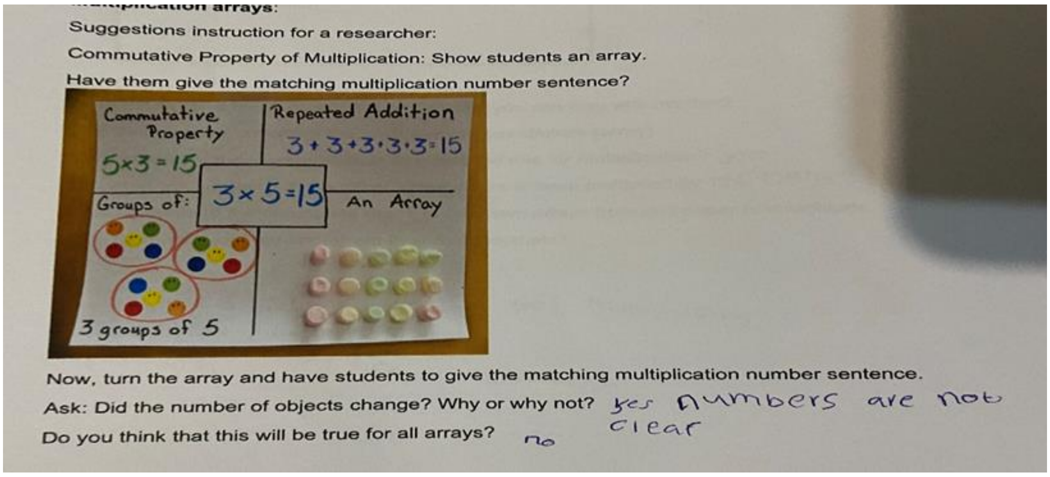

Figure 4.9: Matching multiplication number groups (B)

4.2.2.2. Theme 6: Procedural multiplication knowledge

The findings of the study reveal that learners know the rule of multiplication, but do not know what it means. These learners showed that they knew the four times multiplication table, which gave the impression that they can work with various tables from one to five, at least, but they struggled to apply knowledge of multiplication when they worked with arrays. This shows that their knowledge of multiplication is not conceptual, but it is procedural, according to what they were taught in their respective classrooms. The finding and its analysis show that there is no evidence of problem-solving skills in the participants' classrooms. Teaching is still procedural in the foundation phase classroom; hence, it is a challenge for learners in these grades to link the knowledge they have acquired in class with real-life situations.

This finding means that there is a majority of learners in Grade 3 who still struggle with understanding the concept of multiplication, and who are not able to apply the multiplication rule to solve mathematics problems using the equal groups, numbers and effective mathematical reasoning. The finding was drawn from participants' responses and classroom observations, which indicated that the majority of learners lack the ability to understand numbers as composite units. Furthermore, they lack the ability to recognise and work effectively with the number systems, and have little understanding of the relationship between quantities, which requires critical thinking in mathematics.

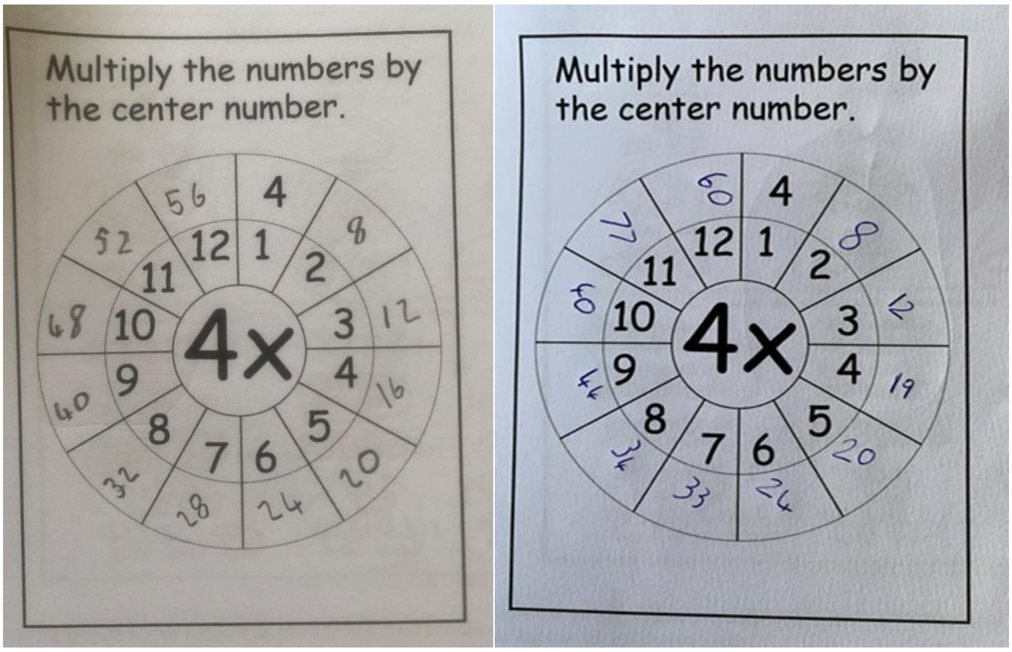

Figure 4.10: Procedural multiplication knowledge

The implications of these findings are that participants in early childhood education learn best with things that they are able to see and touch. These findings indicate that participants with few resources have little understanding of mathematical process, and this affects their thinking level. The participants could not work flexibly with a wide range of numbers, which included very large and small numbers, decimals, fractions and multiplication arrays. In the classroom observation I noticed that conceptual understanding of multiplicative situation was seldom demonstrated, as indicated by the following the responses by participants.

The participants were given a chance to complete the multiplication problem relating to working with numbers and were expected to find correct answers using the number at the centre to multiply by various numbers ranged from 1 to 12. All the participants were able to complete this part of the task, and their responses were grouped to check for correct answers. I found that 23 participants were able to work out all the correct answers; they also indicated that the number at the centre will remain the same if is multiplied by 1. An example of their responses is represented in Figure 4.11.

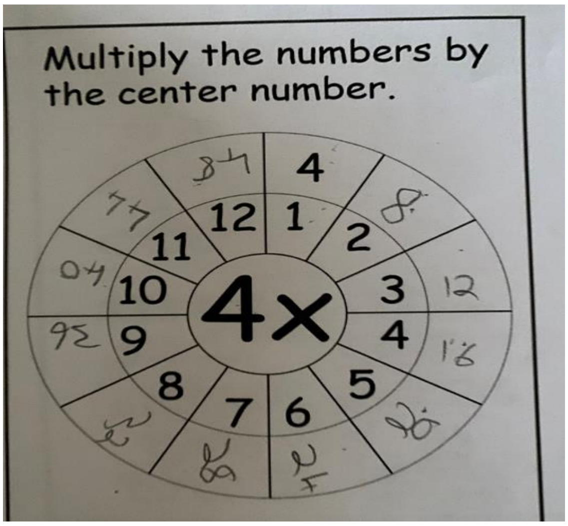

Figure 4.11: Mastery level of multiplication knowledge

Seven participants were not able to provide the correct answers for the multiplication, even though they had said they can guess the multiplication rule. In their responses they had indicated that the number at the centre would change if is multiplied by 1. Even though these learners participated in the study showed willingness to learn mathematics and attempted to solve multiplication problems, their responses to the multiplication rule were considered to be a moderate achievement level which indicate that they still need more teaching and learning for them to be able to master the connection of numbers while working with multiplications. An example of their responses is presented in Figure 4.12.

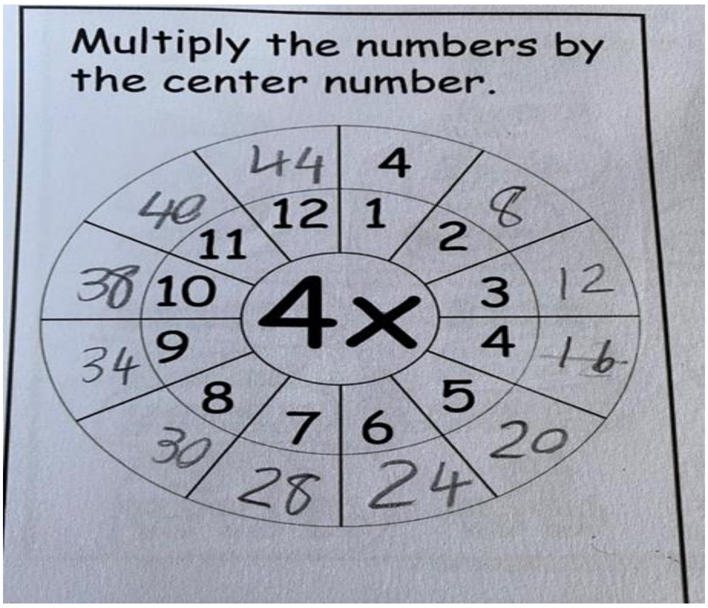

Figure 4.12: Disconnection of multiplication by numbers

The last part of Section B required participants to highlight or circle the lowest and greatest quantities (least and most) in a row using either a pen, pencil or colour pen. This was a way to assess whether they understood numbers, and their ability to use those numbers to solve mathematics problems. All 30 participants managed to complete the section, even though not all were able to count and provide the responses expected. Figure 4.13 gives examples of responses.

The page on the left in Figure 4.13 represents the response of 46% of the participants – a minority – and the page on the right represents the response of 54% of participants – a majority. This highlights that learners have an idea of what is expected of them, since they all know the procedures, though they still have misconceptions about multiplication and numbers.

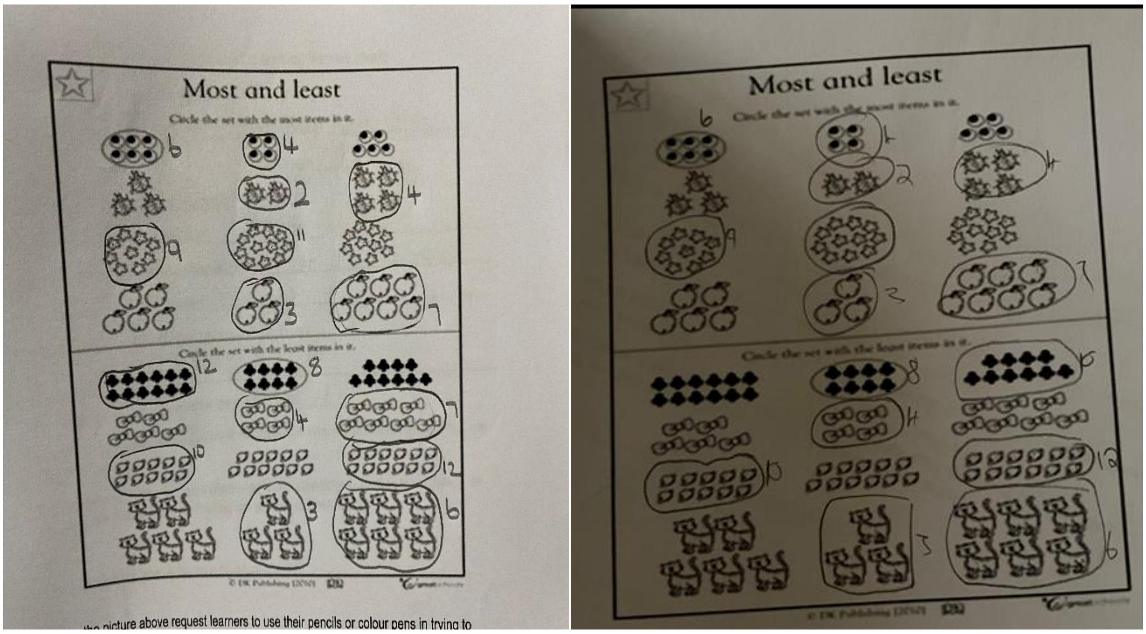

Figure 4.13: Number patterns

Participants were also required to write down their responses in a piece of paper and use their responses to find totals of each line in a row per block. All 30 participants managed to work well with numbers when adding them to get the expected answers. An example of their responses is presented in Figure 4.14.

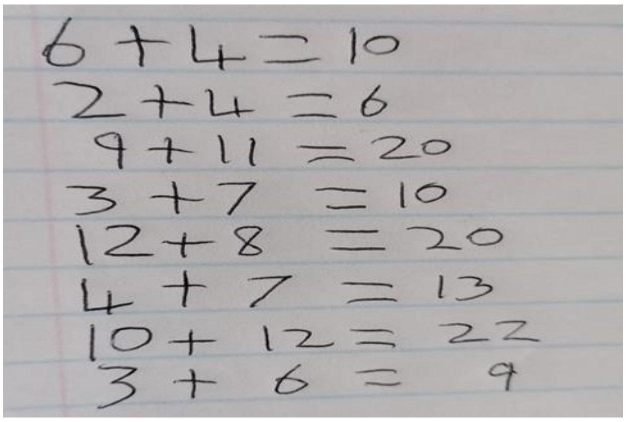

Figure 4.14: Additive calculations

In the last part of Section B, participants were requested to use the same highlighted or circled numbers from the number patterns which they had previously recorded and worked with on the addition part to multiply and get answers. The majority of the participants – 24– managed to get the expected answers, and made use of the relevant multiplication rule. An example of their responses is presented in Figure 4.15.

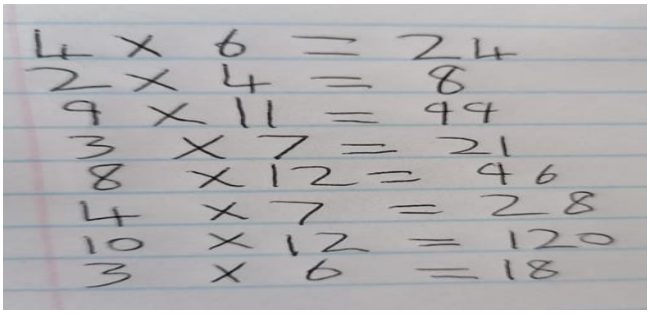

Figure 4.15: The use of numbers to multiply

In response to Question 2, 15 participants could not interpret the question relating to number representation and calculation methods. Their responses were totally unfavourable, and in the follow-up interview, the researcher picked up that these learners needed guidance when dealing with numbers, since they cannot connect abstract representations, numbers and drawings.

4.2.2.3 Theme 7: Developmental Levels and Learners' Perceptions

During researcher's engagement with individual participant's some questions from the clinical interview tool were asked by the researcher. The following are questions and the responses they elicited.

1. *What was mathematics like last year*?

The question elicited various answers, and helped to understand how individual learners feel about mathematics, as the subject that they were studying at school.

Table 4.2: Learners' responses to the question on how they perceived mathematics

Answer options/ choices	Number of responses	Tally	Percentages
Difficult	9	~~IIII~~ IIII	30%
Fair	1	I	3.33%
Good	12	~~IIII~~ ~~IIII~~ II	40%
Very easy	8	~~IIII~~ III	26.67%

The participants' responses indicated that from their previous Grade, majority (40%) found mathematics Good, which means it was Average; 30% of the participants found mathematics Difficult, 3.33% found mathematics Fair, and only 26.67% –which represent the least number of participants, found mathematics Very easy.

2. *What mathematics topics did you enjoy studying last year*?

The question was an open-ended question that sought to find out more about the participants' knowledge of mathematics content and to investigate which content of the mathematics subject participants enjoyed more than others. Participants had the opportunity to give more than one choice.

Table 4.3: Response of participants on mathematics topics they enjoy

Topics	Number of responses	Tally
Numbers, operations and relationships	20	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~
Patterns, functions and algebra	3	III
Space and shapes (geometry)	6	~~IIII~~ I
Measurements	10	~~IIII~~ ~~IIII~~
Data handling (statistics)	15	~~IIII~~ ~~IIII~~ ~~IIII~~

From Table 4.3 it is evident that majority of participants enjoyed learning numbers, operations and relationships; followed by data handling as their second choice; measurements as their third choice; space and shapes (geometry) as the fourth and patterns; functions and algebra as the least enjoyable content.

Additional questions and responses from participants were as follows.

Do you study mathematics at home and why?

The participants were expected to reply Yes or No to the above question and their responses were as follows: 18 participants (60% of the total participants) replied Yes, meaning that majority of the participants were able to study at home.

Participants gave various reason for their answers, some of their responses are indicated below:

Learner 1: I am able to study maths at home because I have a tutor. She comes 3 times week.

Learner 10: I am able to study maths at home because I get assistance from my parents and my older siblings.

Twelve participants replied with No to the above question (40% (minority) of the total participants). The 40 % minority group responses indicated that they were unable to study at home.

Learner 15: I am unable to study mathematics when I get home because I have no one to assist me.

Learner 22: I am unable to do mathematics at home because I stay far from the school and I get home late as I walk daily from and to school and when I get home I am tired.

Another question related to the learning materials participants used to study mathematics.

What do you use to learn mathematics at home?

This question aimed to investigate whether participants had the materials to support their mathematics learning at home. Participants could list all the resources they had at home. Table 4.4 reports the participants' responses in relation to the learning material they used to learn mathematics.

Table 4.2: Participants material report

Resources	Choice total
Board games	9
Laptop	1
Tablet	7
Practice book	21
Counters	3

Responses to the question about the availability of resources indicate that the majority of the participants have material to support their learning of mathematics at home. Most of them (n=21) reported that they had mathematics practice books at home; only 9 had board games, 1 is used a laptop, 7 use tablets and only 3 had counters.

What was your highest level in mathematics in the previous Grade?

This question aimed at comparing participants' current performance as observed during data collection with their competence in the previous grade. Competence is scaled from level 1 (Not achieved) to Level 7 (Outstanding achievement).

The responses of participants indicate that only 1 participant achieved Level 3 (Moderate achievement); 2 performed at level 4 (Adequate achievement); 1 participant performed at level 5 (Substantial achievement); 4 participants performed at level 6 (Meritorious achievement) and 22 performed at level 7 (Outstanding achievement).

The analysis above shows that 22 participants (73.33% of the total participants) had passed mathematics with marks above 80%+ in the previous grade, while 13.33% achieved 70–79%; 10% achieved 50–59% and 3.33% achieved 40-49%.

Table 4.3: Summary of calculation techniques and levels related to the development of multiplicative reasoning

Calculation level	Calculation technique	Description
Level 0	Calculation techniques not used	
Level 0A	Guesser	Guesses the answer with no understanding of the problem
Level 1	Additive calculation techniques	
Level 1A	Unitary counting	Uses fingers or tallies to calculate answer, counting each separately, e.g. 3 + 3 is 1, 2, 3, 4, 5, 6
Level 1B	Skip counting	Counts in multiples, such as 3, 6, 9, but does not know when to stop counting
Level 1C	Repeated counting	Uses repeated addition, e.g. 3 + 3 + 3 = 9
Level 2	Multiplicative calculation techniques	
Level 2A	Doubling	Uses doubling, e.g. 4 x 4, is 4, doubled = 8, doubled = 16

Calculation level	Calculation technique	Description
Level 2B	Double counting	Counts in multiples while keeping track of how many groups have been counted, e.g. 5 x 5 is calculated as one 5 is 5, two fives are 10, three fives are 15, four fives are 20, five fives are 25
Level 2C	Algorithms	Uses an algorithm, e.g. the column method
Level 2D	Distributive properties	For example, 10 x 6 is calculated as 10 x 4 +10 x 2 = 40 + 20 = 60
Level 2E	Derived multiplication fact	For example, 15 x 5 is calculated as 70 + 5 = 75
Level 2F	Known multiplication fact	For example, 3 x 2 = 6

Examples of learners' responses regarding counting as a mathematics strategy were classified as follows:

Responses by Learners 1, 4, 7–9, 11, 23, 26, 27 and 29 (10 learners) were classified as Level 0A, which indicates that they mostly used a guessing system in responding to questions, and lacked an understanding of the problem.

Responses by Learner 13, 14, 16, 22, 24, 25, 28 and 30 (8 learners) were classified as semi-concrete representation, due to their lack of understanding and interpretation of 3D shapes, leading to material misinterpretation and providing evidence of a lack of knowledge of abstract numbers. These findings indicate that learners have problems connecting abstract representations, numbers and drawings

4.2.2.4. Theme 8: Learner language preference

The findings indicate that the majority of participating learners face challenges in switching from learning mathematics in their home language, to English as LOLT. From the researcher's observation and learners' responses, it became clear that educators are influential regarding the way learners engage with and accept the transition to English as LOLT. The curriculum stipulates that educators have to teach mathematics in English from the start of the first term of Grade 4. This poses a serious challenge for learners' development of other language of teaching and learning in mathematics as they have not yet mastered their own home language.

In this study, 25% of participants used two languages alternately (Sesotho and English) when responding to questions in the clinical interviews. Based on the learners' responses, observations during teaching and learning, and face-to-face interaction between the researcher and learners, learners preferred to alternate between languages which they are most comfortable with when they are learning mathematics, as it was evident that by doing so it helps them conceptualises question and gain the confidence in attempting to respond to the set questions, this also poses a positive impact on their performance.

Figure 4.16 shows responses by learners in their home language.

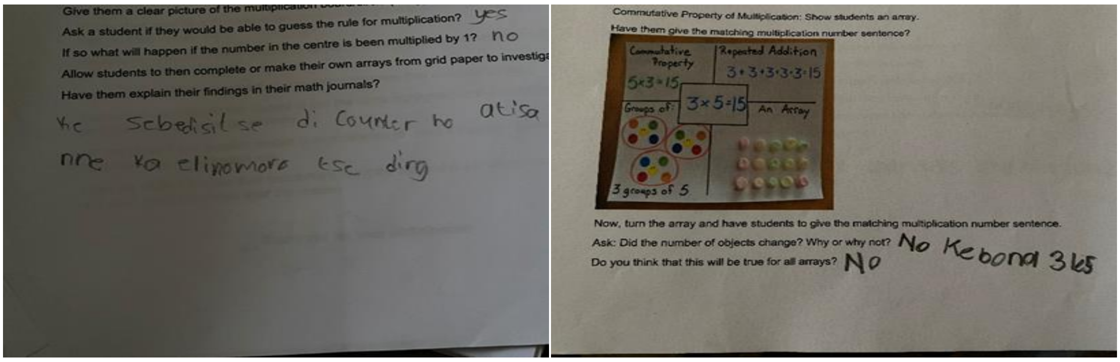

Figure 4.16: Participants' responses in Sesotho home language schools

In Figure 4.16, the responses of learners in Sesotho, their home language, shows they understand multiples structures and have conceptual knowledge of arrays, equal groups, the language of factors. These learners work effectively and efficiently with the numbers operation using their home language.

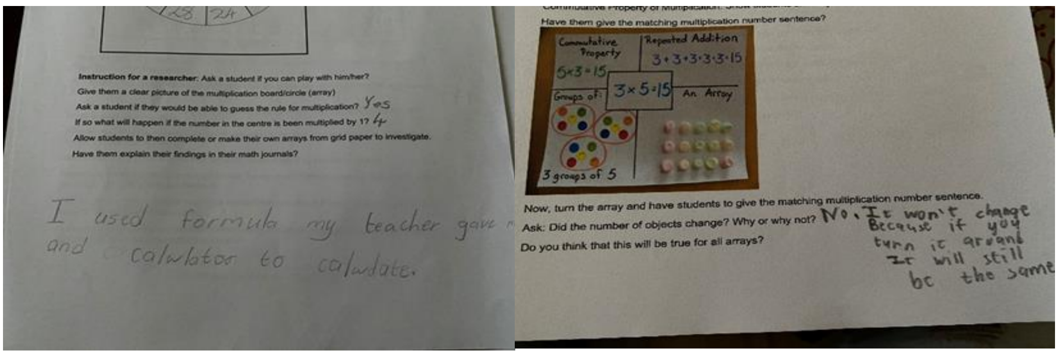

Figure 4.17: Representation of the English home-language school participants

Figure 4.17 shows the response of a learner of the suburban school, who is taught in English. The findings indicate that learners participated in the study; whom are exposed to English as a medium of instruction and live in urban areas were English is commonly used language for communication in everyday lives.as were able to communicate multiple formulas, equal groups, the language of factors and multiples well using English, as they were using it as their home language in their daily communication and interaction with peers and educators during teaching and learning, as well as when they were at home.

The findings in relation to the LOLT indicate that learners are more comfortable and able to understand quickly when they are using the language that they mostly use in their everyday lives. The finding indicates that using learners' home language for the instruction of mathematics makes it easier for learners to understand what they are learning, hence, they can communicate effectively the concepts of multiplicative structure and are able to think out of the box. To confirm this finding, the researcher requested one participant of the suburban school whose home language is Sesotho to respond to a few questions in Sesotho. The learner found it difficult to comprehend and understand what was expected of her.

4.2.3. Research question 3

How does instruction of multiplicative thinking include learners of all gender diversity in the classroom?

4.2.3.1. Theme 9: Dichotomy between home and classroom

The findings of the study reveal that, in the South African context, the classroom environment are conducive as it is expected to, by the department of basic education in promoting inclusive teaching and learning. Learners complain that they do not have a voice in the classroom setting, from the learners' response majority have indicated that since the begin of the COVID-19 pandemic they have found their respective home environment to be very supportive towards their learning, it is evident from the data that home environment is now increasingly transforming to new support structure regardless of the different individual learner's social background.

Learners' responses and the classroom observation shows there is an increase in learner flexibility and freedom, not only in schools, but also different families irrespective of their socio-economic status. The participating learners at the suburban schools reported that they now have opportunities to foster their innovative spirit, and to learn mathematics at home. Some reported that, as a result of the COVID-19 pandemic, they now had various resources to support their learning at home.

> *Learner 1: I am learning mathematics at home using board games and tablet at home assisted by older siblings. (Eleven other participants gave similar responses.)*

> *Learner 5: At home I learn Maths with my tutor, my sister helps me with home works. I have workbooks and board games to help me during maths session. (This response was echoed by 12 other learners.)*

The findings indicate that the majority of learners participated in the study from the urban schools are able to learn and get the necessary support from their parents, guardians and older siblings. While this was only known to be more relevant to learners at the suburban school, who are afforded enough opportunities to express their freedom and flexibility in terms of thinking, fostering responsibility and innovative skills, which promotes the ability to create high quality, talent.

The data are distributed in the following manner: 80% of the participants indicated that they were able to study at home, with the support from tutors, parents, siblings and guardians. This finding indicates that there is a great improvement regarding the investment by parents and guardians in their children's education, compared to the past. This statement is supported by participants' responses, which indicate that the majority of them had resources they could use at home to support their learning of mathematics; some indicated that they used books at home, while others used electronic devices to learn mathematics at home.

The findings indicate that, for educators to be able to promote diversity in their classroom setting, they needed a better understanding of how diversity can promote or hinder learners' understanding of content and the process of effective teaching and learning.

The educators at Schools A and B were found to lack understanding regarding addressing diversity and inclusion in their classroom spaces. During teaching and learning, they both focussed their attention on certain groups of learners. The observation was that these educators ensured that their smart learners were seated in the front row, and that these learners received most of the attention and engagement with the educators during teaching and learning, while the rest of the class was left behind. From my observation and interview responses, it was clear that educators at the urban schools treated learners differently according to their abilities and socioeconomic status, and neglected learners who were struggling to adapt to the language usage and examples used by the educators during the teaching and learning process.

In contrast, at the suburban school, the educator ensured that all the learners, regardless of their culture and ethnicity, religion or gender, received attention during the instruction of mathematics. This teacher used a relevant and a diverse variety of examples to accommodate all learners' abilities, and used a standard LOLT, so that no learner was left behind.

From these results I drew the conclusion that the majority of participating public school educators need training on how to effectively promote cultural diversity and gender inclusion while teaching. During face to face interviews, the educators at the two urban schools commented as follows.

> *Teacher A: The issue of trying to accommodate all learners in a classroom has always been an issue since my arrival in the industry, as we get different learners from lower grades that cannot speak and write and we as educators in the foundation face always have limited time as per curriculum policy guidelines which give us time frame for all the content that must be covered.*

> *Teacher B: I can handle the number I'm currently teaching in class even though we are still facing the spread of COVID-19. The model our school choose does not favour us as the foundation phase educators, because you get to teach two groups in a day and it is so difficult to ensure that all learners are catered for in the classroom while there are not enough teaching and learning materials to support the teaching. This has been an ongoing issue which I though by now the [education] department would have done something with it.*

The findings reveal that learners attending urban schools are more diverse than the learners at suburban schools. Furthermore, an educator's teaching style can be either conducive to teaching and learning, or hinder learners' active participation, and fail to stimulate learning.

These findings are supported by responses and observations at Schools A and B, where educators use the telling method of teaching, which is regarded as a teacher-centred method. Furthermore, these educators do not assess learners' prior knowledge of the previous lesson, and do not frequently assess learners' understanding of the content, to ensure that all learners are following and that no learners are left behind. The findings at these two schools differs from that of School A, where the educator ensures that learners' prior knowledge is assessed, and uses games to introduce lessons.

4.3. CONCLUSION

The results of the study were presented in this chapter of the report. In the first step of the process, the participants' histories were discussed. In the second part of the presentation, the results of the research were discussed. These results were triangulated to produce the presented themes from one-on-one interviews, clinical interviews, and classroom observations. Thirdly, the thoughts and feelings expressed by participants were transcribed word for word. In Chapter 5, the results of the study will be discussed, conclusions will be explained, and suggestions for further research will be given.

CHAPTER 5: DISCUSSION AND CONCLUSION

5.1. INTRODUCTION

This chapter present a discussion of results, a study summary and a conclusion and summary of the findings, in order to respond to the research questions. Furthermore, the chapter will integrate the study themes and issues which came up in the literature, and relate them to the study's theoretical framework, to draw conclusions and highlight the limitations of the study, and present recommendations for further research.

5.2 SUMMARY OF THE STUDY

The study will be summarised as follows. First, the research questions will be given, followed by key findings and themes that were identified in response to the main research questions and pursuing the goals and objectives set for the study; basic numeracy development; language and manipulatives in mediation; how COVID-19 complexities affected learning; classroom management; foundational conceptual understanding; procedural multiplication knowledge; developmental levels and learners' perceptions; learner language preference and the dichotomy between home and classroom. The key findings of this study can be summarised as follows:

- Proficiency in the LOLT language facilitates the development of meaning and abstraction of number concepts.
- Procedural teaching still dominates teaching and learning in mathematics practices of the early years.
- Manipulatives mediate meaningfulness in mathematical ideas.
- Multiplicative thinking of learners/students is impeded by having procedural knowledge.
- COVID-19 transformed homes of participants of a low socio-economic background into supportive learning environments.
- Inequalities continue to disrupt possibilities for quality teaching and learning taking place, because of a shortage of resources (physical and human) at some schools.
- There is a need to develop Grade 3 learners' numeracy skills.
- Classroom management skills contribute to the effective teaching and learning of mathematics content.

These key findings are embedded in the themes discussed in this chapter, thereby differentiating this study from others.

5.2.1. Theme 1: Basic numeracy development

The findings of the study indicate that majority of the learners who participated in the study face challenges related to knowledge of basic number development. As a result, these learners in Grade 3 lack the ability to link to numerate beyond one-to-one correspondence. Most of these learners agreed that this challenge had a negative impact on them, and they are unable to match mathematics concepts, arrays, and pictures, to solve problems fluently. The findings indicate that 70% of these learners – the majority of participants in the study – admitted that they are unable to complete the set classroom tasks and face challenges relating to manipulating concrete objects in solving mathematics problems at Grade 3 level.

The learner responses in the study indicate that most learners knew how to do object counting, but had no conceptual understanding of basic numeracy skills such as skip counting, subetizing, composing numbers, grouping numbers and adding on. During the researcher's interaction with these learners they could not see that there are three groups of numbers, could not recognise small numbers, or do subtilizing, composing and decomposing of numbers. Most learners faced challenges in giving relevant answers to multiplication problems during clinical interviews, which shows that these learners need more time to prepare, and need more opportunities to learn mathematics on different platforms, using relevant teaching and learning material that matches their level. The data reveals that there is a shortage of well-trained educators who can deliver quality content during mathematics teaching, which will enable learners to build solid conceptual understanding from early grades of schooling. The study also reveals that learners' poor conceptual understanding is linked to poor teaching – this was noticed during the classroom observation and interviews between learners and the researcher. Few learners understand fully; most struggle to reach the required conceptual levels – most of these learners are still at the semi-concrete conceptual knowledge level.

5.2.2. Theme 2: Language and manipulatives in mediation

The literature presented in Chapter 2 of the study identifies the need to improve learners' mathematics comprehension skills from the early grades of schooling. From learner interviews, this study found that the LOLT could have a negative impact on learners' mathematics content comprehension. Even though the study did not investigate the impact of using a second language for teaching and learning in the early childhood phases, investigating the multiplicative thinking of learners in the foundation phase exposed it as a factor that contributes to learners' poor comprehension.

Findings from the literature and interviews indicate that learning cannot be effective in the foundation phase of schooling if learners do not possess a good command of the LOLT. If they do not, learners struggle to remember basic mathematics skills they had learnt in previous grades. The implications of this finding are that learners in lower grades face challenges in working fluently with numbers, or solving basic mathematics problems.

From the learners' responses it is evident that poor comprehension has a negative impact on their ability to solve mathematics problems effectively. These learners are also struggling to cope with a language transition, from being taught in their home language up to the end of Grade 3, to English (the first additional language for some of the learners) as LOLT from Grade 4.

These findings support the literature review, which confirms research findings regarding the LOLT and its impact on learners' comprehension ability. Findings also indicate that language is the major influence on learners' mathematics content acquisition, which, in turn, may mean that learners are unable to perform as expected in mathematics. It is evident from learners' responses that they may develop negative attitudes toward mathematics, and conclude that mathematics is a difficult subject.

5.2.3. Theme 3: Covid-19 complexities in learning

The study also found that the majority of the learners struggled to perform at an adequate conceptual level, due to a lack of resources and limited teaching time. Classroom observation and participant responses show that some teachers in the foundation phase lack content knowledge, while some struggle to apply effective strategies to ensure that no learner is left behind in the instruction of mathematics. The findings also confirm that, as a result of the COVID-19 pandemic, the majority of classrooms in the South African context no longer use number charts, number line or counters. The implication of this findings is that learners cannot learn effectively without seeing and touching things.

It is evident from the classroom observations and individual interview responses of learners that learners are neglected due to the timetabling method chosen by schools. The impact of these findings is that most of these learners are affected negatively, as the timetable does not consider that learners need to achieve understanding, but is focused on more saving the academic year, stopping the spread of infections and achieving curriculum coverage. The findings of the study also confirm that implementing a teacher-centred approach in the classroom means that the majority of learners display a lack of connection while working with concrete objects.

5.2.4. Theme 4: Classroom management

Classroom facilitation that was observed presented with shortcomings, which was confirmed by learners. The majority of the participants attending non-fee-paying suburban schools reported that educators at their schools gave their full attention and focus to a specific group of learners (smart learners), while other learners in the same class were neglected and left unattended. This finding was confirmed by the researcher during classroom observation – the educator engaged in continuous interaction with a certain group of learners in the classroom. The neglected learners were the participants who indicated that they were struggling to grasp certain skills of mathematics and were unable to continue with the set tasks.

The majority of participants indicated that there was no effective teaching and learning in their classroom, consequently, most of them faced challenges in understanding mathematics language. The study discovered that educators in public schools are unable to move with learners from concrete to representation levels during mathematics instruction, up to the abstract sequence of learning. During the classroom observation, I noticed that some educators could not provide practical examples while teaching, which would have made it easier for learners to link what they had been taught in the mathematics lesson with the knowledge they had acquired in previous grades.

5.2.5. Theme 5: foundational conceptual understanding

The findings of the study reveal that the majority of participants in the study are not yet fluent in working with numbers. From learners' responses it is evident that they have not been fully prepared to work with numbers effectively. Consequently, these learners face challenges in understanding mathematics content, which leads to a lack of creative thinking by learners when they engage with mathematics problems. Learners' interview responses and the classroom observations lead the researcher to conclude that that these learners face difficulties developing sound concrete understanding of mathematics concepts/skills.

From the researcher's observations during teaching and learning, only a small group of learners showed adequate competence when working with numbers to solve mathematics problems, and the majority of learners faced challenges in developing a sound concrete understanding of mathematics concepts/skills. Only a small group of learners were able to show the expected competency in mathematics at the abstract conceptual level.

The finding of the study from the collected data and classroom observation disclosed that learners were no longer provided with opportunities to practise and demonstrate mastery skills in each topic. This is due to limited teaching time, which means that teachers are not explaining thoroughly by giving appropriate practical examples, and failing to pay attention to all learners during the classroom instruction.

5.2.6. Theme 6: Procedural multiplication knowledge

The findings of the study confirm that learners in Grade 3 were not prepared well in the previous grades. These learners displayed knowledge of the multiplication rule, but do not know its meaning. During the clinical interviews, learners were able to show knowledge of the four times multiplication table, but faced challenges in applying that knowledge when working with arrays. During the observations I noticed that learners' knowledge of multiplication is not real but procedural according to the teaching the learners received. Furthermore, there was no evidence of problem-solving skills in the classrooms. This finding highlights that teaching in foundation phase classes is still procedural, hence, it was challenging for learners participating in the study to link their mathematical knowledge to real-life situations; most of them struggled to give correct answers for multiplication, even when they were afforded the chance to use counters or resources provided by the researcher. The findings also highlight that majority of learners were able to execute multiplication procedures, but struggled to respond to "why" questions. As a result, learners were unable to build connections between multiple mathematics procedures and concepts. Learners were unable to reason effectively, as there was no connection between property and calculations.

5.2.7. Theme 7: Developmental levels and learners' perceptions

From the analysis done in Chapter 4, it is clear that 22 participants (73.33% of the total participants) had managed to pass mathematics with marks above 80% in the previous grade, while 13.33% had achieved 70–79%; 10% had achieved 50–59% and 3.33% had achieved 40-49%, which response to the level of achievement the grade 3 learners are at the current point and time. It was evident from the participants' responses that the improvement in their performance from their previous grade was due to the availability of teaching materials at their homes, even though some still encounter challenges related to their families' socioeconomic status. The majority of participants indicated that they had material to support their learning of mathematics at home: 21 (the majority) indicated that they had mathematics practice books at home, while 9 had board games, one had access to a laptop, 7 use tablets and 3 had counters.

From the analysis in Chapter 4, the findings report the positive impact on performance of participants from their previous grades. In Grade 3, learners start to develop positive attitudes towards mathematics learning, despite minor challenges reported by participants. The positive results are being influenced by the availability of resources at home. This part of the finding is set out to be great progress in the education sectors focusing in the foundation phase.

5.2.8. Theme 8: Learner language preference

The findings indicate that the majority of participating learners are faced with challenges when they have to switch language. The finding has highlighted from the participants' responses when they had to answer clinical interviews using English, the findings highlights that learners prefer learning mathematics using the language that they are comfortable with and they also show that learners are struggling to learn mathematics using English as they have not mastered their own home language. From the researcher's observation and learners' responses, it became clear that educators are influential regarding the way learners engage with and accept the transition to English as LOLT.

In this study, 25% of participants used two languages alternately (Sesotho and English) when responding to questions in the clinical interviews. Based on the learners' responses, observations during teaching and learning, and face-to-face interaction between the researcher and learners, learners preferred to alternate between languages which they are most comfortable with when they are learning mathematics, as it was evident that by doing so it helps them conceptualises question and gain the confidence in attempting to respond to the set questions, this also poses a positive impact on their performance.

5.2.9. Theme 9: Dichotomy between home and classroom

The study found, through data collected in interviews and classroom observations, that classrooms no longer serve their purpose of being safe spaces and promoting effective teaching and learning. Participants complained that they are not being treated well and have no voice in their respective classes than when they are at home. The majority of participants complained about their teachers' tone and use of voice during teaching and learning, which has lead these learners developing a fear of asking questions during the instruction; this passivity means they lose focus.

In turn, the study found that learners' homes have become more supportive environments. The participants indicated that they felt safer at home than at school, because they have a voice and their parents or family members are able to provide support for their studies. Most of the participants indicated having tutors or other people helping them to learn mathematics at home, in addition to electronic devices such as tablets, cell phones and board games.

During interviews and observations, I found that the foundation phase classrooms displayed a lack of gender equality and accommodation of all learners. This finding highlights that educators in the foundation phase prefer to work with a certain group of learners, while another group is neglected. The finding also confirms that classroom seating arrangements are not random, as learners are separated in rows and classified according to their performance, which result in some learners feeling left out, as reported by study participants.

5.3. CONTRIBUTORS/ CHALLENGES TO FINDINGS OF THIS STUDY

5.3.1. Early childhood education

The findings corroborate that early childhood education in the South African context is an ongoing issue that has not received enough attention from the department of basic education, and this neglect has negative effects on learners' later development in mathematics. These findings are congruent with practices that divide according to language, socioeconomic status and geographic location (Kader, 2012; Xaba & Malindi, 2010; Spaull, 2013). The corroborating view of this current study is that, despite some improvements, much more work needs to be done (Kader, 2012; Spaull, 2013). There are discrepancies in the education system between township and suburban schools (Fleisch, 2008; Kallaway, 2009; Kader, 2012). These challenges need to be resolved to improve progress.

5.3.2. Poverty and inequality of disadvantaged school environments

The findings verify that learners come from various backgrounds, though most of the learners who were involved in this study come from working-class and poor backgrounds (Fleisch, 2008; Kallaway, 2009; Kader, 2012). The literature confirms that some schools are situated in poverty-stricken areas (Mampane & Bouwer, 2011; Xaba & Malindi, 2010). Some of the participated schools in this study were mainly from townships or disadvantaged areas. The fact that most of those school were no-fee-paying schools, confirm that they are plagued by poverty (Clarke et al., 2004; Modisaotsile, 2012; Munje & Maarman, 2016; Spaull, 2013).

The findings confirm that significant inequalities still remain in the system, despite the improvements in or transformation of the education system (Chisholm et al., 2004; Crouch & Mabogoane, 2001; Clarke et al., 2004; Munje & Maarman, 2016; Reschovsky, 2006; Taylor et al., 2008; Taylor et al., 2012; Van der Berg et al., 2006). The inequalities are because these schools reported to face adverse socioeconomic conditions (Chisholm & Valley, 1996; Kader, 2012; Mampane & Bouwer, 2011; Xaba & Malindi, 2010).

It is essential to reduce the poverty and inequality at disadvantaged schools (Kader, 2012; Reschovsky, 2006). Doing so would help to curb the low quality of education, which has many adverse outcomes, as outlined in the reviewed literature. It is undeniable that poverty and inequality are some of the biggest challenges facing the education system. The view of this study is that they will remain part of the system for a significant time unless there is drastic economic development. Simply allocating a large budget for education will not solve the problems. There is a need to resolve other, underlying problems that have a direct or indirect impact on aspects outside the realm of teaching and learning.

The participants did not express any views on violence in schools (Bloch & Solomos, 2009; Chisholm & Valley, 1996; Kader, 2012; Mampane & Bouwer, 2011; Ngcongo, 2016). The findings are inconclusive regarding the migration of learners from disadvantaged township schools to more resourced suburban schools (Bloch & Solomos, 2009; Kader, 2012), mainly because this was not a comparative study between the two types of schools. The results of this study do not necessarily confirm or disconfirm that disadvantaged township schools are particularly dysfunctional.

5.3.3. Planning and implementing diverse national interventions

The findings confirm that there is a need to plan and implement diverse national interventions. Interventions suggested by other studies, such as capacity building to increase teacher content knowledge, teaching skill, numeracy and literacy of educators, and managerial, administrative and technical capacity, have the potential to improve the situation (Dikgale, 2012; Spaull, 2013; Reschovsky, 2006). These interventions were suggested for other problems, such as developing effective and improving standards in foundation phase education. The resulting implication is that the education department needs to establish a holistic enquiry into the failures or obstacles that educators and management encounter in early childhood education.

Policymakers, academics, and members of parliament who eventually develop legislative frameworks need to be part of this national enquiry. The outcomes will inform recommendations regarding whether the early childhood education policy in the South African context should be reviewed

5.3.4. Need to review general institutional issues encountered by the education department

The findings attest to a severe shortage of skilled educators with specialised knowledge of teaching effectively in the foundation phase (Chisholm; 2003; Christie, 2010; Kader, 2012). The findings also confirm that educators encounter diverse political, social and emotional pressures (Stott et al., 2015) but these educators invalidate that it is only due to progression and curriculum coverage guidelines, which have to be sent to the Department of Education district offices on a weekly basis. This requirement causes a loss of teaching time – excessive administrative demand do not consider learner needs. The Department of Education do not consider that educators are doing all they can to ensure that learners understand the content taught, and present afternoon classes to relieve the pressure exerted by the education department, in addition to facing the risk of contracting COVID-19.

5.3.5. Need to review the education department's interventions in training and development

The findings of the literature review confirm that some educators are underqualified (Christie, 2008; Kader, 2012); though the findings are inconclusive about the presence of unqualified educators at the schools that were part of the study (Anderson et al., 2001; Clarke, 2007; Carnoy et al., 2008.; Hoadley, 2012; Modisaotsile, 2012; Munje & Maarman, 2016; Maddock & Maroun, 2018; Reschovsky, 2006; Spaull, 2013; Yamauchi, 2011). The justification or explanation is that the main objective of this study did not prioritize the need to review education department's interventions in training and development of ECD educators' aspect as a main focus but it was rather afterthought. The findings verify that there is a need for disadvantaged schools in Mangaung Metropolitan area (where the study took place) to develop better institutional support mechanisms, and to present ongoing professional training and development for their educators and management, to enable them to deal with the challenges they encounter (Clarke, 2007; Marais, 2016).

5.3.6. Need to review the education department's interventions in curriculum and addressing the challenges related to curriculum change

The findings corroborate that learners are generally disadvantaged when the curriculum is not covered in full, and when teaching and learning is not implemented effectively (Bottery, 2004; Kader, 2012; Spaull, 2013; Teese & Polesel, 2003). The findings are congruent with the fact that South Africa has undergone several curriculum changes (Carnoy et al., 2008.; Kader, 2012; Ngcongo, 2016; Rammala, 2009; Spaull, 2013). The findings of this study confirm that these changes face criticism, since some participants reported that educators give them a lot of work to do home, without giving proper explanations and examples, which is perceived by learners participated in the study as a major setback in teaching and learning (Mabodoko, 2017; Maddock & Maroun, 2018; Rammala, 2009). The corroborating implication is that frequent curriculum change means there are conflicting social, theoretical and ideological frameworks (Badat, 2009).

When new curricula are implemented, they create confusion (Mabodoko, 2017; Maddock & Maroun, 2018; Rammala, 2009), which is one of the reasons are criticised and deemed as a failure (Carnoy et al., 2008; Rammala, 2009).

5.3.7. Need to review education department interventions to achieve quality education in the foundation phase

The findings corroborate that the quality of education remains unsatisfactory, and far from ideal (Kader, 2012; Modisaotsile, 2012; Spaull, 2013; Zoch, 2017). The substantiating implication of this finding is that the quality of education at schools in poor neighbourhoods has to be drastically improved (Zoch, 2017).

5.3.8. Issues related to learners' understanding of mathematics in early childhood education

These findings uphold the perspective that teaching in the foundation phase is affected by various factors, which include lack of availability and ineffective use of mathematics resources. The findings also show that using mathematical resources should be paired with a solid understanding of how and when these resources should be used, as different resources serve different functions at different times and in different grades. This is something that should be kept in mind when using mathematical resources (Mtetwa, 2005:255). For instance, flared cards are frequently used for computations, despite the fact that their primary function is to facilitate the acquisition of place value (DBE, 2011:247). According to the findings of the study, it is crucial for all classes in the foundation phase to have access to number lines and to teach their learners how to properly use them. This allows learners to have a deep understanding of numerical concepts at an earlier age.

If this is not done properly, it may spill over and impact other teaching and learning challenges encountered by learners in the foundation phase. Educators and principals need to see their schools as holistic organisms, in which one aspect has an impact on another, hence, the need for a holistic approach when attempting to intervene in emerging challenges.

5.4. ASSESSMENT OF CONTRIBUTING FACTORS

5.4.1. Challenges related to resources and infrastructure

My visits to schools to make arrangements to administer the interviews proved that schools have poor infrastructure (Bush & Heystek, 2003; Mampane & Bouwer, 2011; Kader, 2012; Xaba & Malindi, 2010). The findings confirm that schools involved in the study lack learning resources and materials, such as textbooks (Christie, 2010; Chisholm et al., 2003; Kader, 2012; Mampane & Bouwer, 2011; Motala & Pampallis, 2001; Xaba & Malindi, 2010; Modisaotsile, 2012). The findings indicate that some of the schools have poor infrastructure and some of it need to be fixed (Kader, 2012; Xaba & Malindi, 2010). The view of this study is that, if the issue if resources and infrastructure is not resolved, learners at disadvantaged schools will continue to receive poor quality education (Kader, 2012; Reschovsky, 2006).

The study did not investigate whether the textbooks were prescribed, or whether their content was suitable and relevant (Kallaway, 2009; Kader, 2012).

5.4.2. Need for support structures and remedial services

The findings validate that the participants needed support structures, since many of schools do not have any in place (Alexander et al., 2003; Kader, 2012; Munje & Maarman, 2016). The findings support the notion that there is a limitation of strong systems for remedial action within the schools of participants (Stott et al., 2015). The findings of this study confirm that interventions are needed to address challenges facing teaching and learning of mathematics in the foundation phase, to improve curriculum support and reduce class size (Dikgale, 2012; Spaull, 2013).

The corroborating implication is that professional support for educators and learners is a priority (Hartley, 2006; Munje & Maarman, 2016). The corroborating implication, according to the current study, is that disadvantaged schools need more logistical support, to positively impact teaching and learning of mathematics in the foundation phase (Hartley, 2006; Munje & Maarman, 2016). Better professional support for disadvantaged schools will assist in improving academic performance and instilling better coping skills, which will assist learners in their day to day schoolwork (Hartley, 2006; Munje & Maarman, 2016).

5.4.3. Need to address social ills

The findings confirm that some of the participants were demotivated and disorganised in their academic activities (Modisaotsile, 2012). However, the findings are inconclusive with regard to the perspective that learners who are unmotivated and disorganised are only those who do not receive enough attention at home and do not get emotional support from their teachers. The implication is that these aspects can impact any type of learner.

Another social ill that is reported by literature is that some learners experience a lack of parental involvement in academic matters (Chisholm & Valley, 1996; Dikgale, 2012; Kader, 2012; Modisaotsile, 2012; Mampane & Bouwer, 2011; Ngcongo, 2016; Rammala, 2009). The literature confirms that some learners experience financial difficulties (Dikgale, 2012), hence, they do not have opportunities to study mathematics at home.

The findings are inconclusive with regard to specific home dynamics, such as a lack of family love, the nature of family life and encouragement, disrupted family structures or lack of constructive and supportive conditions at learners' homes (Chisholm & Valley, 1996; Kader, 2012; Modisaotsile, 2012; Mampane & Bouwer, 2011; Rammala, 2009). The implication is that all the internal and external stakeholders of education need to address the diverse social ills that hamper the academic performance of learners from as early as the foundation phase of schooling.

5.4.4. Need to address issues of academic performance and literacy

The findings confirm that there is poor academic performance within some schools of the learners participated in the study (Bloch & Solomos, 2009; Carnoy et al., 2008.; Hartley, 2006; Kader, 2012; Maddock & Maroun, 2018; Munje & Maarman, 2016;

Spaull, 2013; Pretorius, 2014). The findings confirm that there is low or a less of an ideal quality of education in the schools of the participants (Kader, 2012; Reschovsky, 2006). The findings attest corroborate that some foundation phase learners do not put enough effort in their standard of performance because they are lazy and they are unmotivated (Kader, 2012). The findings are inconclusive with regards to the aspect of them experiencing stigma (Kader, 2012). This would have required direct interaction by interviewing the teachers.

The findings corroborate that there are issues that impact the academic performance of learners in the schools of the participants as they struggle to comprehend what they read and write (Kader, 2012). This does suggest that the majority of learners in these schools cannot read, write and calculate at grade-appropriate levels (Spaull, 2013). There mathematical performance of the learners in these schools needs to be given a much attention so that learners performance can increase and have positive impact on later education. This discrepancy is due to the fact that literacy was just mentioned in general.

The findings also confirm that the schools of the participants mostly have an environment that is not ideal or conducive for academic performance (Kamper, 2008; Maddock & Maroun, 2018; Xaba & Malindi, 2010). Therefore, their estimated norms in mathematics, reading, and writing are questionable (Fleisch, 2008; Kader, 2012; Modisaotsile, 2012; Spaull, 2013). The justification is that most are performing poorly (Fleisch, 2008; Kader, 2012; Modisaotsile, 2012; Spaull, 2013). However, as a point of caution there was a comparative analysis of the academic performance across the township schools and sub-urban schools which has indicated that most of the township school are negatively impacted with lack of mathematics resources while the sub-urban school have most of the resources in place to help their learners leaning of mathematics very easy as this was also the main focus of the study.

As a result, the findings of this study can attest beyond a reasonable doubt that the township schools in particular have serious challenges with regards to imparting numeracy and literacy skills because they remain dysfunctional (Spaull, 2013). However, the findings do prove that the unsatisfactory academic performance of the learners is an obstacle towards them accessing opportunities in further education and training opportunities (Spaull, 2013). It corroborates the notion learners from poor environments bear the brunt of performing worse academically (Spaull, 2013).

Unlike in previous studies, certain aspects were omitted as being perceived to be impacting to academic performance. The finding omitted perspectives on child headed families (Ngcongo, 2016; Sayed, et al., 2007). There was an omission with regards to questionable assessment methods (Ngcongo, 2016; Spaull, 2013). The perceptions with regards to cultural background did not emerge at all (Mabodoko, 2017; Ngcongo, 2016). The occurrence of corporal punishment also did not emerge from the clinical interviews (Ngcongo, 2016). This discrepancy may be attributed to the different aims of the studies, the use of different methodologies or the differences with regards to the study population. There are implications with regards to these aspects of academic performance and literacy. The implication is the need to ensure that there is early detection, diagnosis and intervention planning (Spaull, 2013).

5.4.5. Need to address issues that are related to teaching and learning

The findings confirm that there are challenges with regards to language proficiency and the use of English as a Language of Learning and Teaching (LOLT) (Kader, 2012; Nel & Müller, 2010; Van der Berg et al., 2011). The findings corroborate that strikes by teacher unions have a detrimental impact towards teaching and learning (Van der Berg et al., 2011). In general, the findings of this study attest that there is lost time with regards to teaching and learning (Clarke, 2007; Chisholm et al., 2003; Clarke et al., 2004; Kader, 2012; Marais, 2016; Xaba & Malindi, 2010). The findings confirm the aspect that learners do come late to school (Dikgale, 2012). The findings of this study are inconclusive with regards to several characteristics or conduct problems experienced by educators and learners attributed to be detrimental to teaching and learning attributed by past studies. The findings are not specific enough and therefore are inconclusive about the following: (a) the time dedicated towards the planning of lessons (Clarke, 2007); (b) the attendance of scheduled lessons (Dikgale, 2012); (c) the lack of commitment to teach (Mabodoko, 2017)); (d) using ineffective and traditional teaching methodologies, (Mabodoko, 2017); (e) applying a culturally insensitive curriculum (Mabodoko, 2017); (f) not being practical in everyday life. (Mabodoko, 2017); (g) encountering Ill-equipped classrooms (Modisaotsile,2012) (h) having poor content knowledge (Anderson et al., 2001; Hoadley, 2012; Modisaotsile, 2012; Munje & Maarman, 2016; Spaull, 2013; Van der Berg et al., 2011; Yamauchi, 2011). (i) exhibiting poor interpersonal relationships with learners (Leithwood, 2010; Mabodoko, 2017); (j) consistently displaying negative reinforcement (Mabodoko,2017): (k)obtaining remuneration that is not differentiated from those who underperform (Kader, 2012);

It does not mean there are not there. It simply means there were not fully explored to a point of refuting or confirming their presence and impact. Caution should be exercised when attempting to generalize them because doing so will be speculative. These themes emerged in issues related to the education system. Yes, they offer qualitative information with regards to what the context is. However, the fact that findings of this study are silent with regards there means they need to be considered for further study. This is because there is lack of studies which has specifically assessed the aspect of teaching and learning specifically for foundation phase learners.

RESEARCH QUESTIONS, AIMS AND SIGNIFICANCE OF THE STUDY

The first research question of this dissertation was about the extent to which Grade 3 learners understand multiplicative arrays, the concept of equal groups, and the language of factors and multiples The second question asked how learners use multiplicative arrays to articulate their understanding of the multiplicative situation and related ideas, such as the inverse relationship and the commutative property, and the third asked whether instruction of multiplicative thinking include learners of all gender diversity in the classroom?

The study has fulfilled its primary aim, of understanding the thinking processes of foundation phase learners in Grade3 as they engage and learn multiplicative thinking under number operations. It also fulfilled the secondary objectives of establishing and analysing on how the teaching and learning of mathematics in foundation phase classrooms accommodate gender differences and similarities in nurturing learning.

5.6. RECOMMENDATIONS

Several recommendations are made on the basis of the study results.

5.6.1. Recommendation for implementation

As outlined in the discussion of the reviewed literature and the findings of the study, there is a need to make recommendations that will contribute to effective teaching and learning of mathematics in the early grades. The findings of the study lead to recommendations for improved foundation phase teacher training. The study also calls for quality teaching and learning, which will enable learners, from the early grades, to possess a fluent conceptual understanding and representation of concrete mathematics knowledge. A further recommendation is to improve learners' language proficiency.

The results of the study also call for the full implementation of inclusion within classrooms, which will accommodate all genders and diverse teaching methods during instruction in mathematics, from the early grades.

These recommendations for implementation are generally not well implemented at the moment, despite some of them offering good, innovative suggestions for improvement. Unless those who draft curriculum and education policies, such as task team of basic education ministerial to implement progressive reforms which will address the issues at hand, the lack of progress in the field of early childhood education will continue, and later have negative impacts on the education system at large. So, the view of this researcher is that there is a need for inter-sectoral and interdepartmental fora to address issues of early childhood education and the teaching and learning of mathematics in this phase, with a special focus on developing and establishing solid knowledge of mathematics from an early age.

5.7. Recommendations for further research

- This study was undertaken during a global pandemic (COVID-19); therefore, only a limited number of participants from township and suburban schools participated. There is a need for an encompassing study to do comprehensive research on urban, and rural areas.
- Few studies in the South African context have focused on development and understanding of multiplicative thinking in early childhood mathematics education. There is a need for research into the development of number systems, the impact of teaching and learning strategies of mathematics, contributions of parental involvement, the impact of teachers' mathematical knowledge of teaching mathematics in lower grades, and the impact of teaching mathematics in home language on learners' later development.

- There is a need to assess the suitability of the teaching and learning environment, so that gender inclusion and diversity is promoted during teaching and learning.
- Further research is needed to develop new strategies to promote effective teaching and learning environments that are equipped with all relevant visual learning materials suitable for early grades, to cater for all types learners in mathematics classroom settings.

5.8. SHORTCOMINGS OF THIS STUDY

- In relation to the literature review, the researcher found few sources about the South African context to support the themes sourced for the study. It is assumed that early childhood mathematics will becoming an increasingly important research area in South Africa in the future.
- One of the shortcomings experienced with regard to the methodology relate to the use of clinical interviews – the process took longer than estimated to conclude, as participants worked slowly. Because of the COVID-19 pandemic, some schools were closed, which delayed contact with the participants; at one stage, data collection had to be paused.
- All data capturing, including calculations, were done manually. This meant I had to go back and forth to checking if all the information had been captured.

5.9. CRITICAL THINKING AND CONTRIBUTIONS TO KNOWLEDGE

Due to early childhood mathematics education being a recent focus of research in the South African context, it can be said that this study contributes to the body of knowledge. Assessed the literature critically and presented concise arguments.

Therefore, the teacher still has a significant lot of impact over the path that learners received using the available tools. Instead of focusing on memorizing steps or procedures, we should be cultivating our understanding of the concepts. When utilized appropriately, manipulatives have the potential to be beneficial for young children (Boggan et al., 2010:3). Nevertheless, understanding mathematical concepts by means of actual examples is not always simple (Thompson, 1994:3). Even if the substance is something that can be touched and felt, the knowledge that students need to acquire is conceptual.

To ensure that students are able to comprehend the mathematical principles that they are being instructed in, it is crucial to be familiar with the appropriate mathematical materials, as well as when and how to apply those materials. The first topic area can be taught with a variety of different tools, including fraction strips, base-ten blocks, place-value mats, and counters (numbers, operations and relationships). The one-to-one correspondence, ordinal numbers, and fundamental addition and subtraction operations can all be taught with the use of counters.

5.9 CONCLUSION

The researcher is concluding by assuring that study has achieved its main aim and research objective regarding Grade 3 learner’s procedure of multiplicative thinking and the gender sensitivity importance while learning mathematics using number concepts. The findings of this study revealed that a lack of resources or visual aid has a detrimental influence on the learning of learners in the foundation phase. The findings also validated the impact that a lack of learners' native language has on learners' development and conceptualization of other languages. Despite the fact that this was not a comparative study, the distinctiveness of the two contexts involved exhibited both parallel and contrasting characteristics. This was owing to the different locations of the schools as well as their social environments.

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Appendix A: Letter of request to conduct research

Letter of seeking consent /Request for Permission to Conduct Research

The Member of the Executive Council (MEC) and Head of Department (HOD)
Dear Sir/Madam

I am humbly seeking your permission to conduct academic research. My name is **Neo Seseng** and I am a student Central **University of Technology (CUT)** in Bloemfontein. The research I wish to conduct for my **Masters of Education Degree.** The study involves the title **Do numbers make sense: An investigation on how foundation learners engage with multiplicative thinking in Motheo District.** This project will be conducted under the supervision of Professor. N.N FEZA at the Department of Education.

The significance and benefit of this study is that it addresses the lack of research with regards to understanding how foundation learners engage in multiplicative thinking when learning mathematical concepts using numbers. It will contribute to distinguish the challenges that contribute towards positive learning and high learner achievement while learning mathematical concepts. The study requires interviews to be conducted and audiotaped. There will be total ANONYMITY AND CONFIDENTIALITY as NO IDENTIFYING INFORMATION of the participants will be provided to any third party including the department. The findings will be presented in themes and patterns. I commit to ensure that I provide the participants with a copy of the thesis upon completion of the study.

If you require any further information, please do not hesitate to make contact with me at the following contact details: 071 771 9780 or nsesing35@gmail.com in order to address any enquiries or questions you may have about the study. I sincerely hope that you will consider approving this request.

Yours sincerely,

Neo Hendrik Seseng

Appendix B: Letter of information about the study to participants

The Participants

I am humbly seeking your permission to conduct academic research. My name is **Neo Seseng** and I am a student Central **University of Technology (CUT)** in Bloemfontein. The research I wish to conduct for my **Master's in Education Degree.** The study involves the title **Do numbers make sense: An investigation on how foundation learners engage with multiplicative thinking in Motheo District**

This project will be conducted under the supervision of Professor. N.N FEZA at the Department of Post graduate studies (Education).

The significance and benefit of this study is that it addresses the lack of research with regards to understanding how foundation learners learn mathematics using number concepts. It will contribute to distinguish the challenges that contribute towards positive learning and high learner achievement while learning mathematical concepts. I commit to ensure that I provide the participants with a copy of the thesis upon completion of the study. If you require any further information, please do not hesitate to email me at the following address: nsesing35@gmail.com or call me via 071 771 9780 in order to address any enquiries or questions you may have about the study. I sincerely hope that you will consider approving this request.

Please take note of the following

- Participation is voluntary and you can refuse taking part in the study. If you do take part and you wish to change your mind at any time you can stop taking part in the study
- There will be total ANONYMITY AND CONFIDENTIALITY as NO IDENTIFYING INFORMATION will be provided to any third party or department.
- All the necessary research ethics will be adhered to such as the following: (a) obtaining informed consent from potential research participants; (b) minimising the risk of harm to participants; (c) protecting their anonymity and confidentiality; (d) avoiding using deceptive practices; and (e) giving the participants the right to withdraw from the research.
- The questionnaire is user-friendly and does not take a long time to complete.

I sincerely hope that you will consider approving this request. Thank you for your time and consideration in this matter.

Yours sincerely,

Neo Hendrik Seseng

Appendix C: Classroom Observation Form

Classroom Observation Form **(originally developed observation survey form)**

Date of observation_______________

School observed ____

Name of teacher(s)____

Other adults in room____

Time of observation_________________ Age range_________________

Number of students present___________ out of _____________ in class

Spend about 5 minutes observing the room to get a feel for this particular classroom beforetaking any notes. Then take anecdotal notes of behaviors, interactions, or other items of interest to you over the next half an hour or so.

1. Is the classroom seating mixed or separated? Give detail
____
____
____
____
____

2. What are the relations amongst students? Share your observation
____
____
____
____
____

3. Are there observation signs of bullism? Please elaborate? From which group is bullying coming from?
____
____
____
____
____
____

4. How does a teacher address any bullying occurrences?
____
____
____
____

Central University of Technology, Free State

5. How do learners engage with the topic?

6. Which learners engage most in the classroom

7. Which learners are left out

8. Discuss the overall relationship between the educator and learners (is he/she giving more attention to the other gender than another?)

9. How is the educator creating gender-inclusive learning environment in the classroom through the use of scheduled activities and class teaching?

10. Comment on how the educator align gender indicators with other classroom standards

11. Describe how the teacher gives learners space to voice their experience (girls and boys)

Practical Life:

Math/multiplication

Language:

5.Describe the teaching and management styles of the lead teacher.

6.List any group lessons you observed.

7.What is the balance between group lessons, individual lessons, and self-directed activity?

8.What type of systems are used to record children's work and guide their choice of work ?
(e.g. work plans, free choice, journals, recording sheets) ______________________________
____
____
____
____

9.Anything else you found interesting? ____
____
____
____

10.What are your overall impressions about this classroom?

____
____
____
____
____
____

11. How do learners engage with one another? Are girls happier than boys or vice versa?

____
____
____

12. Which gender is more favoured in the class if any?

____
____
____
____

12.1 What are the signs for the response in the above question?

____
____
____
____
____
____
____
____

12.2 Which gender is most favoured in examples used while learning even problems given students?

____
____
____
____
____
____

Appendix D: Clinical interviews for Grade 3 learners

Clinical interview for grade 3 multiplicative thinking learners

(originally developed Survey Questionnaire)

Name of the learner: ___________________________ **School:** __________________________

Grade: ____ **Age:** _________

Section A: Learner History in Mathematics

What was Mathematics like last year? ____

What do you like about Mathematics lessons? ____

What helps you learn mathematics? ____

What mathematics topics did you enjoy studying last year?

---

what was you highest maths level for the previous year? __________

Are you able to study at home? Yes/No (if YES, what motivates you to study at home/ If NO, was makes you be unable?

Section A: numbering systems (Enduring Understanding: Counting is a strategy by the research practitioner for finding the answer to how many)

1. How many wheels are on a standard bicycle?
   - 5
   - 4
   - 2
   - 3

   1
2. How many eyes does a Cyclops have?
   - 4
   - 2
   - 1
   - 3

2
3. How many babies are born if a mother has triplets?
   - 4
   - 5
   - 2
   - 3

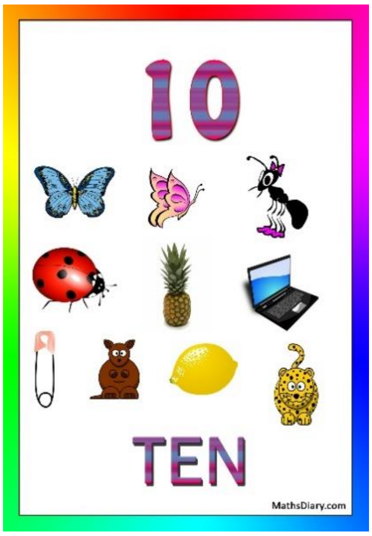
   3
4. Tommy has 10 oranges. He gives 6 oranges to Julie. How many oranges does Tommy have now?

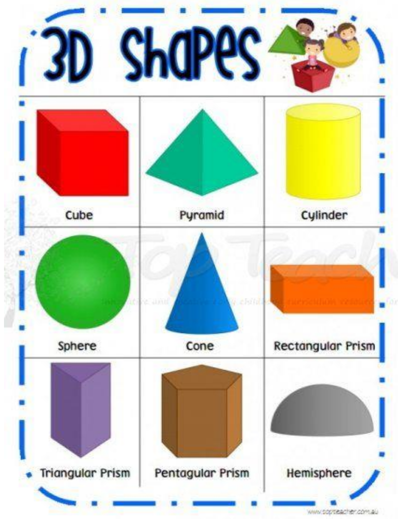
- 4
- 10
- 6
- 0

Section B: Assessing Understanding: Paper-and-Pencil.

Practitioner: Request the student to estimate the number of objects in each box.

Allow the student to explain to you on how they decided on estimation.





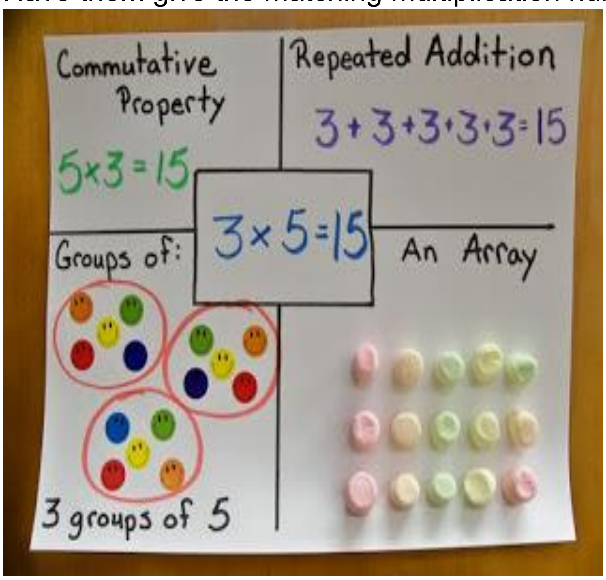
Ask students to record their estimate in their journal and then write about how they arrived at their estimate. For both tasks, the student is able to select and use an appropriate referent (10, 25, 100) make a reasonable estimate explain his or her thinking

Multiplication arrays:

Suggestions instruction for a researcher:

Commutative Property of Multiplication: Show students an array.

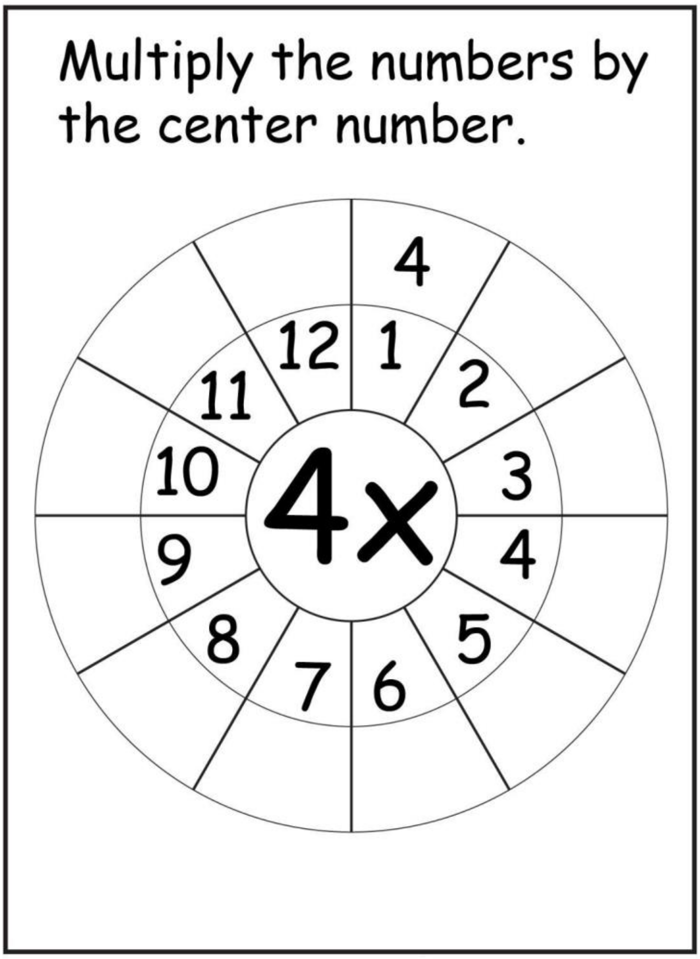
Have them give the matching multiplication number sentence?



Now, turn the array and have students to give the matching multiplication number sentence.

Ask: Did the number of objects change? Why or why not?

Do you think that this will be true for all arrays?



Instruction for a researcher: Ask a student if you can play with him/her?

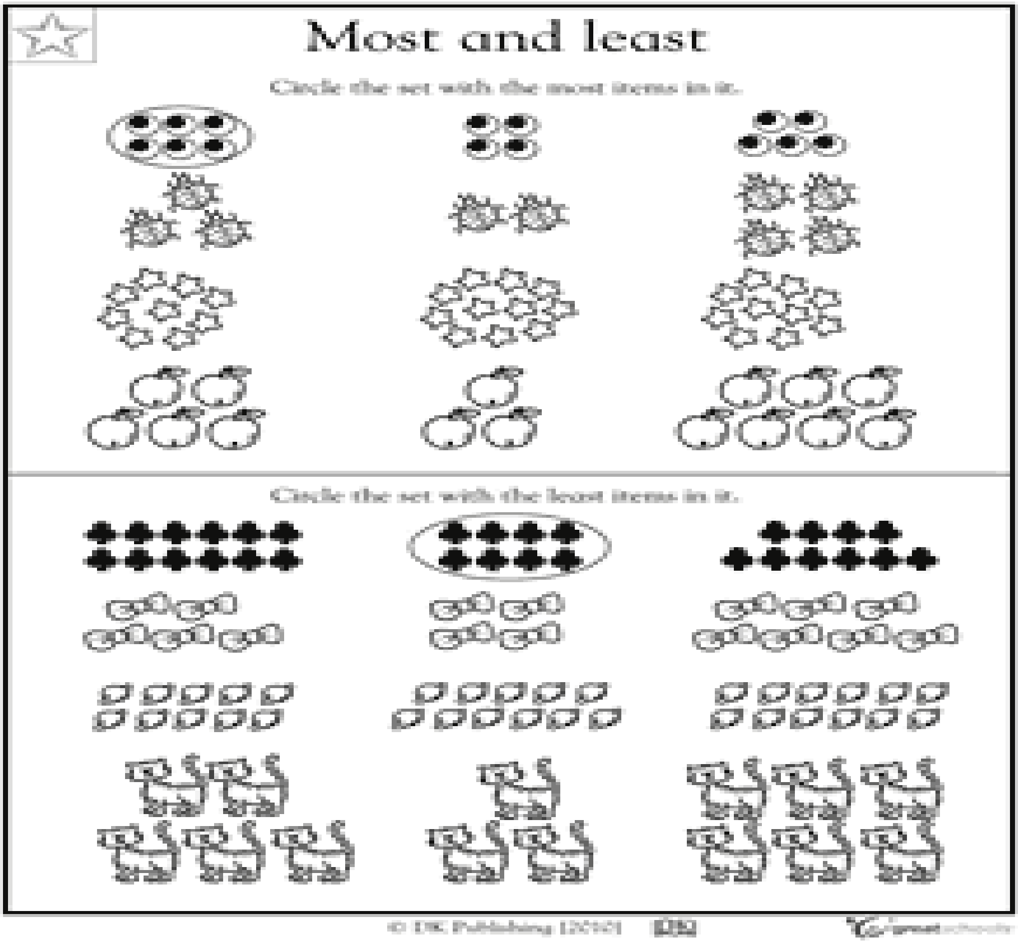
Give them a clear picture of the multiplication board/circle (array)

Ask a student if they would be able to guess the rule for multiplication?

If so what will happen if the number in the centre is been multiplied by 1?

Allow students to then complete or make their own arrays from grid paper to investigate.

Have them explain their findings in their math journals?



From the picture above request learners to use their pencils or colour pens in trying to highlight or circle the numbers.

Researcher: ask student to circle the lower number in the first block against more in the first part

Researcher: student is then requested to used highlighted or circled numbers to find the totals in each line per block.

Researcher: give the student chance to see what is the first step she/he will be following in trying to add those numbers

Researcher: ask them to write their answers down once they are done adding

Researcher also request the student to use the same highlighted arrays or number in a row per block to multiply and get answers

Ask the student any question related to multiplication to check if they still remember or they understood the multiplication rule

Allow the student to show their calculations using the piece of paper which will be attached with each clinical interview after the session

Thank you for your participation

Appendix E: Consent form for parents

Who we are
I am Neo Hendrick Seseng from the Central University of Technology.

What we are doing
We are conducting research on **an investigation on how foundation learners engage with multiplicative thinking in Motheo District: Do numbers make sense.** We will test your child to understand her level of numeracy vocabulary s/he attained to prepare for improving numeracy learning in the classroom. We will also ask your permission to observe in your child's classroom while they are learning on dates negotiated with his/her practitioner. We intend to use the data for reporting purposes only and all information gathered will be reported confidentially, your child's name will not be recorded, mentioned or appear in our reports.

Your participation
We are asking you whether you will allow us to administer these tests and classroom observations with your child. The test will take 30 to 35 minutes to complete. The information gathered from these observations will be captured in an electronic data base.

Please understand that **your child's participation is voluntary** and you are not being forced to allow him/her to take part in this study. The choice of whether your child takes part or not, is yours alone. If you choose not to allow your child to take part in the test and questionnaire the child will continue learning without being treated unfairly However, we would highly appreciate if you allow your child to participate.

Confidentiality

The information collected during the study will be electronically archived and only used for research purposes now or in future. In reporting the study pseudonyms will be used to protect the identity of your child.

Risks/discomforts
At the present time, we do not see any risks in your child's participation. The risks associated with participation in this study are no greater than those encountered in daily life.

Benefits
There are no immediate benefits to your child from participating in this study. However, this study will be extremely helpful to us as we hope to learn more about the participants of this study and their educational outcomes which will help us make useful recommendations to the department of education and research community.

If you would like to receive feedback on our study, we will record your phone number on a separate sheet of paper and can send you the results of the study when it is completed.

Duration of data collection
Please be advice that the clinical interview as one of the data collection tool will be administered during school out, from 13:30 till 14:30. This process will happen twice a week for 2 weeks. The classroom observation which will use videotaping will and observation form will take place during the teaching and learning period, from 11:00 till 12:00 (1 hour) twice a week for two weeks

Who to contact if your child has been harmed or have any concerns

This research has been approved by the CUT Research Ethics Committee. If you any complaints about ethical aspects of the research or feel that you have been harmed in any way by participating in this study, please call the CUT's REC Administrator's number 051 507 4130 e-mail researchoffice@cut.ac.za

If you have concerns or questions about the research you may call the project leader Nosisi Feza at 051 507 3751.

If, you want to check that I'm a researcher or employed by the CUT then please call any of the numbers above or check this website www.cut.ac.za .

CONSENT

I hereby agree to allow my child participate in research on **an investigation on how foundation learners engage with multiplicative thinking in Motheo District: Do numbers make sense.** I understand that I allow my child to participate freely and without being forced in any way to do so. I also understand that I can stop my child from participating at any point should I not want him/her to continue and that this decision will not in any way affect my child negatively.

I understand that this is a research project whose purpose is not necessarily to benefit my child personally in the immediate or short term.

I understand that my child's participation will remain confidential.

……………………………..
Signature of parent/guardian **Date**:…………………..

I also allow that the classroom observations conducted with my child are video-taped.

……………………………..
Signature of parent/guardian **Date**:…………………..

Appendix F: Principal consent form

**GRADE 3 MATHEMATICS STUDY MATHEMATICS:
PRINCIPAL CONSENT FORM**

Dear Sir or Madam,

I am Neo Hendrick Seseng. A master of education candidate at the Central University of Technology and our organization is conducting a study. **An investigation on how foundation learners engage with multiplicative thinking in Motheo District: Do numbers make sense?**

This project will be conducted under the supervision of Professor. N.N FEZA at the Department of Post graduate studies (Education).

The significance and benefit of this study is that it addresses the lack of research with regards to understanding how foundation learners learn mathematics using number concepts. It will contribute to distinguish the challenges that contribute towards positive learning and high learner achievement while learning mathematical concepts. I commit to ensure that I provide the participants with a copy of the thesis upon completion of the study. If you require any further information, please do not hesitate to email me at the following address: nsesing35@gmail.com or call me via 071 771 9780 in order to address any enquiries or questions you may have about the study. I sincerely hope that you will consider approving this request.

We are requesting you to grant permission for the CUT researcher to gain access to your school to conduct this research. This will entail the following:

- Negotiating consent with your Educators
- Administering learner's clinical interviews
- Negotiate consent with parents of Grade 3 learners
- Videotaping lessons selected by educators for sharing
- Only one researcher will administer both activities with both the learners and educator's using the 13:30 till 14:30 time for clinical interviews with learners and 10:00 till 11:00 time for lesson observation as per approval
- The data will only be collected on negotiated dates for a period of 2 weeks' maximum coming two times per week

Please understand that giving me access to your school is voluntary. The choice of whether you allow me to conduct research in your school or not is yours alone. If you choose not to give access, your school will not be affected in any way whatsoever. If you allow me access, you may stop the research at any time. There will be no penalties for withdrawal and your school will not be prejudiced in any way. However, I would really appreciate it if you permit me to come and conduct research in your school.

The information collected during the study will be electronically archived and only used for research purposes now or in future. The information will remain confidential and there will be no "come-backs" from the answers you have provided. That means the information is for research purposes only.

Who to contact if you have been harmed or have any concerns

This research has been approved by the CUT Research Ethics Committee. If you any complaints about ethical aspects of the research or feel that you have been harmed in any way by participating in this study, please call the CUT the REC Administrator at 051 507 3751 researchoffice@cut.ac.za

If you have concerns or questions about the research you may call my supervisor Prof. Nosisi Feza at 051-507-4130.

If, prior the classroom observations, you want to check that I'm a researcher or employed by the CUT then please call any of the numbers above or check this website www.cut.ac.za .

Please complete the attached consent form if you allow me to conduct research in your school and one of our researchers will collect it from your school.

I hope you will favourably consider my request.

Yours sincerely,
Neo Hendrick Seseng
Cell no: 071 771 9780
Email: nsesing35@gmail.com
Master Of Education Candidate at the Central University Of Technology Free State.

PRINCIPAL CONSENT

I hereby give consent for my Grade R practitioners and learner to participate in the CUT research on **exploring multilingualism in enhancing Grade R numeracy teaching and learning**. I understand that my school is participating freely and without being forced in any way to do so. I also understand that I can stop the data collection process at any point and that this decision will not in any way affect my school negatively.

I have received the telephone number of a person to contact should I need to speak about any issues which may arise in this data collection process.

I understand that this consent form will not be linked to the data collected and my school will not be mentioned in the reporting of this study.

I understand that if at all possible, feedback will be given to my school on the results of the completed research.

………………………………..
Signature of Principal **Date**:…………………..

Appendix G: Approval to conduct a research

education

Enquiries: MZ Thango
Ref: Notification of research: N.H. SesengDepartment Education of Tel. 082 537 2654 FREE STATE PROVINCE
Email: MZ Thanqo@fseducation.qov.za

District Director
Motheo District

Dear Mr. Moloi

NOTIFICATION TO CONDUCT RESEARCH PROJECT IN YOUR DISTRICT BY N.H. SESENG

The above mentioned candidates were granted permission to conduct research in your district as follows:

Topic: An investigation on how foundation learners engage with multiplicative thinking in Motheo District of South Africa: Do Numbers makes sense?

1. List of schools involved: Castle Bridge, Nkgothatseng Intermediate, Sebabatso and Pontsheng primary schools.

2. Target Population: Thirty grade 3 learners and three educators teaching grade 3 at the selected primary schools.

3. Period of research: From the date of signature of this letter until 30 September 2021. Please note the department does not allow any research to be conducted during the fourth term (quarter) of the academic year nor during normal school hours. The researcher is expected to request permission from the school principals to conduct research at schools.

4. Research benefits: The study will provide the department of basic education with broad knowledge on how learners in the early grades (foundation) engage in multiplicative thinking using the number concepts and how learning environments can be used to cater for a" genders in enhancing the focus of effective learning and mathematical development amongst the grade 3 learners and also suggest ways in which the DBE can employ when to ensure that learning takes place in equitable ways from the early grade(s).

5. Strategic Planning, Policy and Research Directorate will make the necessary arrangements for the researchers to present the findings and recommendations to the relevant officials in the district.

RESEARCH NOTIFICATION. N.H. SESENG. 03 MAY 2021, MOTHEO DISTRICT

Stategk Mannir4 R%earch & Policy Directoraæ Private Bag X20%5, Bbemfonteln, 9300 - Thuto House, Room 101, Floor, St Andrew Street, Bloemfontein

Enquiries: MZ Thango
Ref: Research Permission: N.H. Sesengeducation
Tel. 082 537 2654
Email: MZ.Thanqo@fseducation.qov.zaDepartment oi

Education

APPROVAL TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

This letter serves as an acknowledgement of receipt of your request to conduct research in the Free State Department of Education.

Topic: An investigation on how foundation learners engage with multiplicative thinking in Motheo District of South Africa: Do Numbers makes sense?

1 . List of schools involved: Castle Bridge, Nkgothatseng Intermediate, Sebabatso and Pontsheng primary schools.

2. Target Population: Thirty grade 3 learners and three educators teaching grade 3 at the selected primary schools.

3. Period of research: From the date of signature of this letter until 30 September 2021. Please note that the department does not allow any research to be conducted during the fourth term (quarter) of the academic year. Should you fall behind your schedule by three months to complete your research project in the approved period, you will need to apply for an extension. The researcher is expected to request permission from the school principals to conduct research at schools.

4. The approval is subject to the following conditions:

4.1 The collection of data should not interfere with the normal tuition time or teaching process.

4.2 A bound copy of the research document should be submitted to the Free State Department of Education, Room 101, 1 st Floor, Thuto House, St. Andrew Street, Bloemfontein or can be emailed to the above mentioned email address.

4.3 You will be expected, on completion of your research study to make a presentation to the relevant stakeholders in the Department.

4.4 The ethics documents must be adhered to in the discourse of your study in our department.

5. Please note that costs relating to all the conditions mentioned above are your own responsibility.

Yours sincerely

Mr. J.S. Tladi
Acting DDG: Corporate Services

DATE: 23/05/2021

RESEARCH APPLICATION BY N.H. SESENG, PERMISSION LETTER 03 MAY 2021. MOTHEO DISTRICT

Strategic Research & Polky Private Bag X20%St Bbemfmtein, 9300 • Thuto Houæ, Room 101, Floor, St Street, Bloemfmtein

Appendix H: Research Ethics Approval

RESEARCH ETHICS APPROVAL

Date: 22 April 2021

This is to confirm that ethical clearance has been provided by the Faculty Research and Innovation Committee **[01/06/16]** in view of the CUT Research Ethics and Integrity Framework, 2016 with reference number:

HREIC 22/04/2021

Applicant's Name and student number	Mr NH Sesing 214 011 003
Supervisor's Name for Student Project	Prof NN Feza
Level of Qualification for Student's Project	M.Ed
Tittle of research project	An investigation on how foundation learners engage with multiplicative thinking in Motheo District of South Africa: Do numbers make sense?
FRIC Resolution Number	FRIC 04/21/01

All conditions as set out below have to be met as set out in your LS 262 a form.

As this research focuses primarily on human beings you will be ethically responsible for the following:

- protecting the rights and welfare of the participants;
- gaining the trust and co-operation of all the participants with the assurance that the information collected will be kept confidential;
- informing the participants from the outset that their participation will be voluntary, and that the data collected will be conducted with the consent of the Free State

Department of Education, the principal(s) of the sample school(s), the teachers, and the learners;

- adhere to the principles of rigorous data collection, analysis and interpretation consistent with the design of the study;
- keeping a data trail for possible auditing purposes and safe-keeping of raw data for a period of three years after publication of the results/findings; Respecting the confidentiality of the data.

We wish you success with your research project.

Regards

Prof JW Badenhorst

Chairperson: Humanities Research Ethics and Innovation Committee

Appendix I: Language and technical editing certificate

Declaration

9 November 2022

PO Box 4
Otjiwarongo
Namibia
+264 813359120
hettie.human@gmail.com

Master's thesis: Do numbers make sense: an investigation on how foundation phase learners engage with multiplicative thinking in Motheo District, South Africa

Student: Neo Hendrick Seseng

I confirm that, in April 2022, I edited the thesis, indicated sources that are cited that did not appear in the reference list, and recommended changes to the text.

After the thesis had been assessed and changes recommended, I once again checked selected portions of the texts. I did not reread the thesis as a whole.

H Human

MA Language Practice

Hettie Human
WRITER | EDITOR | TRANSLATOR | INTERPRETER

+264 813 359 120 | hettie.human@gmail.com

Appendix J: Plagiarism report

DO NUMBERS MAKE SENSE: AN INVESTIGATION ON HOW FOUNDATION PHASE LEARNERS ENGAGE WITH MULTIPLICATIVE THINKING IN MOTHEO DISTRICT, SOUTH AFRICA

ORIGINALITY REPORT

13%	12%	3%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	pdfs.semanticscholar.org Internet Source	2%
2	hdl.handle.net Internet Source	2%
3	Www.lectitopublishing.nl Internet Source	<1%
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