STRATEGIES TO ENHANCE PERFORMANCE OF FOUNDATION PHASE GRADE 3 LEARNERS IN DIVERSE MATHEMATICS CLASSROOMS IN THE WATERBERG DISTRICT

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DEDICATION

This work is dedicated to my mother Mehlaba Elizabeth Sambo, my daughter Hlulani and my brothers and sisters. May God richly bless you.

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I should like to take this opportunity to thank my Heavenly Father for giving me life and making it possible for me to complete this project. The word of the Lord from the Amplified Bible, Psalm 37: 2-3 “Trust in the Lord, and do good. Dwell in the land and enjoy safe pasture. Also delight yourself in Yahweh, and He will give you the desires of your heart”. Luke 12: 3 “Seek God’s Kingdom, and all these things will be added to you”. These scriptures always strengthen and encourage me.

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ABSTRACT

Worldwide, mathematics is regarded as one of the most important subjects, where it has been recognised that basic mathematical and quantitative skills are becoming increasingly important in all jobs and life skills, for tasks including budgeting and data handling, and the changing nature of the international economy. The purpose of this research was to explore the strategies that can enhance the performance of Foundation Phase learners in diverse mathematics classrooms. The performance of Foundation Phase learners in diverse mathematics classrooms is an issue of concern because teachers should identify different strategies that can accommodate the needs of all learners in the Grade 3 class. The study was underpinned by the Universal Design for Learning theory, which recognises the need of making education more responsive to learning differences between individuals, as well as increasing the power of flexibility in teaching. The Universal Design for Learning also emphasises that the "what" of learning should be presented through a range of options, providing options for the "how" of learning, and providing multiple options for engaging the "why" of learning. The study infused *ubuntu* African philosophy because it focuses on humanity, kindness, friendliness, respect, mutual communication, care, and support during teaching and learning. The research study followed a mixed-method research design. Data collection techniques took place through conducting pre-test and post-test, using interviews and lesson observations. Excel was used for data management, and Stata Release 15 was used for statistical data analysis. A t-test was used to compare the two study groups, the experimental and the control groups. The results were interpreted at 95% confidence limit (2-sided). In other words, the results were declared significant if the p-value was less than 0.05. The post-test results after the intervention strategy showed improvement for both experimental and control groups. In particular, the experimental group showed an improvement in the mean score ($\bar{x}$ = 55.05455) as compared to the pre-test mean score of ($\bar{x}$ = 40.70175). The results revealed that the experimental group improved significantly ($\bar{x}$ = 0.0016) in pre-test and post-test, less than 0.05 at 95% confidence limit in the post-test, which suggests that the intervention strategy had a positive impact on learning numbers, operations and relationships (NOR) concepts. From the qualitative data, different codes to form different themes were identified and used to describe the collected data during lesson observations and interviews. The group work had a positive impact on the changing of P1's teaching practice, where the learners' performance improved. It is envisaged that

the findings of the study might provide teachers with strategies that can be used to enhance learners' performance in diverse mathematics classrooms.

Keywords: diversity, foundation phase, learning barriers, performance, strategies, effective learning, intervention, mathematics

LIST OF ABBREVIATIONS AND ACRONYMS

ACER	Australian Council for Educational Research
ANA	Annual National Assessment
CAST	Center for Applied Special Technology
CEDU	College of Education
DBE	Department of Basic Education
DoE	Department of Education
FAL	First Additional Language
FP	Foundation Phase
GPLMS	Gauteng Primary Language and Mathematics Strategy
HL	Home Language
IP	Intermediate Phase
IRR	Institute of Race Relations
LoLT	Language of learning and teaching
NECT	National Education Collaboration Trust
NEEDU	National Education Evaluation and Development Unit
NOR	Numbers, operations and relationships
OECD	Organisation for Economic Co-operation and Development
PDST	Professional Development Service for Teachers
SACMEQ	Southern and Eastern African Consortium for Monitoring and Educational Quality
TIMSS	Trends in International Mathematics and Science Study
UDL	Universal design for learning
UNICEF	United Nation Children's Fund
USA	United States of America
WP	White Paper 6
ZPD	Zone of Proximal Development

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CHAPTER ONE

ORIENTATION TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND TO THE STUDY

There is a need for Foundation Phase (FP) learners to acquire basic mathematics skills, knowledge and understanding to improve their performance. Mathematics is a scarce skills subject, in which learners in South Africa (SA) do not perform well. According to Rickard (2013:6), “Basic mathematical concepts and numerical skills are considered in almost all careers and life-skills, for duties including making financial arrangements, data handling and the altering nature of the worldwide economy”. People with mathematical skills and knowledge are in high demand both in the country and abroad. Industry specialists, specialists in science and technology and the public in general, express the need for mathematics in this Fourth Industrial Revolution (4IR) era in which we are living. According to the Department of Basic Education (DBE) (2011a:8), mathematics is necessary to develop procedures that improve rational thinking, critical thinking, intellectual accuracy, and problem-solving skills that are needed in decision-making. It is vital that as early as the FP, learners acquire mathematical skills, knowledge and understanding that will help them manoeuvre in this era.

Every individual learner is exceptional and acquires knowledge differently. Therefore, teachers must possess knowledge about different teaching methodologies and strategies that can be applied in diverse classrooms. McAteer (2012:8) asserts that effective mathematics teaching requires teachers who possess different mathematical teaching skills and fluency in the subject to extend the learners’ knowledge, skills and understanding. Teachers with varied skills and fluency in mathematics are important for the effective teaching and learning, and for good performance of learners. Mathematics teachers in the FP must possess relevant skills and fluency in the subject to accommodate all learners so that no learner experiences barriers and under -performs in mathematics.

It is the right of every learner to perform at their best level, irrespective of the language they speak, where they come from or their socio-economic conditions. In SA, most schools admit learners who speak different languages, both from within the country and from neighbouring countries. In the FP, mathematics is taught in African languages, especially in previously disadvantaged schools. Although most schools admit multilingual learners, these learners are taught mathematics in the language that is adopted by the school. As such, most learners still learn mathematics in a language that is not their home language. Considering this, the researcher assumed language as another barrier that causes learners' poor performance in mathematics. The National Education Evaluation and Development Unit (NEEDU, 2013:35) states that even though mathematical terminologies for mathematical concepts and processes are developed in African languages, teachers are not always familiar with them, nor are they used in everyday commercial transactions. As such, this creates a barrier for learners to understand what is taught, and eventually this causes them not to perform well in the subject. Chinn (2016a:101) contends that understanding mathematics is highly dependent on language.

Communication and understanding are important for learners to perform well. According to Landsberg, Kruger and Swart (2019:217), multilingualism may contribute to difficulties in mathematics. Learners require support to improve their performance, and it is a reality that many learners in SA are not familiar with the language used for teaching mathematics. Acknowledging multilingualism and diversity can work in teachers' favour as this will help them to access numerous learning approaches, communication designs and language texts (Cruz, Ellerbrock, Vasquez & Howes, 2014:13). This means that language diversity should be appreciated and embraced. Teachers should be conscious of this so that they can devise means of accommodating and supporting all learners in their classrooms.

Westwood (2016:12) maintains that the knowledge that learners possess must guide the teacher's choice of teaching methodologies, and the preparation and arrangement of the curriculum. A teacher should ensure that s/he know the strengths and weaknesses of all learners in the classroom and support them accordingly. Teachers must be able to identify previous knowledge of individual learners and how every learner acquires knowledge so that they can plan according to those needs, as it is the right of every learner to receive a curriculum that meet their needs. According to the Department of Education (DoE, 2003:6), learners have different experiences, interests, strengths and barriers to learning, which need to be identified so that they can be accommodated. Teachers must differentiate their teaching in an inclusive classroom to accommodate the diverse needs of all learners. Westwood (2013:12) states that curriculum differentiation is a procedure that distinguishes and acknowledges the variances amongst learners, and teachers need to alter the curriculum and change teaching methods where there is a need. Marishane, Marishane and Mahlo (2015:254) argue that curriculum differentiation requires well-positioned teachers, who can provide the best learning support to ensure access. Curriculum differentiation requires teachers who can identify learners' strengths and weaknesses and know how to accommodate these in their teaching. Marishane et al. (2015:255) further argue that to comprehend the necessity of curriculum differentiation in the teaching of mathematics, the teacher must recognise the setting in which the curriculum is offered.

According to the DBE (2011b:4), curriculum differentiation comprises adjusting, varying, familiarising, extending and changing teaching practices, teaching approaches and appraisal strategies. This requires teachers with the knowledge to ensure that all learners are accommodated, and effective teaching and learning take place. Evers (2011:19) asserts that equality in mathematics education entails acknowledging that the requisite standards are kept while flexibility in instructional approaches and procedures of assessment acknowledge the abilities and weaknesses of all the learners. Effective mathematics classroom practices include acknowledging learners' previous knowledge and planning tasks that permit flexibility to provide for every learner.

In 2015, The National Education Collaboration Trust (NECT) was introduced in the Waterberg district to assist learners improve their performance in mathematics and reading in both Home Language (HL) and First Additional Language (FAL). To date, the NECT programme is continuing, however, the performance in mathematics in the district is still far behind. McAteer (2013:8) remarks that learners who are very low achievers in mathematics at seven years are likely to remain so at eleven and will never master most foundational mathematical skills throughout their schooling. Learners should master basic mathematics skills in the early grades so that they are not identified as learners with learning barriers or are misidentified as having special learning needs. Landsberg, Kruger and Swart (2019:217) present that there is a link between the internal and external factors that affects the ability of the learners to master mathematical concepts. Learners' poor performance in mathematics might be due to application of strategies not accommodating and supporting their learning and understanding. There appears to be limited support or little attention to strategies that can be employed to support FP learners and Grade 3 learners, in particular, in diverse mathematics classrooms. Hence, different strategies need to be identified to enhance the teaching and learning of numbers, operations and relationships to FP learners in the diverse mathematics classrooms.

1.2 RATIONALE FOR THE STUDY

The study investigates and explores different strategies that could be used to improve teaching and learning of mathematics in FP and therefore, the performance of learners so that they grasp basic mathematics concepts before progressing to the Intermediate Phase (IP). By exploring strategies, this allowed the researcher to understand the various strategies applied by teachers in their classrooms to teaching numbers, operations and relationships to Grade 3 learners. The study focuses on the different strategies that can be used to improve the performance of learners so that they grasp basic mathematical concepts before progressing to the IP. Sagor and Williams (2017:1) present that learning in a diverse society should improve young learners' appreciation for arts and culture, capabilities to comprehend and have compassion and their ability to solve problems. It is imperative to develop a solid foundation of basic mathematics skills for FP learners so that they can apply the knowledge in higher grades. According to the DBE (2011a:10), FP mathematics produces the connection between early childhood experience and life outside school experience on the one hand, and the intellectual mathematics for the following classes on the other hand. If there is no link between mathematics in pre-school life, the learner may not perform in mathematics.

Learners come across mathematical concepts in their daily lives, hence, there is a need to identify strategies that could be adopted to enhance Grade 3 learners' performance in numbers, operations and relationships (NOR) in diverse mathematics classrooms. Landsberg et al. (2019:212) proclaim that when children enter school, many of them are aware of some basic mathematical concepts, and they reveal their awareness of these concepts at an early age. Learners need to grasp topics of numbers, operations and related concepts since mathematics is considered one of the subjects required to progress into the IP.

The current study was conducted in two phases, namely phase one and phase two. Phase one investigated the performance of Grade 3 learners before the application of the strategies on numbers, operations and relationships, while phase two investigated the performance after the application of the strategies. The teaching strategies advocated focused on learners' involvement, accommodation and support; and the assessment to measure performance. The researcher examined the types of questioning used for the assessment tasks and the resources applied during the teaching and learning processes. The study assisted the researcher in identifying the strategies that could be used and which accommodate the diverse needs of learners as well as improve learners' performance in NOR. The strategies helped learners to acquire basic mathematical concepts and established a good foundation for learning mathematics.

1.3 THE PROBLEM STATEMENT

Grade 3 mathematics performance in the Waterberg District, in particular, the Nylstroom circuit, is not pleasing. Most previously disadvantaged schools in the area are still under-resourced and have a large number of learners from different language backgrounds. Furthermore, most learners in the Nylstroom circuit also do not reach the district level performance target in reading and writing. In addition, most teachers in the FP are not exposed to various teaching strategies for teaching mathematics in diverse classrooms. This is indicative of the poor performance of schools in the circuit in FP mathematics. Feza (2015:1) confirms that SA learners perform poorly in mathematics, regardless of all the means the country is doing to improve the situation. This indicates that assessments of mathematics education point to the lack of basic knowledge as a major factor for poor performance, especially in previously disadvantaged schools (Ibid). A study conducted by Essien and Sitabkhan (2017:5) in SA, Kenya and Malawi reveals that the Grade 3 learners do not perform well in mathematics because teachers are not provided with adequate training to effectively apply the teaching strategies, such as code switching, in multilingual classrooms.

Graven and Venkat (2017:13) assert that the immediate switch from learning mathematics in mother tongue to English when learners are promoted from Grade 3 to Grade 4, contributes to the drop in national results from the average of 56% in Grade 3 to 37% in Grade in 4. Similarly, Dhlamini (2021:15) indicates that learners who were taught mathematics in their home language (HL) from Grade 1 to 3 experience challenges when they transit to mathematics in English in Grade 4. Graven and Venkat (2017) continue that learners have difficulties with problem-solving as a skill in mathematics as this requires them to understand the mathematical language which should now be in English. This affects learners' ability to mathematically express themselves clearly and adequately and ultimately leads to them dropping mathematics in Grade 9. This is an indication that the mathematical 'crisis' begins in the FP.

The Trends in International Mathematics and Science Study Report (TIMSS, 2015) established that South African learners in Grade 3, 6 and 9 fared poorly when compared to their peers in fifty-seven countries. SA learners are rated among the five worst performing in mathematics with Singapore identified as the best performing nation in mathematics (TIMSS, 2015). SA was in position fifty-two, which indicates the urgent need to improve learners' performance in mathematics. TIMSS assesses the learners' application of reasoning skills, and the results are used to help the country to improve the teaching and learning of mathematics and science. Learners who understand and acquire mathematics skills can apply the skills in relevant real life situations. Mathematical skills allow learners to participate in global change, where mathematical knowledge is needed. In the FP, learners must be taught mathematical capabilities that will provide them with various chances 'to solve, speak and record' their mathematical reasoning (DBE, 2011a:10). If learners are not fully exposed to mathematical experiences in the early grades, their opportunities of understanding the concepts at the higher grades are limited.

According to the Organisation for Economic Co-operation and Development (OECD), the South African education system is ranked 75th out of 76 countries of the world (South African Institute of Race Relations (IRR), 2018:3). The rankings were decided after assessing how well learners performed in mathematics and science. This might go some way towards explaining why SA did not perform as well in mathematics compared to other countries. According to the IRR (2018:4), and the Southern and Eastern African Consortium for Monitoring and Educational Quality (SACMEQ), SA improved in Mathematics from 9^{th} in 2007 to 6^{th} in 2013, out of 16 countries. However, this raised considerable concern about the SACMEQ assessments as the results from teachers' assessments declined from 80% in 2007 to 32,9% in 2013. According to TIMMS, the Western Cape and Gauteng are the best performing while the North West and Eastern Cape were the worst-performing provinces.

The researcher assumed that many teachers are teaching learners in a uniform and standardised way, while not accommodating or supporting other learners, who are experiencing learning barriers. Teachers should be able to apply different strategies in their teaching to accommodate and support individual learners. Furthermore, teachers needs to be aware of learners' prior knowledge to identify the relevant teaching and learning strategies that can accommodate all learners. Science and technology are the future and promise to be pervasive in the workplace and everyday life, thus, the demand for mathematical understanding and the ability to formulate and solve complex problems. Witzel and Little (2016:7) state that mathematics is not only important to learners in school but is vital for their social life and skills needed in the future. Mathematics provides every individual with the knowledge and skills needed to function completely in the present complicated economies. Learners without the knowledge or skills of mathematics lacks some of the tools crucial in their daily lives to make sound decisions.

Witzel and Little (2016:5) state that learners develop mathematical phobia early in school, because they misunderstand the concepts early on, or cannot follow the procedures to solve problems. It is crucial to building learners' love of mathematics early on in their school career. Venkat, Rollnick, Loughran and Askew (2014:4) argue that a certain threshold of content knowledge is needed for effective teaching of mathematics. Teachers must be well-informed about mathematical content to become effective mathematics teachers in the FP. Nationally and internationally, mathematics and science education face challenges, such as an increasing need for mathematics and science teachers and graduates. Venkat et al. (2014:5) further state that teachers' knowledge in mathematics continues to be a field that excites considerable interest in public debates, driven by ongoing concerns about poor student performance in many countries. If learners do not have a strong foundation in mathematics, their performance in the subject will always be affected, and they may end up disliking it.

According to DoE (2001:16) White Paper 6 (WP 6), learners experience problems in learning due to the system being incapable of incorporating and appreciating the variety of their learning needs or abilities and as such, they need to be supported. The lack of support may result in many disliking mathematics, impacting their performance, while creating a learning gap. Even though learners’ performance in mathematics is poor in SA, it is considered a passing requirement from FP to IP. This implies that learners' knowledge of mathematics needs to be improved so that their performance can be improved. Learners need to grasp most mathematical knowledge and skills early on so that they do not experience problems in higher grades. For this reason, it was crucial for the researcher to explore strategies that can be used to enhance the performance of Grade 3 learners in diverse mathematics classrooms.

1.4 HYPOTHESIS AND RESEARCH QUESTIONS

This study tested the following hypotheses to determine the significant difference between the two study groups and between the pre-test and post-test in the experimental group.

H_0 – There is no significant difference between the two study groups when using teaching strategies employed in this study.

H_1 – There is a significant difference between the two study groups when using teaching strategies employed in this study.

H_0 – There is no significant difference between the pre-test and post-test when using teaching strategies employed in the experimental group.

H_1 – There is a significant difference between the pre-test and post-test when using teaching strategies employed in the experimental group.

1.4.1 Research question

The study was guided by the following main question: What are the strategies that can be used to enhance the performance of Foundation Phase Grade 3 learners in diverse

Mathematics classrooms?

Secondary research questions

The following secondary research questions are used to help address the main question of the research study.

- How are teachers applying their teaching strategies to enhance the performance of the Foundation Phase Grade 3 learners in diverse Mathematics classrooms?
- What challenges are experienced by teachers when using those strategies in enhancing the performance of Foundation Phase Grade 3 learners in diverse Mathematics classrooms?
- What do respondents think would be the best teaching practices that could be employed to meet the performance needs of Foundation Phase Grade 3 learners in diverse Mathematics classrooms?

1.4.2 Aims of the study

The main aim of the study is to explore the strategies that can be used to enhance the performance of Foundation Phase Grade 3 learners in diverse mathematics classrooms.

- To explore how teachers apply teaching strategies to enhance the performance of the Foundation Phase Grade 3 learners in diverse Mathematics classrooms.
- To identify the challenges that are experienced by teachers in improving the performance of Foundation Phase Grade 3 learners in diverse Mathematics classrooms.
- To determine the best teaching practices that could be employed to meet the performance needs of Foundation Phase Grade 3 learners in diverse Mathematics classrooms.

1.5 RESEARCH METHODOLOGY AND DESIGN

The study follows a mixed methods research approach, where qualities of both quantitative and qualitative approaches are combined. De Vos, Strydom, Fouché and Delport (2011:434) note that the mixed methods approach comprises gathering both numeric and text data and evaluating quantitative and qualitative data. According to Maree (2016:313), a mixed methods approach can be used to address different research objectives. Employing the mixed methods approach enables the researcher to integrate data collected quantitatively and qualitatively (Creswell & Creswell, 2018a:214). The mixed methods helps the researcher to identify strategies and to take actions to help alleviate the problem, as well as evaluate the development and outcomes of the programme (Maree, 2017:313). Collected data from conducted interviews with teachers and performance from learners were used to find the solution to the problem under study.

The researcher chose an explanatory research design through the application of mixed methods to explore the strategies that could be used to enhance Grade 3 learners' performance in diverse mathematics classrooms (Du Plooy-Cilliers, Davis & Bezuidenhout, 2014:197). The researcher collected quantitative data through a pre-test, which eventually was used to build interview questions to collect qualitative data (Creswell & Creswell, 2018b:223), to explore the performance of learners in NOR in Grade 3 diverse classrooms. Cohen, Manion and Morrison (2018:440) advocate for looking at the problem, looking at the areas of benefit and identifying solutions to the problem. Similarly, Du Plooy-Cilliers et al. (2014:197) point out that research design helps in finding ways to address the identified challenge and improve the situation while promoting professional growth and providing a change in the teaching and learning. Explanatory research design assisted the researcher to describe the teaching strategies that could be used to improve Grade 3 learners' performance in diverse mathematics classrooms while, at the same time, providing teachers with the solution to the identified challenge.

1.6 RESEARCH APPROACH

The researcher followed an explanatory, sequential, mixed methods design. Creswell and Creswell (2018a:128) state that in explanatory sequential design, the researcher begins with collecting quantitative data first and then explains it in-depth. Quantitative data was explored to formulate open-ended questions that were used to collect qualitative data from participants. The researcher used the findings from qualitative data together to identify the strategies that should be used for intervention (Creswell & Creswell, 2018a:129).

The sampled schools were divided into two groups, Group A (experimental group) and Group B (control group) where tests were administered. The researcher first assessed both the experimental group (Group A) and control group (Group B) (Maree, 2016:167). In this research study, the identified teaching strategies were implemented only with the experimental group (Group A) after the pre-test was administered, while no identified teaching strategies were implemented in the control group (Group B). The respondents in the control group continued teaching the same way s/he used to teach. The researcher embedded the action research method since it is cyclic and encompasses the qualities of applying pre-test, semi-interview, post-test and open-ended interviews. Action research is defined as a methodological process intended at enhancing the educational practices and their complexity, to comprehend and create knowledge (McNiff, 2010:16). Similarly, McMillan and Schumacher (2014:477) state that the action research can be used to provide teachers with information that can improve their daily teaching practices. Reconnaissance action research was chosen for the study. According to the Education and Training Foundation (ETF, 2021:7), reconnaissance is a situational analysis that is aimed at improving change to certain practices as well as producing a broad overview of the action research context and concerns. Reconnaissance action research gave teachers and the researcher a chance to examine what was not working and helped both to arrive at an understanding (ETF, 2021:20). Hence, discussions with participants assisted in identifying the strategies that could be used to enhance the performance of Grade 3 learners in diverse mathematics classrooms.

1.7 POPULATION AND SAMPLING

The researcher chose to conduct the research in the Nylstroom circuit of the Waterberg district of the Limpopo province because learners there were not performing well in mathematics (Pickard 2013:59). According to Pickard (2013:59), sampling is the procedure of selecting a few from a large population on which to do the research study, hence, the researcher chose the two primary schools out of 15. The study focused on two primary schools that were the worst performing in mathematics out of 15 in the Waterberg district. The two sampled teachers were teaching Grade 3 classes at the time when the research was conducted. The learners sampled from the two primary schools were 131 (Experimental group = 57 and Control group = 74) and they were from the ages of 8 to 10. The research was conducted with Grade 3 classes because Grade 3 is referred to as an exit grade. The results from both tests provided information indicating whether Grade 3 learners grasped basic mathematics or not. Du Plooy-Cilliers et al. (2014:142) note that purposive sampling comprises the characteristics that are recognised by the researcher or that can be accessed by the researcher.

1.8 INSTRUMENTATION AND DATA COLLECTION TECHNIQUES

The researcher chose a pre-test and post-test, interviews and lesson observations as research instruments for data gathering. The interviews were used to deeply explore how and why participants structured their thoughts in the manner that they do, and to create relationships amongst opinions, principles, experiences, views or conduct throughout (Cohen et al., 2018:506). Extensive interaction with the participants using data collection toolsm such as interviews and lesson observations, were used. Using open-ended questions in the interviews permitted the participants to respond according to their understanding and allowed the researcher to make follow-up questions where necessary (Mligo, 2016:136). According to Mack, Woodsong, MacQueen, Guest and Namey (2011:2), open-ended interview questions in qualitative methods allow flexibility and revision of the interaction between the researcher and the participants. Through interaction with the participants, the researcher was able to understand their perspectives.

Lesson observations were used as a tool to collect data. Maree (2016:90) notes that observation is a systematic way of collecting data by recording what happens in the natural setting without asking questions. The researcher observed naturally occurring events in the classrooms which helped to examine the events as they unfolded (for example, how teachers applied the strategies) were they ignored or taken for granted. Lesson observations helped the researcher to realise events that participants were un able to discuss in the interviews, this enabled the researcher to extend beyond the views expressed and to gain experience with participants (Cohen, et al., 2018:543).

The researcher arranged a proper time with participants to observe and understand the situation being described. The researcher observed how teachers taught and how they applied the strategies. Lesson observations allowed the researcher to record data that could not be recorded telephonically or any other means used that might have prevented the observation of what naturally occurred in the classroom (Creswell, 2014:239). The researcher was a non-participant observer in the baseline lesson observations, which allowed for the smooth collection of data, without any interference to participants. The researcher observed how teachers taught the learners in their classes, and how learners participated. In the second phase of the study, the researcher then became the participant observer in the lesson observations as the study followed action research in identifying strategies that could enhance learner performance in Grade 3 NOR.

1.9 DATA ANALYSIS AND INTERPRETATION

The researcher first analysed quantitative data in terms of numerical results of both pre-tests and post-tests (Creswell & Creswell, 2018b:219). Statistical analysis was used to synthesise and describe quantitative data through organising, summarising, and calculating the mean score (McMillan & Schumacher, 2014:163). The pre-test and post-test gathered data were firstly characterised as follows: Correct Answers (CA), Partially Answered (PA), Wrong Answers (WA), Number Reversal (NR) or Wrong Spelling (WS) and Not Answered (NA) for the answers to the questions (Didis & Erbas, 2015:1141). Then, the researcher analysed the qualitative data by coding and collapsing the codes into broader themes (Creswell & Creswell, 2018a:159). Thereafter, the researcher presented the collected data by first reporting the quantitative numerical data and then deliberating on the qualitative results that either agreed or disagreed with the numerical findings (Creswell & Creswell, 2018b:220).

For interpretation purposes, the researcher discussed data by comparing both quantitative and qualitative database results and qualitative data collected later after qualitative data was used to explain the quantitative data (Creswell & Creswell, 2018a:221).

1.10 CREDIBILITY AND TRUSTWORTHINESS

The researcher spent time interpreting collected data to ensure that data were interpreted accurately. The researcher ensured that the research findings were submitted to the participants to confirm their credibility and correctness (Bryman, 2012:391). Quantitative and qualitative data were interpreted in such a way as to invite the research readers to associate components of the study and their personal experiences or research (Maree, 2016:124).

The researcher has kept a journal that was used for note-taking during data collection and it is available for analysis. According to Maree (2016:124), the researcher must keep a journal during the research process for data gathering and analysis as that will help others to follow the researcher’s reasoning. The researcher ensured that the data collected is documented so that the readers can understand how it was analysed and interpreted.

Du Plooy-Cilliers et al. (2014:259) refer to confirmability as a procedure of how well the collected data support the outcomes and the interpretation of the researcher. The findings from the data were well interpreted and the correct methods were used. Maree (2016:125) asserts that the researcher must avoid developing the relationship with participants to reduce bias. The researcher managed to avoid having very close relationships with the participants, hence the importance of conducting the research was not missed. This enabled the researcher to observe what she intended to see. The researcher reproduced enough text to allow the readers to decide what the participants tried to express.

According to Cohen, Manion and Morrison (2018:245), validity establishes that a specific instrument measures what it proposes to measure. The researcher used a pre -test to measure the performance of the learners and then used the post-test to measure if the intervention strategies had a positive impact on improving learners' performance. For the research study to be reliable, it should establish that if it is carried out on a similar group of participants in a similar context, then similar results would be obtained (Cohen et al., 2018:268; McMillan & Schumacher, 2014:245). Hence, the researcher firstly administered the same test to a pilot study with another group that was not included in the study, but from the same population to ensure that the test was reliable and that it was going to measure the performance of Grade 3 learners in NOR.

1.11 ETHICAL CONSIDERATION

The researcher applied for an ethical clearance certificate from the College of Education (CEDU) at UNISA. Thereafter, the researcher approached the district office of the Limpopo Department of Education for permission to conduct the research from schools in the Nylstroom Circuit. Permission was also sought from the principals, SGBs of the two primary schools identified as well as from teachers and their learners. The schools were identified as Schools A and B to shield the distinctiveness of the schools participating in the research study. The researcher explained in advance the purpose of the research study to participants to ensure and make clear to them what they were consenting to (Coe, Waring, Hedges & Artur, 2017:60; Donley 2012:82). Participants were informed that their participation was voluntary and that they were free to withdraw from participating if they wished to do so during the process of the study (Cohen et al., 2018:117). The researcher assured the participants that their names would not be mentioned in the research study, but pseudonyms would be used to protect and maintain the confidentiality of participants (Coe et al., 2017:61).

1.12 LIMITATIONS AND DELIMITATIONS OF THE STUDY

The research studies has limitations. Du Plooy-Cilliers et al. (2014:275) assert that limitations are the restrictions in the research study that are beyond the researcher's control. The limitations of this study were time, because the researcher planned to conduct the study at a particular period, and then COVID-19 happened and this affected the availability of participants. Some of the participants withdrew from taking part, which, according to ethical research, should be expected and accommodated. The study focused on two primary schools that performed poorly in mathematics out of 15 primary schools in the Waterberg district. The study was limited to the two Grade 3 mathematics teachers and their learners.

There were also delimitations in the research study. According to Du Plooy-Cilliers et al. (2014:276), delimitations are all specific decisions made by the researcher before or during the research study. The research study was restricted to the Foundation Phase Grade 3 learners from poor performing schools in the Waterberg District of Limpopo. The aim was to explore the strategies that could be used to enhance learners' performance in diverse mathematics classrooms.

1.13 DEFINITION OF KEY CONCEPTS

Assessment: Hoadley, Jansen, Reed, Gultig and Adendorff (2012:198) define assessment as the process of assessing learners and is possibly important in deciding the evaluation measures so that learners comprehend what the proposed curriculum requires them to study as well as the level of intellectual reasoning they are required to achieve.

According to Van De Walle, Karp and Bya-Williams (2010:76), assessment is the procedure of collecting proof about a learner's knowledge of, capability to practice, disposition concerning mathematics and of creating interpretations from the proof for a variety of determinations. According to the DoE (2002:3), assessment must offer suggestions for learner attainment in the most active and well-organised way and ensure that learners participate and use their abilities. Assessment must support learners to decide on their performance, set goals for development and inspire additional learning.

Barriers to learning: According to the DBE (2005:9), barriers to learning refer to problems that occur within the entire education system, the learning location, and/or inside the learner him/herself which inhibit both the system and the learner's needs from being met. When established on the purpose of evaluation made by an educational mandate, it is determined that teaching and learning are hindered where such needs are not met.

Content: According to the DBE (2011:4), content refers to whatever learners are being offered to learn and what they are required to acquire, recognise, comprehend or be able to do. It incorporates evidence, ideas and skills that learners will attain in the learning situation.

Curriculum: According to Westwood (2016:17), the curriculum is the form of information, skills and identifications that a community programme desires to hand over to their children and young people. Westwood further contends that a curriculum is designed to develop effective learners, self-confident and inspired persons, and vigorous and conversant people. The curriculum is offered as a development of learning that ensures teachers, parents, learners and others in the broader community know what is to be imparted, and the excellence of learning anticipated of young people as they advance through school.

Curriculum Differentiation: According to the DBE (2011b:4), curriculum differentiation is a vital tactic for reacting to the requirements of learners with diverse learning techniques and desires. It considers learners' capability levels, desires and experiences. Curriculum differentiation can be accomplished at the level of subject matter, teaching practices, evaluation and learning situations.

Westwood (2016:18) defines curriculum differentiation as a tool that usually involves devising a variety of ways of moving towards the achievement of the main objectives, with some modifications for students with special needs. The challenge here depends on distinguishing objectives, activities and tasks without prolonging or stretching an accomplishment inequality that already occurs between the most able and least able learners. The guiding principle must be that a core curriculum should be modified while still ensuring that all students can participate as little as possible and succeed.

Diversity: The DBE (2011b:) defines diversity as a group of learners from dissimilar socio-economic, language, cultural, religious, ethnic, racial, gender, sexual orientation, capability groups, etc. Every one of these learners brings to a school their various forms of knowledge and practices.

Foundation Phase: The DBE (2011:a) defines the Foundation Phase as Grade R to 3, where ethics, manners and fundamental learning techniques are developed. This is the phase where formal schooling groundwork is laid. Learners in this phase range from the ages of five to nine years. This is a four-year phase, starting from Grade R where a learner is allowed to repeat only one time from Grade 1 to 3. The subjects in the phase are Home Language, Mathematics, First Additional Language and Life Skills

Inclusivity: According to the DoE (2003:6), inclusivity incorporates numerous social justice and human rights matters, and at the same time, it includes the various diversity of learners and societies for active and expressive decision-making and is operational for everyone one involved. Schools are encouraged to generate principles and practices that safeguard the full involvement of every learner regardless of their culture, race, language, economic background and ability. Every learner brings to the school their personal experiences, interests, strengths and barriers to learning, which must be taken into consideration.

Support: This refers to the co-ordinated interventions presented at schools and in classrooms to improve learning (DBE:2011a). Support could provide learners with learning resources and mentor peers in the classroom.

1.14 CHAPTER OUTLINE

Chapter 1: Introduction and overview

This chapter provides a general overview of the study that includes the introduction and background of the study, rationale and significance. It also includes the problem statement, research questions, aims and objectives, the purpose of the research and concept clarification.

Chapter 2: Theoretical framework

Chapter 2 provides the theoretical framework for information concerning the performance of learners in mathematics in diverse classrooms.

Chapter 3: Literature review

Chapter 3 provides a literature review in connection with the research study. It examines the literature on how teachers can support quality learning and improve performance.

Chapter 4: Research method and data collection

Chapter 4 describes the research process in detail including the research methodology that was used for the study.

Chapter 5: Presentation of the findings

The fifth chapter provides the raw data, analysis of the data and presentation of the findings of the research study.

Chapter 6: Discussion of the findings

This chapter presents the discussion of the results from the collected data through pre -test and post-test, open-ended interviews and lesson observations. The findings are compared to other related literature identified in the study.

Chapter 7: Conclusion and recommendations

This chapter summarises the results of the research study and presents the conclusion drawn from the study. Then the limitations and the recommendations for future study are also discussed.

1.15 CHAPTER SUMMARY

This chapter presented the introduction and background of the study. It also presented the rationale of the study, research problem, aims, objectives and research questions that needed to be answered. Research method, credibility and trustworthiness were also briefly discussed. Ethical considerations and both limitations and delimitations of the study are also discussed. Finally, definitions of the key concepts are provided.

CHAPTER TWO

THEORETICAL AND CONCEPTUAL FRAMEWORKS

2.1. INTRODUCTION

This chapter presents a universal design for learning (UDL), the theory that was founded by members of Center for Applied Special Technology's (CAST) in the 1990s. In this study, the Universal Design of Learning (UDL) employed strategies that could be used by teachers to enhance learners' performance in diverse mathematics classrooms. The strategies can either directly or indirectly influence the learners' performance. The study also incorporated active learning, Vygotsky's Zone of Proximal Development (ZPD), mediation, scaffolding, as well as *Ubuntu* African philosophy is used to understand the phenomenon being studied.

The study applied UDL because it encompasses the utilisation of successful teaching procedures, as well as the purposeful variation of instructional methods to meet the diverse needs of learners (Meyer, Rose & Gordon, 2014:13). UDL emphasises that the core curriculum should be adjustable for different learners' needs, instead of changing the learner for the curriculum (CAST, 2011:1). UDL encourages teachers to meet the challenges of learners with specific learning needs while enhancing learning for all and presents options for demonstrating what learners know (Meyer, Rose & Gordon, 2014:14). UDL is also rooted in concepts such as ZPD, scaffolding, mentors, and modelling (CAST, 2011:10).

2.2. UNIVERSAL DESIGN FOR LEARNING

Universal design for learning is an instructional preparation and conveyance framework that helps to address learning difficulties by proposing flexible objectives, procedures, resources and assessments, which empower teachers to meet various learning needs of learners in an inclusive classroom (CAST, 2011:4; Israel, Ribuffo &

Smith, 2014:6; La, Dyjur & Bair, 2018:3). Strategies that increase understanding and meaningful learning to enhance the performance of FP learners in diverse mathematics classroom are needed.

The theory focuses on providing all learners with reasonable and equivalent prospects to learn by including learners with various capabilities, experiences and enthusiasm within the general education curriculum (CAST, 2011:3). According to CAST (2011:3), UDL was developed because most curricula are incapable of changing to accommodate different learners. Members understood that learning included certain challenges in the subject matter and pointless barriers needs to be removed, without removing the necessary challenges. It was important to "fix" the curricula, and not the learner. The theory also focuses on providing teachers with various strategies, such as group work, differentiated activities, peer activities, use of technology, etc. These strategies can be applied in different learning environments and cater to the diverse needs of all learners (CAST, 2011:3).

The definition provides the understanding that teachers need to be flexible and use different strategies in their classrooms. Identifying and applying different effective strategies may assist with the improvement of learners' performance in mathematics. CAST (2011:4) further argues that the UDL framework generates flexible strategies from the beginning and possess adapted opportunities, which permit different learners to advance from where they are, rather than from where the teacher thought they should be. According to Harbour (2012:1), UDL is a teaching technique that functions to support the needs and capabilities of all learners and eradicates pointless hindrances in the learning process. The researcher needed to explore how the teachers apply the strategies in their classrooms and how learners were accommodated in diverse mathematics classroom.

According to Beamish, Brown, King and Palmer (2014:2), UDL stipulates a plan for generating instructional objectives, approaches, resources and assessments that accommodate every learner; it is not a single, one-size-fits-all solution, but changeable methods that can be modified for each learner's needs. The focus of the study was to identifying the strategies that are effective and support the needs of all learners in a diverse classroom. Padden, O'Connor and Barrett (2017:1) state that

UDL gives teachers a framework that supports reflection and embraces diversity. A diverse mathematics classroom requires a teacher who will identify the strategies that are suitable for learners, without leaving anyone behind.

Hall, Meyer and Rose (2012:3) recognised three groups of brain networks that can support teachers to improve and recognise how the brain functions throughout learning. The networks inspire concentration and enthusiasm for learning, provide information and subject matter in various ways and distinguish the ways learners can reveal what they know (CAST, 2011:11). The three groups of networks are:

- **Recognition networks** which are specialised to feel and signify the patterns we look at; they allow teachers to recognise and comprehend knowledge, concepts and ideas. This refers to the "what" of learning.
- **Strategic networks** which are predominantly associated with administrative purposes and specifically to create and administer intellectual and motor patterns. They allow teachers to design, implement and examine activities and proficiencies. This is the "how" of learning.
- **Affective networks** which are specialised to assess relationships and transfer emotional implications; they allow teachers to participate in assignments or activities with learning and with the world. This constitutes the "why" of learning.

The networks assist in the process of transforming information towards compatible knowledge, in preparing and co-ordinating determined measures in the classrooms, in motivating and engaging learners in active learning (Meyer et al., 2014:54). This implies that to balance teaching in the diverse mathematics classrooms, strategies to engage purposeful learning, recognition of information to be learned and processing of information by learners need to be identified and effectively applied.

Hall et al. (2012:3) proclaim that comprehending the recognition, strategic, and affective networks and their interrelationships can support teachers in realising the variations every learner introduces into the learning procedure, and the necessity for flexibility in the "what," "how," and "why" of learning. This emphasises the importance of recognising how individual learners learn and how to accommodate them during learning so that the teacher can identify strategies that will help improve learners' performance.

2.2.1. Primary principles of Universal Design for Learning

The three principles for UDL identified by CAST (2011) are Principle I, Principle II and Principle III. The three primary principles are grounded in neuroscience research, guide UDL and offer the fundamental framework for the recommendations. Hall et al. (2012:10) proclaim that the UDL recommendations are instruments that support teachers and curriculum designers in the instructional preparation stage and propose various prospective answers to address the barriers that various learners may face in classrooms. UDL guidelines are expected to provide Grade 3 teachers with solutions to address the learners' performance in numbers, operations and relationships. The three primary principles are: provide multiple means of representation (the "what" of learning); provide multiple means of action and expression (the "how" of learning); and provide multiple means of engagement (the "why" of learning). The three principles are discussed in detail below:

2.2.1.1. Principle I: Provide Multiple Means of Representation (the "what" of learning)

The focus of this principle is to explore the strategies that can be used to enhance the performance of FP learners in the diverse mathematics classroom. CAST (2011:5) claims that learners vary in the ways they see and understand the information offered. Different ways of presenting information to learners should be applied to allow them to acquire information and knowledge equally. Edin (2017:4) maintains that the teacher should use a variety of methods to present information and provide various means of support. Teachers who understand and know how their learners learn may be able to apply the principle to accommodate and support the diverse needs of every learner when teaching numbers, operations and relationships (NOR) in Grade 3 classrooms. The principle emphasises that learners, regardless of their disabilities, language or cultural differences and/or social background require varied techniques to access the subject matter. CAST (2011:5) proclaims that using multiple representations allows the conveyance of learning, which happens when numerous representations are employed because it permits learners to create relationships inside the content being learned, as well as amongst the other related ideas.

The National Center for State Collaboration (NCSC, 2012:6) states that in providing multiple means of presentation, the focus should be placed on alternatives such as clarifying symbols, vocabulary and structures to convey information. Similarly, Israel et al. (2014:7) emphasise that offering subject matter through several approaches, such as debate, readings, digital texts and multimedia presentations, may help learners comprehend information faster or more proficiently, rather than offering learners written text only. Quirke and McCarthy (2020:39) assert that teaching by promoting different ways of participating with material and displaying information and the subject matter in different ways to support understanding creates a positive learning environment for learners. This implies that teachers should offer learners alternative opportunities to present what they know, and to motivate them towards effective and positive learning. Effective learning happens when different strategies are used in the study of NOR in Grade 3 classes, so that learners can make relationships within, as well as amongst, the ideas. This principle assisted the researcher in addressing and meeting the research aims.

The following are UDL guidelines of Principle 1: Provide Multiple Means of Representation (the “what” of learning):

a. Providing options for perception

CAST (2011:14) states that providing the same information through different approaches that can be modified by the user, reduces barriers to learning. This could provide teachers with information that learners need and that caters to their learning abilities when learning NOR in Grade 3. Modified information is important to enhance the performance of learners and it will ensure that learners access learning without experiencing barriers. Rose and Gravel (2010:7) state that presenting information to learners in different ways allows them to express what they know. Similarly, Hall et al., (2012:15) assert that offering learners with information presented only in-text will eventually generate a barrier to learners who are struggling readers, or who have visual impairments. This assisted the researcher to understand how teachers can cater for the needs of all learners when teaching number concepts in diverse Grade 3 classrooms.

b. Provide options for language, mathematical expressions and symbols

According to CAST (2011:16), a significant instructional approach should ensure that different illustrations are offered, not only for availability, but for precision and comprehensibility. Different symbols and mathematical expressions need to be clearly explained to learners to avoid confusion and misinterpretation. Hall et al. (2012:15) maintain that a teacher can present, for example, the division procedure by allowing learners to distribute a group of interlocking blocks into identical groups which will help young learners' comprehension of division. Offering learners alternative ways of doing mathematical division might assist learners in interrelating and comprehending division. To ensures the accessibility of mathematical language, the teacher should link or associate it with an alternative representation of the meaning of the key vocabulary, labels, icons and symbols, so that learners can comprehend information (CAST, 2011:16). Learners need to be exposed to mathematical language so that they can perform mathematical problems without experiencing challenges. Mathematical vocabulary and symbols should be exposed in ways that encourage the relationship between the learners' involvement and previous knowledge. Thus, learners' performance is enhanced in the concepts of numbers, operations and relationships.

c. Provide options for comprehension

Learning with understanding when dealing with NOR should be developed so that learners can comprehend what they are learning. CAST (2011:18) maintains that the ability to change available information into practical knowledge is a lively exercise that encourages active participation. Meaningful understanding should be developed when teaching NOR content to allow learners to utilise that knowledge to resolve real life challenges. The guideline encourages teachers to develop learners' thinking skills and to become independent. According to Meyer et al. (2014:122), knowledge is created when learners are actively engaged, rather than passively absorbing and where learners can accomplish this independently. Learners need to be guided so that they are actively engaged in learning. CAST further argues that constructing useable knowledge relies not on simply observing information, but on active "material processing skills" like discovering, listening, mixing the latest knowledge with earlier knowledge, strategic categorisation and effective memorisation. Learners should be guided to connect their prior knowledge towards learning and comprehending NOR so that their performance is enhanced.

Teachers in the classroom should provide scaffolds that will help learners to integrate their prior knowledge into new learning. CAST (2011:19) declares that barriers and injustices occur because certain learners lack the contextual knowledge that is important to integrating or applying new information. The other barrier that learners have and is essential to knowledge is applicability. Prior knowledge is important for the learner, and it is also important for the learner to know how to apply that knowledge. To be able to apply prior knowledge to existing knowledge when learning NOR, the teacher's needs to use scaffolding.

2.2.1.2. Principle II: Provide Multiple Means of Action and Expression (the "how" of learning)

The second principle of UDL is concerned about how learners learn the content in the classrooms. CAST (2011:5) proclaims that learners vary in the ways they perceive the learning atmosphere and demonstrate what they recognise, hence, they require essential techniques, preparation and planning. Teachers needs to accommodate different learning abilities and take them into consideration when delivery content. According to NCSC (2012:6), providing different programmes and other means to learners work in the learners' favour. Offering appropriate instruments and approaches to conveying the learned information, scaffolding or progressing levels of support for instruction and practice, and optimising access to tools, are examples of multiple means of action and expression. Edin (2017:3) posits that learners should be provided with alternative ways to demonstrate what they know to develop their learning skills. Similarly, La et al. (2018:8) agree that resources such as videos, audio, symbols or concrete objects offer learners ways to engage and understand information and practices. Concrete objects are learning resources that increase the understanding of learners in the FP, and when appropriately applied, they can help learners to understand and solve NOR problems.

According to CAST (2011:5), each learner approaches learning assessments differently, where for example, some might demonstrate their understanding through writing, others will fare better in speaking, and vice versa. Learners should be offered different ways of expressing themselves and should be acknowledged; these actions necessitate essential strategies, exercise and planning. NOR content should be presented using different strategies to enable learners to convey their understanding and to appreciate the learning capabilities of every learner so as to enhance their performance. This principle emphasises that learners are unique and various ways to access and engage with learning materials and information, should be provided as early as in the FP so that they develop their understanding skills. The following are the UDL guidelines for the principles: Provide Multiple Means of Action and Expression:

a. Provide options for physical action

La et al. (2018:8) state that in text layout, textbooks or workbooks offer inadequate methods of navigation or practical representation, such as handwriting in spaces supplied. Learners require adequate space where they should practice writing properly. Workbooks do not provide sufficient space for learners to write, or even to do corrections, hence subjects like mathematics require enough space for learners to practise mathematical problems. According to CAST (2011:220), limited space may introduce barriers and discourage navigation and interaction for some learners. Learners experiencing challenges require a variety of assistance, they need to be supplied with resources and space that allow them to write clearly and practise mathematical problems .

b. Provide options for expression and communication

Learners vary in the way they express themselves to demonstrate understanding. CAST (2011:23) proclaims that offering different methods for expression level the playing ground amongst learners and permit them to properly express their knowledge, thoughts and perceptions. When learning NOR, learners need to be encouraged to express themselves to show their understanding. According to Tichá, Abery, Johnstone, Poghosyan and Hunt (2018:27), teachers should be able to adapt their communication skills to related activities, individual involvement of learners and their learning abilities. This enables teachers to adapt activities that hinder learners from communicating effectively during teaching and learning. Alternative ways should be provided during teaching and learning to allow learners to explore and apply their understanding with ease when dealing with NOR problems.

c. Provide options for executive functions

Teachers should be able to guide and scaffold learners' concerns when dealing with the numbers concept to improve performance. CAST (2011:25) says that the teacher should offer advice and scaffold learners towards emerging new skills intended for setting effective objectives. Learners possess different skills; however, they need teachers or someone more knowledgeable to guide them on how to develop and use those skills effectively in the classroom. According to Tichá, Abery, Johnstone, Poghosyan and Hunt (2018:27), learning cannot happen without feedback, hence they need a clear picture of the progress they make in class. Regular feedback will allow the teacher to make proficient decisions about the learning of the learners and allow learners to monitor their own progress. NOR content in mathematics requires constant feedback to keep learners on track, through effective learning and understanding.

2.2.1.3. Principle III: Provide Multiple Means of Engagement (the "why" of learning).

The third and last principle concerns why learners are learning or why they should learn. According to CAST (2011:5), learners vary particularly in the ways of involving or motivating them to learn. This emphasises that the diversity of learners in the classroom have the right to learn and equitable access to learning for all, should be created. La et al. (2018:8) state that multiple means of engagement link learners' welfare, backing self-reflection of learning, adaptive teamwork, and different levels of assessments lead to active involvement in learning. The content of NOR requires multiple means of engagement so that learners become motivated and can reflect on their own learning. CAST (2011:5) announces that some learners are inspired by doing activities alone, whereas others are driven by working with their friends, hence the inclusion of multiple options for engaging learners in number concepts is vital.

NCSC (2012:6) presents that promoting motivational practices, encouraging collaborative learning, giving feedback and prospects to participate in whole class activities, and using compliments to encourage effort are all examples of multiple means of engagement. La et al. (2018:11) affirm that variation in teaching and learning activities by integrating deliberations and small group exercises in the classrooms and embedding involvement resources, such as sample puzzles, support learners to understand their learning. Integrating discussions and small group activities will encourage learners to be effectively engaged in learning, to be passionate about their learning, to be capable to employ their knowledge and to have the desire to learn more on their own. These will help to enhance their performance in mathematics and to love and enjoy learning mathematics in their classrooms.

The following are UDL guidelines for the factor Provide Multiple Means of Engagement:

a. Provide options for recruiting interest

It is vital to capture learners' interest to promote a positive learning environment and understanding. Hall et al. (2012:18) confirm that teachers should certify that activities are as consistent as possible, thereby enhancing concentration, offering a sense of determination, and making it simpler for learners to link the information to their contextual knowledge. Connecting NOR content to the background of learners would make them feel responsible and make it easy for them to understand what is being taught. According to CAST (2011:29), the teacher should plan learning activities in such a way that the learning objectives are communicated to learners and their purpose is clear. CAST highlights that incorporating learning exercises that encourage the use of the mind to answer different and related challenges or make perception of difficult concepts in an inspired way captures learners' interest. According to Edin (2017:4), tapping into learners' interest by offering choices of content and tools, and adjusting levels of challenges, motivates learners to participate actively. If learners' interests are captured, lively classroom engagement is fostered, and they will understand the content of numbers, operations and relationships, and improve their performance.

b. Provide options for sustaining effort and persistence

According to CAST (2011:30), learners should be engaged in assessment discussions to connect their cultural backgrounds and interest. Learners should be provided with assessments of the content of numbers that capture their interest and focus during learning. Learners should be provided with challenging assessments with relevant resources that will require learners to make possibilities that properly stabilise the challenge and encourage effective learning (CAST, 2011:31; Hall et al., 2012:18). Assessment of NOR content should provide learners with the opportunity to participate actively and equally, using different mathematical resources.

CAST (2011:31) declares that changeable, rather than static groupings permit improved differentiation and various roles, as well as delivering prospects to acquire how to work most successfully with others. Solving problems from NOR might require learners to work in flexible groups so that they learn to work with each other. This might also develop learners' skills that will improve their performance. Hall et al. (2012:18) decree that producing co-operative chances with peers or offering different resources and scaffolds for certain activities to practice, and perseverance are significant for achievement. NOR activities require continuous fruitful feedback so that learners are successful and can improve performance in a diverse mathematics classroom.

c. Provide options for self-regulation

Behnsen (2018:6) states that self-regulated learning is a way of learning where the learners regulate and assess their own learning. Allowing learners to evaluate themselves will encourage them to take control of their learning. According to Edin (2016:4), the teacher can use group work to develop group-working skills and support a rational method, where learners feel safe to contribute, question, discuss challenges, and take charge of their learning (Edin, 2016:4). The study explores how teachers develop learners' skills of taking charge of their learning and being able to evaluate themselves during learning. Cody, Rule and Forsyth (2015:1485) declare that learners should be offered the chance to establish their own objectives, establish their achievement standards and assess their performance. This can be used to encourage learners not to depend on the teacher but be provided with an opportunity that will show how capable they are of solving challenging problems from number concepts and achieving their own goals.

CAST (2011:32) claims that learners are required to be offered support to deal with hindrances and side-step nervousness during the procedure of achieving their objectives. Learners should be provided with options and support when dealing with problems from number concepts, such that they do not become frustrated. Hall et al. (2012:19) argue that learners should develop their skills to set suitable targets to help them achieve individual goals and manage their feelings. Grade 3 learners need to be supported and be equipped with skills that will help them to cope with their emotions. Learners should be encouraged to evaluate their own development and to do self-reflection on their own successes and failings so that they know where they need to improve.

2.3 VYGOTSKY's ZONE OF PROXIMAL DEVELOPMENT (ZPD)

The Zone of Proximal Development (ZPD) originates from a socio-cultural theory developed by Levy Vygotsky, which is mostly recognised and used in studies about teaching and learning of various subject matters, including reading, writing, mathematics, science and first additional language learning (Kozulin, Gindis, Ageyev & Miller, 2003:41; Vygotsky, 1978: 86). According to Vygotsky (1978:86), the "Zone of proximal development is the space in the middle of the concrete improvement level as established by impartial problem unravelling and the level of prospective growth as concluded through problem solving beneath mature supervision or teamwork beside more competent colleagues". Guiding learners towards independence in solving mathematics problems is important so that they can develop understanding and improve performance. Teaching should be a sensitive process which guides the learner to attain what is out of reach and stepping back when the learner can do the work on their own (Magolis, 2020:16).

Kozulin et al. (2003:41) maintain that the zone of proximal development affects communication on activities amongst a mature, experienced individual and a less experienced individual, such that the less experienced individual develops success at whatever was originally a mutual accomplished exercise. The teacher, as a more competent person, interacts with the learner guiding him/her to become an independent learner. Similarly, Schunk (2012:244) agrees that in ZPD a teacher and learner work collectively on a problem that the learner might not achieve when doing it alone due to the level of difficulty. According to Vygotsky (1978:88), the presence of someone more knowledgeable and skilful than the learner allows the learner to both observe and put into practice the learned skills. Van De Walle, Karp and Bay-William (2014:20) assert that ZPD refers to the variable of knowledge that cannot be reached by a person on their own but is accessible through support from peers, or those more knowledgeable. Numbers at Grade 3 level need the teacher to support learners to acquire the skills needed to access knowledge so that they can understand them on their own.

Learners in Grade 3 bring knowledge of NOR learned from Grade R to 2. Although this is the case, most learners still require the teacher's support so that they can refine the knowledge. According to Schunk (2012:244), in ZPD, learners do not develop knowledge inactively from the collaborations but create their interpretations of collaborations and build meanings by incorporating those interpretations into their capabilities. This emphasises the fact that learners bring their own experiences in the classroom and build on these when they are taught. The teacher is required to provide support to learners so that they develop their experiences and connect them to the content being learned. Zhou and Brown (2015:35) emphasise that learners should be provided with frequent opportunities to articulate their comprehension. They go further to indicate that learning activities adapted by the teacher should focus on the learners' personal competencies.

Learners require someone more knowledgeable to activate the knowledge in their memory so that they become active and apply the experiences in learning. Seifert and Sutton (2009:36) state that throughout learning, understanding is discovered frequently with proficient assistance, where the proficient is talented and inspired, they should support the learner. The proficient should organise involvement that permits the learner to exercise vital skills and develop innovative knowledge. This helps learners to practice the acquired skills in NOR that will develop their knowledge and eventually, improve their performance. Continuous support is necessary until the learners arrive at independent practice.

2.4 MEDIATION

Mediation refers to the process where teachers, parents, peers and others assist learners to develop knowledge (Donald, Lazarus & Lolwana, 2009:87). Teaching and learning in the 21st century encourage a learner-centred approach. In relation to UDL, ZPD, active learning and mediation are important in guiding the learner to discover his/her capabilities. According to Kozulin et al. (2003:17), the Vygotskian theory specifies that the enhancement of the learner's upper intellectual procedures depends on the existence of mediation received in the learner. Some learners need teachers, or a more knowledgeable person, to mediate their learning so that they gain confidence to become independent. According to Donald et al. (2009:59), a parent, friend, teacher or another advisor should support learners to think further and create relationships between the known and the unknown. A mediator can assist the learner to make connections between what s/he has already learned about numbers, operations and related content from the previous grades and what is being learned in Grade 3.

Donald et al. (2009:60) stipulate that teaching and learning should not be just about teachers' "providing" knowledge to learners, it is supposed to include determination to challenge and assist the learner. Teaching concepts of numbers, operations and relationships should be about developing learners' comprehension skills that will allow them to solve challenging activities. Developed and creative learners attempt to solve difficult and real-life problems on their own, and eventually become self-motivated.

2.5 SCAFFOLDING

Scaffolding was first introduced by Bruner, Ross and Wood in 1976 while using Vygotsky's concept of ZPD in various learning situations (Bruner, Ross & Wood, 1976: 90). Bruner et al. (1976) state that scaffolding is a procedure that grants a learner the ability to resolve a question, fulfil an assignment or accomplish an objective, which would be beyond him/her if unassisted. This implies that if scaffolding is provided, a learner can perform activities that s/he could not yet perform. According to Zhou and Brown (2015:35), scaffolding should be offered to learners based on their learning. During the process of scaffolding, teachers should support learners and slowly reduce their support as the learner reaches the desired goal (Zhou & Brown, 2015:35). Learners require support from the teacher so that they can undertake the work independently. Van De Walle et al. (2014:23) agree that when the learner becomes more comfortable with the content, the scaffolds are removed and the learner becomes more independent. Through scaffolding, learners might gain confidence and be able to solve challenging NOR problems.

Learners who are continuously supported become aware of what is expected when given activities and end up being independent. Rousseau (2018:1) asserts that by employing scaffolding, the teacher applies a variety of instructional procedures that assist to shift learners towards a greater comprehension and enhance individuality in their education advancement. Teaching should be sensitive during the process of scaffolding or helping the learner to achieve that which is just out of reach and should allow stepping back when the learner is able to do the work without assistance (Gouw s, 2019:47). This approach will assist in accommodating the needs of all learners in diverse mathematics classrooms. The DBE (2017:24) states that in a scaffolded learning situation, learners can raise questions, provide answers and assist their peers in discovering innovative information that presents the opportunity for them to take responsibility for their own education. When teaching number concepts, learners should be encouraged to become actively involved and ask questions as that will develop their understanding. NOR concepts require learners who are offered the prospect of contributing to the teaching and learning by approaches such as scaffolds that necessitate them to step further than their existing expertise and understanding levels.

2.6 UBUNTU AFRICAN PHILOSOPHY

Ubuntu is explained as a concept that focuses on the attention a person gives to another, kind-heartedness, politeness, consideration, openness and friendliness in connections with other people; the type of behaviour or an attitude that is expected from others (Mahaye, 2018:12; Müller, Eliastam & Trahar, 2019:26). According to Letseka (2016:4), *ubuntu* encompasses qualities such as humanity, compassion, kind -heartedness, loving and respect for others and it is grounded in humanity. Embedding *ubuntu* in the study mean understanding and embracing inclusive education, accommodating and supporting learners in the teaching and learning process.

Ubuntu is relevant because, as an archaic African worldview, it is centred on the primary principles of humanity, considerate, sharing of resources, treating each other with respect, compassion and a sense of belonging (Letseka, 2016:6). Teachers should respect, care for others and care for all the learners, regardless of their background, culture or language (Mahaye, 2018:12). Inculcating the values of *ubuntu* into learners will help to develop positive behaviour towards each other by showing respect, love and support during teaching and learning (Müller, Eliastam & Trahar, 2019:26). *Ubuntu* teaches learners how to learn and relate to others. This principle should help teachers to structure lessons in such a manner that they enable learners to recognise their different learning abilities in such a way that the effective learning emerges and a sense of belonging and acceptance is created (Tavernaro-Haidarian, 2018:2).

Ubuntu is the belief that in caring for everyone's wellbeing and an individual's kindness is conveyed through the association with others through acknowledgement of each other's benevolence (Letseka, 2016:6; Onazi, 2014:84). The philosophy assisted the researcher in understanding how learners during teaching and learning can respect and value each other's ideas. The philosophy of *ubuntu* explains the moralities, rights and responsibilities of each person while endorsing an individual as a social being. Hence, the theory assists in determining how teachers and learners should interact with one another to promote a sense of belonging. African morals and values of *ubuntu* are a cornerstone of inclusive education. *Ubuntu* encourages learners to share ideas and support each other during teaching and learning without expecting anything in return and equips learners with communication and collaboration skills that will bring about a change in learning (Letseka, 2016:6).

Learners should be made aware that supporting or helping each other during teaching and learning develops their leadership skills and interaction skills. *Ubuntu* encourages a teaching and learning environment that supports learners to attain better results (Letseka, 2016:11). This enables learners to bring their unique contribution to their learning process and help the teacher to view inclusion as a method of responding to learner diversity and seeing learner variances not as problems, but as prospects for inspiring teaching and learning (Tichá, Abery, Johnstone, Poghosyan & Hunt; 2018:6). Learners should realise also that everyone has different skills and strengths and through common support, they can assist each other to acquire knowledge and understanding. *Ubuntu* speaks particularly to interconnection and the fact that effective learning cannot be developed when learners learn in isolation (Mahaye, 2018:12).

2.7 CHAPTER SUMMARY

This chapter discussed the UDL theory that underpins the research study. The theory and the rationale for its selection were discussed in great detail. ZPD, mediation, scaffolding and *ubuntu* African philosophy were also incorporated to support the principles and guidelines of UDL. The rationale for using these theories to underpin this study was also discussed. Chapter three discusses the literature related to the study, starting from international studies, then other African counties, and lastly, SA.

CHAPTER THREE

LITERATURE REVIEW

3.1 INTRODUCTION

In this chapter, the in-depth literature review related to the study is discussed. The chapter starts by briefly explaining the importance of the literature review on the study. It also presents the application of various teaching and learning strategies that can be applied in diverse classrooms targeting individual learners, small groups. and whole classes. Finally, the definition of teaching strategies and their importance, other related concepts to the study and then literature from international countries, African countries and South Africa is discussed.

3.2 LITERATURE REVIEW

McMillan and Schumacher (2010:73) state that a literature review is an essential link amongst the prevailing knowledge and the research problem being explored. The literature review is used to link and to enhance the credibility of the research study. The literature review is also used to assist the researcher to identify ideas, materials or strategies that can be incorporated in the present research study. The existing literature on a given research topic is a means of developing an argument about the significance of the research study and indicating where it leads (Bryman, 2012:98; Creswell & Creswell, 2018a:26). The researcher interprets what the other researchers have written and uses their ideas either to support or to refute a particular viewpoint or argument.

3.3 TEACHING STRATEGIES AND THEIR IMPORTANCE

Strategies are complex ideas or tactics that can be used to achieve one or more goals under conditions of uncertainty (DBE, 2018:7). In mathematics, teaching strategies are used to achieve goals by performing mathematical calculations and processes. Grant and Jordan (2015:11) define a strategy as a proposal, technique, or sequence of events intended to accomplish particular long-term goals or impacts, through the allocation of resources. In order to enhance learners' performance in the FP, particularly in Grade 3, teachers should identify effective teaching strategies and allocate appropriate mathematical resources.

Effective mathematical strategies for performing different calculations and processes, need to be identified so that learners' achievements are improved. These strategies should assist learners to understand numbers, operations, and relationships (NOR) so that they are able work both confidently and fluently. Grant and Jordan (2015:7) proclaim that, without effective implementation of teaching strategies, even the best are likely to fail. This implies that effective implementation of strategies to improve performance of learners in the diverse mathematics classroom is important.

The DBE (2018:7) maintains that learners should be exposed to various types of approaches to create their personal techniques when they work out mathematical challenges and do mathematical computations. These will enable learners to identify effective strategies for themselves or strategies that are simpler for them. Learners should be exposed to strategies that will allow them to establish what numbers are, comprehending the connection to one another, to accomplish mental mathematics calculations proficiently and successfully, and being capable to apply numbers in real-world circumstances (Chikiwa, Westaway & Graven, 2019:3). Similarly, Maghfirah and Mahmudi (2018:2) support the notion that number sense not only puts emphases on the mathematical information system but also aids as significant to personal capability for comprehensive uncomplicated mathematics computations. It is important that learners attain the capability to work flexibly with NOR and execute operations proficiently. If learners are given various opportunities to develop their procedural fluency and to build their conceptual understanding, they might improve their performance in numbers, operations, and relationships in a Grade 3 diverse classroom.

Grant and Jordan (2015:10) state that the continuing challenges of the 21st century requires teachers who are able to choose strategies that can be adapted to different sets of activities. Effective teaching and learning strategies that enhance performance of the Foundation Phase (FP) learners in a diverse mathematics classroom are essential at this stage for the effective participation of learners. Effective strategies should develop learners' knowledge, abilities, and mental attitude as this will assist them to engage critically in numbers, operations, and relations and that will support and extend positive learning. This study therefore focused on strategies that would enable learners to make progress in their achievement and maximise their accomplishment of the learning outcomes.

3.3.1 Teaching strategies

Effective teaching is considered to promote learning with understanding and to assist learners to create knowledge so that they can work independently. Mupa and Chinooneka (2015:125), in Zimbabwe, applied a mixed method research to explore the factors that contributed towards effective teaching and learning in primary schools. They established that teachers do not apply various teaching strategies in their teaching, which causes poor learner performance. It was also established that teachers do not prepare various teaching and learning materials to use in the teaching and learning, hence their instructional materials are limited to textbooks and the curriculum. This means that they do not go an extra mile in their teaching. It is reasoned that using a variety of teaching and learning strategies can improve learners' performance, thus accommodate all learners. It is also argued that using various teaching and learning resources can help to improve learners understanding and to acquire more knowledge.

Delić-Zimić, Kudumović and Destović (2017:540) examined the application of problem teaching method in mathematics in the elementary classes of primary school to clarify its position and significance in improving the educational and operational impact. They found that a problem teaching method can be effectively employed in mathematics lessons, and that this form of teaching as an effective and beneficial way of learning, motivates the growth of general educational performance. It was observed that with this method, learners of all departments displayed curiosity and improvement in mathematics. Examining and checking the responses of learners revealed that the problem teaching is more exciting for learners, and they become more determined to work and be taught. Thus, learners who are intellectually engaged in problem solving, spontaneously relate their views, employ the aforementioned knowledge, which ultimately deepens following experiences.

Pellegrini, Lake, Inns and Salvin (2018:11) employed quasi-experimental evaluation to identify strategies that can be used to improve mathematics in elementary classes in the United States of America (USA). It was established that tutoring, especially one-to-one, permits tutors to completely adapt their instruction to the needs of the learners. They found that well-trained tutors can start with struggling learners where they are, and move them forward rapidly, instead of leaving them to stumble in the regular class with challenges too far above their current capabilities (Pellegrini et al., 2018:15). Pellegrini et al. (2018) state that tutors are likely to build close personal relationships with learners, giving them the necessary attention and praising their effort. They further state that in small group tutoring, learners may also build relationships with groupmates, which may allow for mutual assistance, as well as motivation.

Van Den Berg, Bosker and Suhre (2018:339) likewise, applied quasi-experimental pre -test and post-test to examine the degree to which the use of goal-directed instruction, appraisal and instant instructional response is effective in improving learners' performance. The teachers were able to identify learning goals by teaching clarification of mathematical techniques or representing mathematical numbers in a number line or abacus and employing various assignments to measure the learners' understanding (Van Den Berg et al., 2018:345). If procedures of doing the assessment are clearly explained to learners, their understanding may be increased and eventually, their performance will increase.

The findings of the study conducted by Machaba (2018:47) revealed that teaching FP learners many concepts in one week caused them to perform poorly. Machaba found that this did not give learners enough time to comprehend the content while the teachers were unable to support them to engage meaningfully with the content. Learners need time to comprehend and understand the content being taught so that they progress to the next grade with basic knowledge of the content. On the other hand, the findings by Du Plessis and Letshwene (2020:76) revealed that the regular introduction of new topics which teachers are not equipped to teach create poor performance of learners. This indicates the importance of equipping teachers with strategies for teaching new topics before they teach learners. Their findings further revealed that teachers were concerned about the quality of learners who progress to the next grades while the DBE is more concerned with the number of learners passing. Allowing teachers to focus on producing more quality learners than the quantity of learners can improve learners' performance in mathematics.

3.4 MATHEMATICS PROFICIENCY

Kilpatrick, Swafford and Findell (2001:5) identify five interwoven and interdependent strands that indicate how learners acquire mathematical proficiency. The five strands are: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition.

3.4.1 Conceptual understanding

Kilpatrick et al. (2001:5) state that conceptual understanding refers to the ability of learners to be able to understand mathematical ideas, operations and relations. When learners are dealing with NOR problems, they should comprehend the problems presented to be able to solve them without experiencing any difficulties. Conceptual knowledge is referred to as a linked network of information, that is, a system in which connecting relations are recognised as the unique chunks of knowledge (Hiebert & Lefevre, 1986:12). This highlights not only what is recognised (knowledge of concepts), but the way people come to distinguish concepts and their influences and how learners may apply them to remember and make conclusions and estimations (Machery, 2010:200).

The National Council of Teachers of Mathematics (NCTM, 2020a:7) confirms that in conceptual understanding, learners are expected to look forward and backward along the mathematical perspective. This implies that learners should be able to apply their preceding knowledge to understand what they are learning. Garg (2017:1) stresses that conceptual understanding is the awareness of the relations of mathematical themes. Learners with conceptual understanding should be in a position to organise their knowledge logically to connect new ideas with what they already know (Math Assessment Resource Service, 2017:5). Learners should be taught to make connections regarding how concrete materials and technology can also assist in the development of conceptual understanding (NCTM, 2020b:9).

3.4.2 Procedural fluency

According to Kilpatrick, Swafford and Findell (2001:5), procedural fluency is regarded as the ability to bring out processes openly, correctly, effectively and properly in learning mathematics. Garg (2017:1) defines procedural fluency as the knowledge and application of guidelines and techniques to carry out mathematical activities and representation used to characterise mathematics. The Math Assessment Resource Service (2017:5) claims that learners who do not possess procedural fluency have difficulties expanding their comprehension of mathematical concepts or cracking mathematical questions. Learners need to develop procedural fluency and understanding skills to help them in solving mathematical challenges. According to NCTM (2020b:17), procedural fluency comes from the capability of solving challenges, reasoning through concepts and communicating understanding which learners develop by doing mathematics, not by inactively listening to how others have formerly made sense of mathematics. This suggests that learners should be encouraged to do more mathematics on their own to make sense of the concepts.

3.4.3 Strategic competence

For Kilpatrick et al. (2001:5), strategic competency refers to being capable of articulating, signifying and resolving mathematical challenges. Similarly, this applies to learners who can design a strategy to solve a particular problem or be able to come up with an idea of finding the solution to a given problem (Garg, 2017:1). A learner who has strategic competence can choose openly between various strategies to match the demands of the challenge and the condition displayed (Math Assessment Resource Service, 2017:5). Learners must be taught how to apply different approaches to solve problems to show their understanding and capabilities.

3.4.4 Adaptive reasoning

Kilpatrick et al. (2001:5) define adaptive reasoning as the ability for rational thinking, reflection, description and reasoning. In adaptive reason, learners should demonstrate the ability to reflect, evaluate or adapt their own work after finishing writing (Garg, 2017:1). Learners who have developed reasoning skills, acquire knowledge with the understanding that they will be able to provide mathematical facts and methods for solving new and unfamiliar problems (National Research Council, 2002:2). Reasoning skills are imperative for learners to be able to make relationships between emerging content being learnt, and the content that is already learnt and understood.

3.4.5 Productive disposition

Kilpatrick et al. (2001:5) elucidate productive disposition as a distinctive sense of mathematics that is practical, beneficial and valuable. Garg (2017:1) states that learners show productive disposition by being able to think and reason before attempting to solve a given problem. Learners have to engage with the problem positively to make sense of it so that they are able to solve it (Graven, 2016:3). Learners need to be encouraged to engage with mathematical problems, learn to interpret them and come with creative ways to solve them, this has to start as early as in the FP.

3.5 DIVERSITY IN THE CLASSROOMS

South African schools comprise a variety of learners who come from diverse backgrounds, cultural groups and even speak different languages. According to Westwood (2013:11), diversity in the classroom happens because learners come from wide-ranging families, have different life practices, and have different inherent and attained features. However, all learners need to be incorporated or accommodated in the teaching-learning situation.

Wells, Fox and Cordova-Cobo (2016:8) state that diversity in the classroom establishes and encourages learners to develop critical thinking and problem-solving abilities, while also enlightening numerous supplementary qualities linked to academic achievement, comprising learner fulfilment and motivation, universal information and logical self-assurance (Wells, Fox & Cordova-Cobo, 2016:8). In a diverse classroom, a comfortable learning atmosphere is formed, and learners acquire a great deal from those who have different life experiences from theirs. Different classrooms are diverse in ways that can improve learning if properly connected and learners have a chance to learn more when they feel protected and they become confident to share their different perceptions (Sanger & Gleason, 2020:3). Learners who experience positive interactions in a diverse classroom become open minded and participate in classroom conversations (Possi & Milinga, 2017:28). Learning in diverse classrooms helps learners to develop confidence. Better-quality learning might happen in these classrooms, because intellectual thoughts are tied directly to existing and real examples drawn from a variety of experiences (Pang, 2017:6). This indicates that diverse classrooms are important for interaction, acquiring knowledge and skills and for developing critical thinking.

Diversity should be given attention since we are facing a changing world. According to Sanger and Gleason (2020:3), diversity in teaching is important because learners' identities help to promote intellectual thinking, communication, and problem-solving abilities essential to impact current learning. However, some teachers treat all learners the same and work with the assessment system that benefits certain abilities (Naraian, 2017:6). This eventually leads schools to mistakenly classifying some learners as those having barriers to learning. Helman, Rogers, Fredericks and Struck (2016:25) postulate that when teachers do not engage in multi-level practices, this is frequently an absence of professional development that leaves them underequipped, overloaded and under-compensated. Teachers should be prepared and equipped with knowledge and skills to work with multi-level practices in a diverse mathematics classroom. Suh and Seahaiyer (2017:3) note that lack of awareness or knowledge to adapt teaching strategies often contributes to some teachers' hesitation about including all learners in teaching and learning situations. However, most teachers appear not to have enough knowledge and skill to address different learning barriers in an inclusive classroom, because training has not been done. Hence, Naraian (2017:78) proposes that all schools that are inclusive and friendly to every learner, should be reinforced and positioned to alleviate a full variety of learning barriers in an inclusive environment to serve as leading schools of full inclusivity.

3.5.1 Teaching mathematics in diverse classrooms

A diverse classroom requires teachers with knowledge and with different skills of engaging learners. Teachers should be aware of each learner's academic level as this will allow them to plan teaching and learning in such a manner that the strengths and weaknesses of individual learners are catered for (Chinn, 2016b:10). Teaching in diverse classrooms promotes inclusion and encourages learners to work together and to understand each other's strengths and weaknesses. Learners working together may lead to their performance in mathematics improving. Baglieri and Shapiro (2017:12) argue that knowing learners' abilities in a diverse classroom enable teachers to vary their teaching approaches, curriculum content and teaching resources. It is important for teachers to teach in a diverse classroom to develop an understanding of different learning levels learners possess so that they can support them accordingly (Engelbrecht et al., 2014:132; Suh & Seshaiyer, 2017:4).

Bateman and Cline (2016:166) state that to create a good learning diverse classroom, teachers need to encourage learners to create friendships with each other. Foreman and Arthur (2017:19) support the above by suggesting that teaching and learning in a diverse classroom prepares learners for diverse opportunities, responsibilities, and life experiences. Teaching and learning mathematics in a diverse classroom requires positive relationships among the learners so that they can work together, where there is a need to improve understanding and their performance.

3.5.2 Supporting learners in diverse classrooms

Support and motivation are very important towards the achievement of better performance of learners. Goepel, Sharpe and Childerhouse (2015:41) argue that teacher are obliged to daily support all learners for their progress and development. Teachers need to understand and know all learners' learning difficulties so that s/he can support them according to their needs. Smith, Bill and Raith (2018:9) indicate that providing support to learners early in their learning career helps the teacher to know them better as this will enable them to use their findings to shape learning opportunities. Learners need to be supported as early as possible so that their learning can be improved, as well as to help them reach their fullest potential.

Some learners work better and understand the content clearly when they learn or do the work together in the classroom. Puigserver (2017:42) asserts that it would be impractical to ignore diversity in the educational setting by enforcing generalised learning goals and teaching practices. This implies that learners should be supported by enforcing different teaching strategies and assessments based on their learning abilities.

3.6 TEACHING MATHEMATICS IN THE FOUNDATION PHASE

Mathematics is one of the subjects that is regarded and required for the promotion of learners from one grade to the next in the FP (DBE, 2011a:10). According to the DBE (2011a:9), mathematics in the Foundation Phase covers five content areas which are: Number operation and relationships; patterns, functions and algebra; space and shape (Geometry); measurement and data handling. Numbers, operations, and relationships covers 65% for Grade 1, 60% for Grade 2 and 58% for Grade 3, which indicates that an understanding of this component is important (DBE, 2011a:9). Learners should be equipped with mathematical skills to ensure that they acquire, use knowledge and abilities. It is imperative for the teacher to know the mathematical content of the grade that s/he is teaching.

According to Maghfirah and Mahmudi (2018:2), in numbers, operations and relationships, learners should be taught the number sense which is a holistic notion of the capability to comprehend amounts and the measure of the numbers. Learners should be taught how to apply numbers efficiently and the flexibility of making mathematical judgements. According to Bussi and Sun (2018:15), almost everywhere in the world, most learners lack basic mathematical skills and they are unable to answer simple addition and subtraction challenges. This shows that basic mathematical skills should be emphasised in early grades to enable learners to gain understanding of the content taught.

Steyn and Adendorff (2020:40) argue that teachers should be able to create the mathematics inquiry classroom, build trust and encourage positive engagement during the teaching and learning of mathematics. Being a FP teacher does not mean that one has the skills and knowledge to teach mathematics, hence teachers need to be equipped with skills to teach all FP subjects, especially mathematics. Teaching involves applying skills and knowledge to maximise the learning abilities of learners (Kaiser, 2017:15). This implies that teachers need to focus on developing learners' mathematical thinking and reasoning skills, so that they can understand and solve challenging mathematical problems. Teacher should not only focus on the content that is too easy for learners, where they are not required to think. Learners should be guided creatively so that they become capable and apply their own comprehension towards the given problem.

Learners should be taught mathematical skills so that they are able to apply those experiences in their daily lives. Learners should be introduced to mathematical practices that provide them numerous opportunities "to do, speak and write" their mathematical thinking (Pellegrini, Lake, Inns & Slavin, 2018:11). Learners who are exposed to mathematical knowledge and skills at an early age tend to do well with challenging problems. Davin (2013:191) had earlier raised this by arguing that providing sufficient opportunities for learners and creating an environment that is rich with mathematics activities and tools can stimulate their curiosity. Learners have to be made aware that undertaking challenging mathematics activities is a process of equipping them with thinking skills that will help them in future to solve similar problems.

3.7 LANGUAGE OF LEARNING AND TEACHING (LOLT) MATHEMATICS

Engelbrecht, Swanepoel, Nel and Hugo (2014:3) posit that many learners who are learning in their second language struggle to achieve academically, and as such, are placed into remedial classes, and labelled slow learners. According to Jansen Van

Vuuren (2018:1), supporting learners in acquiring English skills rapidly in the FP is necessary because English is employed as a language of learning and teaching in Grade Four. Chitera, Kasoka and Thomo (2016:309) used pre-observation, observation, and interviews to obtain an in-depth understanding of the practices and progress related to the teaching and learning of mathematics in African languages in primary schools in Zimbabwe. Chitera et al. (2016:313) observed that learners and teachers were able to interact easily, however, they faced major challenge regarding the mathematical content. They established that teaching mathematics in African languages is not as simple as it is expected to be, particularly if the mathematical concepts are not well established. The absence of mathematical practical words and descriptions makes it difficult, hence teachers struggle a great deal in their descriptions and in the process, the idea is lost in translation. Similarly, Robertson and Graven (2020:4) point out that the learners who learn mathematics in their home language in the FP, experience a greater degree of mathematical language problems in Grade Four. This implies that it is imperative to start teaching mathematics in the FP in English so that learners do not struggle when they are promoted to Grade Four.

Riccomini, Smith, Hughes and Fries (2015:237) suggest that to enhance learners' general mathematical competency, teachers need to identify the importance of and use research-authenticated instructional techniques to impart valuable mathematical vocabulary. They argue it is important to equip teachers with an overall understanding of mathematical vocabulary and specific evidence-based instructional strategies so that they can impart crucial mathematics vocabulary to their learners. Growth and understanding of mathematical language is important for learners to be vigorously involved in historical mathematics and ordinary computational necessities (Riccomini et al., 2015:248).

Maluleke (2019:1) suggests that HL (code-switching) can be used to clarify some content being learnt in English to teach mathematics in multilingual classes in SA. Code-switching, as a strategy, can assist learners to improve learners' understanding and improve their performance. Using both African languages and English is a strategy that offers teachers an opportunity to create a strong bond with their learners and inspire learners' interest in the content (Maluleke, 2019:1).

Knowledge is a solid ground of learning and allows learners to enjoy content with confidence and challenges them to step beyond the edge of uncertainty where opportunities wait (Kilpatrick, 2014:34; Weigand, McCallum, Menghini, Neubrand & Schubring, 2019:7). Teachers should understand that teaching mathematics is about facilitating learners' mind so that they realise the vision that they can succeed in life. Mathematics requires teachers who understand language, and value the diverse linguistic resources learners bring to the classroom (Singer, 2014:8; Kaiser, Forgasz, Graven, Kuzniak, Simmt & Xu, 2018:31). Teaching in the FP should concern an understanding of the diverse needs of every learner and ways to personalise instruction to meet their needs.

3.8 MATHEMATICS CONTENT KNOWLEDGE

Content knowledge refers to the quantity and establishment of information the teacher has concerning the subject that s/he teaches (Shulman, 1986:9). Shulman (1986) emphasises that the importance of learning and knowing contents should be thoroughly explained to learners. The teachers should be actively engaged in active questioning and reflect on their own learning to develop mathematical content knowledge (Cotton, 2016:2). Three categories of content knowledge distinguished by Shulman (1986:9) are: subject matter content knowledge; pedagogical content knowledge; and curriculum knowledge, which are discussed respectively below.

3.8.1 Subject matter content knowledge

Subject matter content knowledge requires understanding the structure of the subject matter in different ways (Koponen, Asikainen, Viholainen, & Hirvonen, 2017:1950; Shulman, 1986:9). Mathematics teachers should be able to explore ideas through engaging in investigations and practical activities (Cotton, 2016:4). Cotton (2016) posits that the teacher should be able to move beyond habit interpretation of mathematical procedures to realise and comprehend the relations and influences amongst various means of mathematics content.

Knowing mathematical content that is expected to be taught in the grade that the teacher is teaching is important. Hart, Oesterle, Auslander and Kajander (2016:5) state that the teacher's deep knowledge of correct representations, appropriate classroom contexts, different strategies and interconnections, as well as how new concepts can be built upon the existing ideas is important. Grade 3 FP learners require teachers who will assist them in acquiring mathematical content knowledge so that when they proceed to the Intermediate Phase (IP), they have developed the understanding required. This implies that Grade 3 learners should have appropriate knowledge of mathematics to deal with concepts in the IP.

Teachers who do not have enough knowledge of the content often develop a negative attitude and end up being frustrated because they do not have any idea of what to teach and how to teach (Van De Walle et al., 2014:10; Kaiser, 2017:12). Teachers can eliminate the negative attitude through expanding their knowledge in the subject. Spaull, Van Der Berg, Wills, Gustafsson and Kotze (2016:8) recognised weak teacher content knowledge as an essential restriction for learners to learn mathematics with understanding and to perform well. Teachers with low mathematical content knowledge are unlikely to teach learners with understanding and produce good mathematics results. If basic mathematical knowledge is not developed from the FP grades by teachers, learners move to the higher grades with the gap which has been created by their early learning.

Teachers should examine and reflect to themselves for the parts that require development on achievements and encounters for the purpose of progress and advancement (Lee, Capraro & Capraro, 2018:76). It is the responsibility of the teacher to reflect on himself or herself so that s/he can identify the areas where development is needed. Teachers require continuous development to acquire more knowledge towards mathematics. It is imperative to equip teachers with content knowledge so that they can apply different strategies that will improve learners' understanding. The teacher's content knowledge impacts the implementation of relevant standards of knowledge assessment involving learners at thought-provoking levels of reasoning (Hine, 2015:8; Sinay & Nahonick, 2016:10). This indicates that mathematics content knowledge for teachers at FP is crucial as it impacts on the development of learners' reasoning skills.

Teachers should ensure that learners are equipped with skills that will develop their fluency and proficiency in mathematics. Mathematical proficiency, understanding concepts and being confident and fluent with procedural skills are vital for every learner in enhancing their performance (Sinay & Nahonick, 2016:9). However, if learners are taught by the teacher who has no mathematical proficiency and fluency, they may end up developing a negative attitude towards mathematics. This means that teachers should be fluent and proficient mathematically to engage learners at different levels.

3.8.2 Pedagogical content knowledge

Pedagogical content knowledge incorporates an awareness of being able to teach specific topics and understanding of what makes the learning simple or tough (Shulman, 1986:9). A teacher should be able to choose examples to introduce a particular concept, teaching approach or teaching strategies and group learners according to their needs (Cotton, 2016:5). Teachers require knowledge of strategies to be able to reorganise the understanding of learners from their conceptions and preconceptions from mistaking them as misconceptions (Shulman, 1986:9). According to Guerreiro (2017:30), teachers' pedagogical knowledge is not motionless, hence innovative emerging information needs to be retrieved, administered, assessed, and converted into knowledge of practice. Teachers are anticipated to process new knowledge and regularly upgrade it so that they can enhance learners' understanding and performance. Pedagogical content knowledge allows for the identification of different portions of awareness for teaching and comprises the connection of content and pedagogy (Albieri de Almeida, Ferreira Davis, Gimenes Corrêa Calil, Mallmann & Effori de Mello 2019:134). Albieri de Almeida et al. (2019) go further to indicate that this helps in understanding how specific topics, problems, or subjects are prepared, characterised, and modified to learners' several interests and skills.

FP teachers in South African schools teach full time in their classes, which means that there is no changing of periods or subjects. Excell and Linington (2015:8) state that foundation phase teachers should be able to demonstrate an in-depth comprehension of how learners learn and to be able to create an early-learning environment. According to Shulman (1986:9), the teacher should be able to explain to learners why a specific proposal is considered necessary and justify why it is worth knowing and how it relates to other proposals in theory and in practice. This implies that FP teachers should understand young learners, and know how they learn, so that they are able to create a constructive learning atmosphere. Excell and Linington (2015:130) emphasise that teachers should be able to enhance the learning produced by learners and offer them opportunities to make choices and give reasons for those choices. Similarly, Hart et al. (2016:5) argue that FP teachers must possess knowledge about mathematical topics at the FP level including understanding of why concepts and procedures make sense mathematically, as this will enable them to develop learners' reasoning skills as early as possible so that they are able to use those skills when working with any mathematical content.

If teachers are unable to develop learners' reasoning skills in the early grades, it might be difficult for learners to work on activities that require their reasoning skills later in higher grades. Teachers should be able to design a productive learning atmosphere that provides an orderly and structured approach to learning, thus helping learners achieve the desired goals (Noonan, 2013:80; Brown, 2016:16). Learners in the FP require teachers who understand how they learn, can accommodate their different needs and are able to create a positive learning environment. Similarly, Small (2017:17) proclaims that the teacher should create a learning atmosphere that provides learners with the opportunity to engage with one another, as well as with themselves. Interaction between learners and the teacher allow learners to improve their communication skills, to develop their thinking skills and expand their knowledge, especially in solving number content problems. Brown (2016:17) states that teaching requires selection and translation of discipline knowledge learning and the adoption of instructional goals and measures of learner performance. Teachers therefore should be able to engage learners by helping them increase their interest and capacity to learn and master learning goals.

Even though teachers are the managers of their classes, they should allow learners to experience free learning without exercising too much authority. Effective teachers use humour and goodwill to win learners' co-operation and avoid the use of positional authority in the role of teacher to seek compliance with classroom directives (Small, 2017:3). Teachers who exercise their roles of teaching practice and resist the use of authority, can win learner co-operation during teaching and learning. FP teachers should be able to apply a learner-centred approach to gain learners' involvement in the teaching and learning situation.

Schwarzer and Grinberg (2017:17) present that teachers need to provide learners with the support and opportunity to make sense of mathematics and connect that with prior knowledge. Teachers in the FP need to create a positive learning classroom with mathematics resources that will support and provide learners with positive learning opportunities. Foreman and Arthur-Kelly (2017:20) state that getting learners to be reflective requires a teacher who can engage them in interesting problems, to which they can apply prior knowledge to find the solution while creating new ideas in the process. Learners should not only be engaged in problems that need simple answers, but also with problems that will trigger their thinking skills and allow them to create new ideas. A classroom with different mathematical resources allows learners to explore, to be creative and to become independent.

3.8.3 Curriculum knowledge

Curriculum is represented by different types of programmes intended for teaching subjects and content areas at the intended level and different instructional material accessible in relation to those programmes (Shulman, 1986:10). Teachers should understand the curriculum, materials and be able to integrate the content to be taught in the subject. Understanding the curriculum will enable the teacher to choose appropriate strategies and activities to engage in learning a particular mathematics idea (Cotton, 2016:4; Shimizu & Vital, 2018:14). Curriculum represents content to be taught for that subject (Koponen et al., 2017:1954; Shulman, 1986:10) and the teacher's knowledge of the curriculum allows him/her to make careful planning for the next stage of learning (Cotton, 2016:5).

Cotton (2016:5) identifies four stages at which learners can be taught, as: foundations for learning, beginning to understand, becoming confident and extending learning. Understanding the stages allows the teacher to make decisions about what is appropriate for learners at their stage of learning (Cotton, 2016:5). Curriculum knowledge enable teachers to choose textbook series suitable for his/her own teaching style (Koponen, Asikainen, Viholainen & Hirvonen, 2017:1972). Curriculum ensure equity for all learners and careful planning is crucial for effective implementation (Shimizu & Vithal, 2018:15). Understanding the learning stages of learners will allow the teacher to plan and choose strategies that will accommodate all learners.

3.9 EXPECTATIONS OF GRADE THREE TEACHERS

When reflecting from the above discussion about the FP teacher, it is evident that teachers play different roles in teaching and learning. Ndlovu and Chiromo (2019:4) postulate that teachers should be able to apply a learner-centred strategy to their teaching to provide quality and effective education. Starting from the early grades, teachers should be able to teach learners with understanding as opposed to simply transferring information (Kortjass, 2019:4). Teachers should be able to examine their teaching strategies, explore possible ways of recognising various learning styles, be able to adapt to each class and carefully select the appropriate teaching styles to ensure that all learners are involved in learning (Landsberg et al., 2011:76; Philpott, 2009:20). This will enable the teachers to teach learners with understanding, rather than transferring knowledge and expecting learners to be the receivers of knowledge. Numbers, operations, and relationships need to be learnt with understanding so that learners can apply the correct learning strategies to solve the problems.

3.9.1 The teacher as subject specialist

FP teachers should be subject specialists and should be in a position to teach all subjects since every class is taught by one teacher. Mathematics teachers specialists should have the ability to use different mathematical techniques to solve problems, guide and motivate learners to be creative (Junqueira & Nolan, 2016:979). Teacher should be lifelong learners and creative to develop deeper understanding of the subject to easily identify strategies that can successfully incorporate the different learning needs of all learners. As a subject specialist in subjects like Grade 3 mathematics, the teacher will be able to adapt numbers, operations and relationships lessons to accommodate the diverse needs of all learners. Effective participation of learners during lessons will eventually enhance their performance. Teachers of mathematics should deliver a variety of chances for learners to acquire their mathematical reasoning abilities, capabilities for reasonable thinking, reproduction, description, and reasoning (DBE, 2018:8).

Mathematics teachers, as subject specialists, should be able to predict conceivable misunderstanding or misinterpretations and distinguish the way to support learners to be innovative (Cotton, 2016:6). Reid and Reid (2017:853) state that teachers who are not subject specialists are unlikely to have knowledge to help learners master the content. Mathematics teachers should understand how learners learn the subject, as well as why it is useful to learn the subject, so that they are able to communicate key mathematical ideas and their connections (Barbour, 2016:7). A mathematics specialist should be a teacher who has acquired questioning techniques that lead to understanding and enable learners to work on the solutions on their own (Steyn & Adendorff, 2020:5).

3.10 LEARNING IN THE FOUNDATION PHASE

An important reason for learners to be at school is to acquire knowledge and different skills through learning. Kaya and Akdemir (2016:9) outline learning as a more or less everlasting transformation of conduct that occurs at the end of experience. Learning helps learners to develop skills and values, and to acquire new knowledge. It is vital to recognise the early learning experiences of learners, the skills they bring to the school system, and how these factors influence their achievement (Visser, Juan & Hannan, 2019:2).

Spaull, Van Der Berg, Wills, Gustafsson and Kotze (2016:6) state that early learning determines matriculation results. This indicates that learners who learn without understanding from early grades, are unlikely to reach matriculation or satisfactory matriculation results. Meaningful learning should be developed from lower grades so that learners reach Grade 12 with the mindset of learning with understanding. Teachers sometimes neglect learner errors and fail to correct them, particularly when they possess misconception of certain problems, slow pacing, and little abstract content of mathematics teaching (Janqueira & Nolan, 2016:982; Spaull et al., 2016:6). Jangueira and Nolan (2016,982) also indicate that teachers avoid day-to-day knowledge instead of teaching the principles of mathematics, with teaching strategies that concentrate on excessively real problem-solving. Teachers frequently lack knowledge of how learners learn to work with numbers (Spaull et al., 2016:7). Learners should develop adequate skills to identify numbers, as well as to interpret and analyse the facts and mathematical ideas in the FP (Sharma & Verma, 2017:22298). Teachers should understand how learners work with numbers and during learning, help them rectify their mistakes and to develop their understanding. According to Xu Hua Sun, Chambris, Sayers, Siu, Cooper, Dorier, González de Lora Sued, Thanheiser, Azrou, McGarvey, Houdement and Ejersbo (2018:99), counting numbers daily starting from zero to two hundred and backward from two hundred to zero, should be encouraged among young learners so that they can develop a number sense. The Michigan Department of Education (2020:14) proposes that for learners to demonstrate conceptual understanding, they should be making sense of numbers and be able to compose and decompose numbers.

Learning is not about obtaining a higher score when writing the tasks, but it should be about developing comprehension and acquiring skills to resolve different mathematical challenges. Through the application of different teaching strategies by the teachers, learners should be taught the ability to identify, on their own, the strategies they can use to solve other challenging mathematical problems. Askew (2016:13) identifies three views of learning mathematics as follows:

- *the individual child is at the centre of learning mathematics;*
- *learning mathematics is a process of acquiring knowledge; and*
- *acquiring this knowledge is a well-ordered process.*

Learners from the FP should be aware that acquiring knowledge is a process and it needs the individual learner's attention. If the learner does not have the ability to learn, it will be difficult for him/her to acquire knowledge and to solve challenging mathematical problems in large numbers. Teachers need to understand that an individual learner has a significant role to play in learning mathematics to be able to recall what s/he has learnt (Ndlovu & Chiromo, 2019:5). This implies that learners need to be encouraged to be positive in each learning situation, so that they can gain both knowledge and understanding. Askew, Venkat, Mathews, Ramsingh, Takane and Roberts (2019:5) maintain that focusing only on what learners are learning may divert the teacher's attention on who they are becoming, because what they are learning is not just about mathematics, but also about themselves and others. Learning mathematics should guide learners on who they are becoming through the acquisition of knowledge.

Teachers should be aware that for learners to understand the content being taught, mathematics should be integrated with other related subjects. Schwarzer and Grinberg (2017:11) proclaim that connections are formed when the content and instruction are relevant to learners' lives inside and outside of school. Learners should be made aware of the relevancy of the content that they learn in the classroom, and life in general, so that they are able to make connections with ease. Effective teaching requires meaningful connections between learners and the curriculum (Schwarzer & Grinberg, 2017:11). Teachers should also ensure that they teach effectively so that learning can be meaningful.

Learners should understand the importance of learning mathematics starting from the FP so that when they reach higher grades, they do not experience the challenge of understanding mathematics. Learning mathematics means creating strategies for determining solution to problems, using those strategies, examining if they point to the answers, and examining to realise whether their responses are logical (Adler, 2017:2). Through learning, learners should gain confidence that enables them to tackle mathematical problems. Learning different mathematics strategies will help learners to solve different problems without fear of making mistakes. According to Excell and Linington (2015:252), learning mathematics is the principle of building new knowledge from the existing knowledge. Understanding number concepts from Grade 3 might help learners to later build on that knowledge and understand what they will be learning in higher grades.

In the FP mathematics is allocated seven hours per week so that learners can have ample time to grasp the basic concepts (DBE, 2011a:11). The allocated time should enable learners to grasp basic conceptual mathematical concepts that will help them acquire knowledge. As such, allocated time for mathematics in the FP should enable learners to make sense of what numbers mean, be flexible in using numbers in mental mathematics, estimations, and comparisons; as well as have the ability to use numbers in their everyday activities (Adler, 2017:1). For learners, developing number sense can be acquired through learning with understanding so that they are able to recognise numbers represented in different ways. Learning new concepts depends on mastery of earlier ones, so that the learners can make a connection between what they are presently learning and what they have already learned (Hall, Meyer & Rose, 2013:74; Junqueira & Nolan, 2016:983). If learners can make a connection between the new concepts and what they have already learnt, they will develop understanding and grasp the new concepts easily.

3.10.1 Active learning

Active learning, like UDL, focuses on developing the learners' skills as opposed to just transmitting information. Peko and Varga (2014:60) argue that the success of active learning strategies relies on the teacher's understanding of his/her role. They maintain that the main role of the teacher starts with preparing and arranging the classroom environment that would offer active learning. Teacher's planning should create an awareness of the teaching goals, technique offered and anticipated learning objectives. Numbers, operations, and relationships problems should be presented in an interesting way.

Active learning is used to promote learning, with understanding, so that learners can apply the attained knowledge to real life situations. Brame (2015:1) remarks that active learning engages the learners in the process of learning through activities. Some learners tend to participate actively when working with others and interacting with each other in small groups. Working together as learners helps them to value and respect each other's ideas, especially in a diverse mathematics classroom. Similarly, Kenta (2017:43) acknowledge that active learning successfully involved learners in their learning, through thinking, generating, distribution, collaborating and creating new knowledge. This will help the teachers to encourage Grade 3 learners to acquire ownership of their learning in number concepts. Learners' performance in an inclusive classroom will improve if teachers substitute the old-school "sit and get" method to teaching through enhancing their understanding.

Janney and Snell (2013:37) argue that in an inclusive classroom, active learning provides practical meaning to content and assists learners to construct their own knowledge through manipulation of interactive materials and the use of primary data sources. This suggests that various teaching and learning resources can be used to encourage active learning through effective involvement in a diverse mathematics classroom. Consequently, teachers should adapt and plan learning activities that can challenge learners' misunderstandings, thus helping them to restructure their intellectual models (Pieters, Voogt & Roblin, 2019:12). Misconceptions that may arise when teaching number concepts need to be confronted by designing activities that promote active learning and understanding.

According to the University of Minnesota Center for Educational Innovation (2020:1), a ctive learning activities provide learners with the opportunity to think and engage with the content and material, practice skills for learning and applying the acquired knowledge in real life situations. Content of numbers requires learners' understanding, rather than memorising knowledge as they might not be unable to apply it in future learning or real-life situations. Similarly, Abramovich, Grinshpan and Milligan (2019:2) support the view that active learning in mathematics education at the primary level, combined with repetition, conveys mathematical concepts to real life and assists in motivating learners in their learning and in developing their understanding. Abramovich et al. (2019:3) assert that a suitable approach to teach mathematics for different abilities is to do it through practical examples, instead of applying old-fashioned techniques whereby teachers spend most of the class time talking, and learners listen and 'absorb' information. Real-life applications will motivate learners while learning mathematics and enable them to apply the knowledge they have gained.

Professional Development Services for Teachers (PDST, 2017:9) proclaim that active learning focuses on the learner's learning; enhanced information retention; progress of communication and logical thinking skills; improved inspiration; and variation of learning occasions. These might assist teachers to identify effective strategies that will provide learners with the opportunity to participate effectively and eliminate the barriers to improving their performance in a diverse classroom.

Interaction between learners develops skills of responsibility and enables them to work effectively and collaboratively with one another. Pieters et al. (2019:34) proclaim that the teachers should teach social interaction and task-related skills required for the effective interaction to function effectively during active learning. Learners will acquire effective communication and listening skills; and gain more confidence in the learning process. Kenta (2017:44) states that allowing learners to work together in small groups to solve problems and share ideas not only leads to a more profound learning and understanding but also shapes the critical teamwork abilities that draws on the desire to learn. If learners can work together in groups or in pairs, their performance might improve and barriers for learners who experienced problems might also be resolved.

3.10.2 Forms of active learning

Learning can take different forms; however, it is important that learners be actively involved in the learning process so that they are able to develop an understanding of the content being learnt. Two forms of learning are identified as learning by doing and learning as a game, as discussed below.

3.10.2.1 Learning by doing

Willacy and Calder (2017:6) argue that involvement happens when learners appreciate and recognise that the learning and doing of mathematics is an imperative, meaningful task, beneficial both inside and outside the classroom. Learners in the FP can be actively involved through using real objects like counters that will assist them in working with numbers and understanding basic operations in mathematics. Teaching aids facilitate the understating and learning of mathematics and improve learners' performance (Alshatri, Wakil, Jamal & Bakhtyar, 2019:448). Different teaching materials can be used to enhance learners' understanding when they practice the problems in the classroom. Learning by doing can help researchers make sense of how teachers use their resources to promote meaningful understanding in solving number concepts' problems.

Furner and Worrell (2017:2) explore the factors that contributed to teachers' use of manipulation in their instructional mathematics lessons in Florida. Note that using concreate objects provide teachers with an opportunity to be creative and to do additional work on mathematics concepts instead of merely relying on worksheets. Tangible and intangible resources influence learners' educational experiences and establish a favourable learning environment (Visser, Juan & Feza, 2015:1). The availability of resources or the use of concrete objects in teaching FP mathematics assist in emphasising an understanding of what is being taught and makes learning enjoyable, while improving performance (Visser et al., 2015:6). Similarly, Ndlovu

(2018:236) found that the availability of resources has a positive influence on learners' performance if they are correctly applied.

3.10.2.2. Learning is a game

Cody, Rule and Forsyth (2015:1485) claim that using games in mathematics teaching and learning makes it more meaningful, interesting and facilitate the growth of mathematical knowledge. Learners should play, move, and experience subject matters through different sensory organs during teaching and learning (Behnsen, 2018:4). Learning through play gives learners the opportunity to become free and be able to interact with each other without any fear. Kenta (2017:40) also confirms that games can have an influence on reasoning skills, attitude and abstract conduct that are significant mechanisms to improve academic achievement. Most young learners, especially in the FP, enjoy learning through participating in different games related to mathematics concepts, and this can enhance the development of number concepts and improved learners' performance. Games can also enhance learners' concentration and attention during teaching and learning, improve learners' classroom behaviour and performance.

Ramani and Eason (2015:27) use a quantitative approach to investigate the impact of learners learning mathematics through games and play, finding that play and games can provide learners the chances to acquire and develop foundational mathematics skills that are associated with Common Core standards. Similarly, The LEGO Foundation and the United Nations Children's Fund (UNICEF) (2018:8) indicate that through play, learners' mastery of academic concepts are enhanced and they develop learning interest and motivation.

The time learners spend playing games with friends might direct them to acquire new skills, rehearse their current capabilities, and develop their interests, particularly in mathematics, as well as to recollect mathematical concepts (Ramani & Eason, 2015:28; Google Image, 2018:5; Rondina & Roble, 2019:5). According to Rondina and Roble (2019:5), play and games produce a robust foundation for 1st through 3rd grades when learners achieve operations with numbers, deliberate on place values, and reason about geometric shapes. They note that the interaction of learners through number board games in small groups enhanced learners' numerical knowledge. This implies that play and games are important in enhancing learners' knowledge in numbers. Learners' interest and development of new skills through games should be encouraged as this will enable them to understand mathematics more easily and better and therefore help improve performance.

Lai and Hwang (2016:131), in Taiwan, employed quantitative research methods to determine whether self-regulated flipped classrooms could help elementary learners plan their out-of-class time successfully. Lai and Hwang's findings revealed that mixing self-regulated strategy into flipped learning can enhance effective learning and improve performance.

3.10.2.3 Collaborative and small groups learning

According to Donald et al. (2009:95), collaborative learning is a process that takes place between two, or among a few learners, with the aim of working together. Similarly, the Professional Development Service for Teachers (PDST, 2017:7) also defines collaborative learning as any instructional technique in which learners work together in small groups towards a joint aim, while being evaluated independently. Young learners learn to talk by working together with others. According to Cohen and Lotan (2014:5), group work encourages communication among learners and reduces peer competition and isolation. Similarly, Jacob and Jacob (2018:6) believe that small groups provide discussion and communications amongst the learners, and it also offers opportunity for individualised instruction. If learners work together in a group, they can gain confidence to speak, and this promotes positive interrelationships and oral language development. Cox and Grove (2012:33) are also of the opinion that small groups encourage learning by doing, learning by trial and error in a safe environment, as well as learning through interaction, communication, and teamwork. If learners make mistakes during learning and on their own find a way to rectify them, they will be able to apply the knowledge they have developed in a similar situation. However, teachers should support the groups' capabilities through supervising, guiding by asking open-ended questions, presenting propositions, scaffolding, and strengthening (Baines, Blatchford & Webster, 2015:19). It was established that through small groups, the atmosphere of the interaction inspires learners to discover, to expand the way of reasoning, to discover some different thinking, and to learn to accept contributions from other learners or the situation (Apriliyanto, Saputro & Riyadi, 2017:2).

Backer, Miller and Timmer (2018:4) found that small groups are a positive way of encouraging active participation. Groupwork is a learner-centred approach of teaching that emphasises collaboration, co-operation, and teamwork, where learners work together to construct knowledge and accomplish the task through interacting with one another (Morris, 2016:4; Retnowati et al., 2017:667). The teacher needs to be aware of how to structure the groups, including the size, expectations for the learners' behaviour, individual and group's roles, supervising both the process and the outcomes of the group experience (Retnowati, Ayres & Swellers, 2017:667). The University of Suffolk (2019:4) found that heterogeneous groups provide the learners with the opportunity to work with peers with different abilities, enabling more diverse learning experiences. It is important for the learners to understand their learning differences because, if applied properly, they can help to complement each other to acquire knowledge. Learners can borrow knowledge from the other groups and reorganise connecting new information with prior knowledge gathered in longstanding memory (Retnowati, Ayres & Swellers, 2017:668). Group communications can assist individuals in making sense of the information and provoke the reorganisation of the information accordingly (Retnowati, Ayres & Sweller, 2017:668).

It is the duty of the teacher to ensure that the learners in their groups participate actively and work together collaboratively. According to Kato, Bolstad and Watari (2016:23), collaborative learning is aimed at fostering social skills and maximising learning objectives, where learners interact to achieve those objectives. Learners who work together collaboratively, develop their social interaction skills and share different views that will enable them to solve problems. It is the obligation of the teacher to make certain that learners work together efficiently in their groups so that they achieve the learning goals. According to Abubakari (2020:25), grouping learners assists in improving the performance of learners while narrowing the gap that might exist between learners of different abilities. This indicates that during group work, learners support each other, learn from each other, and experience learning in their own ways. According to Mallipa (2018:202), changing group members every time learners take on a new topic gives learners the experience of working with learners of different characters, different learning abilities and helps them to deal with different problems.

According to Lin, Yin, Han and Han (2020:3), small groups enable the teacher to interact with a few learners directly, motivate them, positively engage with them, and helps the learners communicate freely with the teacher. It is important for the learners to be close to the teacher so that the teacher can understand the learners better and be able to support their learning needs. Similarly, Gamlem (2019:2) found that effective interaction between teachers and learners promote long-term school success and learners who are engaged in mathematical argumentation, write in ways that expose their reasoning to one another and to their teacher. This indicates that small group teaching is effective and encourages support to learners by the teacher.

Lin et al., (2020:4), in their research, found that interaction between the teacher and learners during small group discussion strengthens their relationship and even the relationship among the learners develops while learning to respect each other. Similarly, Apriliyanto (2017:4) asserts that learners learn effectively in groups in such a way that they inspire each other to ask questions, clarify and validate their opinions, develop coherent reasoning, and summarise their knowledge. Molina, Pushparatnam, Rimm-Kaufman and Ka-Yee Wong (2018:11) postulate that one characteristic of positive classroom attitude involves expressing admiration and compassion toward the learners including commendation and inspiration and this is vital during group work to encourage positive participation. However, Baines, Blatchford and Webster (2015:15) contend that there is a need to ensure the classroom layout encourages the possibility for group-work, the arrangement, size and permanency of groups, lesson planning and group-work activities. This ensures that group-work assessments are thought-provoking and permit group interactions of a high level and involve the application and combination of knowledge which is a challenge to most of the teachers. These show that group-work needs thorough planning to ensure that effective teaching and learning takes place.

Learners need to be introduced to different learning styles that will enable them to interact effectively with other learners during their early learning. Learners need to understand that finding the correct answer to the problem is not the only purpose of shared learning experiences. However, discussing different ideas, questioning, and refining each other's tactics, and generating a mutual understanding are the essential learning objectives and all learners should invest time and effort in this process (Mutara, 2016:241).

3.11 SUPPORTING LEARNERS THROUGH MATHEMATICAL ADAPTATION

Since most learners in SA experience challenges and do not perform well, mathematics adaptation in a diverse classroom and intervention needs to be provided as soon as in Grade 1. Janney and Snell (2013:154) state that teachers should follow the following options for supporting learners:

- Permit the learners to maintain using practical and/or illustrative representations of number concepts and procedures.
- Go on using mathematics reference tools or resources and pictorial aids like number charts, number lines and place value charts.
- Increase prompts to calculation problems in scripts and tests: "+ means add", "- means subtract." Or use markers to colour-code calculations signs, i.e., green for addition, red for subtraction.
- Minimise the amount or complication of problems done by learners (i.e., have learners do only the two-digit multiplication problems of two- and three- digit problems on a page).
- Give examples on worksheets and assessments.
- Give more clues, prompts and comments as a learner concludes practicing activities.
- Offer selections for the responses to worksheet exercises (i.e., on a worksheet with clock faces and blank lines on which learners will write the time, write two choices, and have the leaner make a ring around the correct answer).

Concreate materials and using pictures to represent information are some of the ways that help young learners to understand what they are being taught. In the FP, teaching and learning needs to be more practical so that all learners are accommodated, and understanding will be encouraged. Parker and Thomsen (2019:34) proclaim that using different resources and real objects when teaching different numbers may help learners to improve their performance.

It is crucial that active participation and learning be encouraged as early as possible so that the learners can perform better. According to Brown (2016:16), learners may have difficulty with mathematics and range from poor organisational skills that interfere with the execution of paper-and-pencil operations. If different accommodative options for the curriculum are applied, learning may improve, and better performance may be realised. If proper support is given, performance will improve and a good foundation of mathematics would be laid.

3.12 PRACTICING AND SUPPORTING TEACHERS THROUGH COLLABORATION IN DIVERSE CLASSROOMS

Collaboration can be referred to as planning together, as teachers in the same grade or phase share information, solve problems and build essential teamwork to improve performance (Kenta, 2017:45). Working together as teachers can assist in discovering how other teachers accommodate different learners in a diverse classroom. Campbell -Whatley and Lyons (2013:129) state that inclusive education can be promoted by providing time for teachers to plan and collaborate. Inclusive education allows all learners to partake equally. Successful inclusive education can be encouraged by teachers' partnerships, accepting one another's ideas and sharing resources (Campbell-Whatley & Lyons, 2013:129; Sciullo, 2016:32). Collaboration among the teachers might help teachers to come up with strategies that assist learners to enhance their achievements in mathematics and to increase positive learning.

Similarly, Jaworski, Chapman, Clark-Wilson, Cusi, Esteley, Goos, Isoda, Joubert and Robutti (2017:263) proclaim that collaboration encompasses mathematics teachers working together in shared tasks, exchanging ideas and investigation. They go further to indicate that mutual support, tackling problems that the teachers encounter professionally and reflecting on their part in school and in the community are also part of collaboration. Collaboration helps in closing the content knowledge gap and offers insight into the school's effects (Crowley, 2017:2). Collaboration increases interest in examining different activities, processes, contexts and increases teachers' expertise and teaching practices (The International Program Committee, 2019:2).

Campbell-Whatley and Lyons (2013:130) explain that co-teaching is a method used when both general and specialist teachers work together in carrying out essential instructions to combined group of learners in the same lesson. Collaborative processes in group work in a diverse classroom promote positive learning and socialisation among learners (Frykedal & Chiriac, 2018:1). Learners need the teacher's support during collaborative learning so that they can improve their interpersonal skills, increase disciplinary knowledge, and develop mutual respect for each other (Van Wyk & Haffejee, 2017:159).

3.13 MATHEMATICS ASSESSMENT STRATEGIES IN DIVERSE CLASSROOMS

Marinho, Leite and Fernades (2017:185) proclaim that assessment is administered to measure the effectiveness of curriculum materials, teaching strategies and to evaluate the learners' knowledge and skills. Assessment should be used to identify barriers that hinder learners' performance and point to inclusive strategies that accommodate diverse needs of learners. Learners should be given the opportunity to write different assessments based on their level of performance. Van Den Berg, Bosker and Suhre (2018:341) state that if properly administered, continuous assessment prevents learners from developing knowledge gaps and eventually enhances performance. The DBE (2014b:16) outlines assessment principles as summarised below.

Assessment needs to be administered in such a way that it provides support to the individual learner. It should be multi-dimensional and differentiated and should include different forms and perspectives. Assessment should be used as a part of different strategies with the aim of enlightening teaching and learning procedures offered to learners and also as part of individual support. It should be fair, clear, open, and sensitive to different learning abilities. Assessment should be manageable, time-efficient, documented and clearly communicated to learners.

Similarly, the Teaching and Education Standards of New South Wales (2016:18) confirm that assessment tasks within units and across the programme should reflect the diversity. Learners in a diverse mathematics classroom should be given assessment according to their ability levels so that every learner is accommodated. The authors assert that assessments should exhibit sufficient breadth and depth to ensure that learners demonstrate knowledge, understanding and the expertise expected. In most cases, assessment tasks written by learners do not reflect the diverse range of learners in the classroom, hence most learners end up not performing well, as not all level of abilities are considered.

Assessment procedures should support teachers and learners in understanding where they have been, where they are and where they may go (Ever, 2011:9; Marinho et al., 2019:188). The teacher should use different types of assessments to find information about learners' understanding, their progress and use the information to guide his/her teaching practice. Van Den Berg, Bosker and Suhre (2018:342) postulate that assessment should be used to inform learners about the proactive role they must take in their learning, to determine which knowledge and skills will be taught, and to draw conclusions about learners' level of understanding and knowledge. The teacher needs to share feedback with learners and encourage them to evaluate their own work so that they understand what went wrong. Learners who can evaluate their own work and are given feedback regularly, might improve their understanding, and perform well in mathematics.

Effective mathematics classroom procedures include measuring learners' previous knowledge, planning tests that permit freedom of techniques and arranging classroom debates that allow every learner to effectively acquire and gain mathematics concepts (Evers, 2011:20; Barbour, 2016:7). To accommodate all learners, flexible assessment methods that recognise the strength and the weaknesses of all learners need to be administered. Marishane (2013:29) argues that learners can be evaluated informally or formally in groups, pairs or individually. Using different types of assessment to assess learners in the FP can help them improve their performance and help teachers to identify intervention needs for those learners who are experiencing barriers. Assessment in the FP is not only subjected to writing; learners can also do oral work.

3.14 DIFFERENTIATION IN MATHEMATICS

Every learner is unique, learns differently and comes to school with their own experiences, as such, strategies to accommodate different learning styles are vital. Curriculum differentiation and instructional differentiation strategies are key for responding to the needs of learners with varied learning styles (Small, 2017:4). It is the teacher's responsibility to identify the background knowledge of the learners, learning capabilities and language so that s/he should respond appropriately. Curriculum differentiation encompasses the methods of altering, adjusting, reworking, expanding, and changing teaching practices, teaching strategies and assessment strategies (Haug, 2017:211; Small, 2017:6). Teachers might possess the skills and knowledge of adapting and varying teaching methods or strategies so that all learners are supported and accommodated. Teachers need to understand the strengths and weaknesses of differentiation and the context of which the curriculum is delivered to learners in diverse classrooms (Marishane, Marishane & Mahlo, 2015:255). This will allow teachers to prepare their lessons in such a way that learners' needs are accommodated. Learners should be given the opportunity to engage effectively with their peers, the teacher, and the subject matter.

Learners differ, and learn differently, however, they all require the teacher to support and provide them with equal opportunities so that they can achieve. The teacher should ensure that learners are actively and positively involved such that no-one is left behind (Haug, 2017:208). All learners need to be supported; if done appropriately, their understanding and performance in mathematics will improve. Differentiation requires teachers to ensure that learners with different abilities receive the same lesson in different ways and it requires the teachers to know when to assess learners (Noonan, 2013:164; Tichá, Abery Johnstone, Poghosyan & Hunt, 2018:107).

Learning must be planned with care, including routes for how differences in learning styles and rate may be managed so that all learners, irrespective of the learning barriers, are included. However, some of the teachers give up on reaching out to all the learners, because the system fails in helping them to meet every learner's needs, by not providing enough resources or developing them professionally (Arthur, Badertscher, Goldenberg, Moeller, McLeod, Nikula & Reed, 2017:6). Providing teachers with enough teaching and learning resources and providing professional development can assist teachers in accommodating the different learning abilities of learners in their classrooms.

Teachers need to acquire knowledge and skills of how to apply curriculum differentiation in a diverse mathematics classroom. Teachers' lack of understanding and lack of necessary preparation can cause them to apply instructional strategies that are in conflict with evidence-based strategies of teaching in inclusive classrooms (Marishane, 2013:64; Tichá et al., 2018:107). Teachers have the responsibility to be equipped with knowledge and skills of how to apply curriculum differentiation in an inclusive classroom so that all learners receive equal education. Differentiation is about a frame of mind and is a teaching philosophy that should be linked to effective learning (Thousand, Villa & Novin, 2015:2; Goepel, Sharpe & Childerhouse, 2015:51). This will assist teachers in adapting the instructions in a way that the needs of all learners are provided for and include changing of teaching methods to support every learner.

3.15 PERFORMANCE IN MATHEMATICS

Ngware, Ciera, Musyoka and Oketch (2015:111) examined the influence of excellence mathematics teaching to learner achievement in Kenya. Their findings demonstrated that high-level teaching of mathematics was lacking in primary school classrooms. They also found that there were as many as 80 learners in certain classes, which made it difficult for teachers to focus on all of them. The findings of Ngware et al. (2015:125) established that teachers should provide higher mathematical proficiency, cognitive demands of a given task, and mathematical knowledge to benefit the learners' learning. It was also established that quality teaching represents successful education. This implies that mathematical proficiency and mathematical knowledge are important for teachers to be able to teach quality mathematics, which may also contribute to learners' achievement.

Spaull and Kotze (2015:13) used data that was drawn from the National School Effectiveness Study for Grade 3 in SA to establish that learners attain a learning deficit early in their schooling careers, and the results cause underachievement in the following years. Spaull and Kotze (2015:15) found that by Grade 3, learners in the previously disadvantaged schools are already three years behind the former Model C schools, this gap grows as they progress through school levels. The Australian Council for Educational Research (ACER) and UNICEF (2016:3), from the study conducted in Zimbabwe, in a three-year research project, found that Grade 3 learners' performance in mathematics was 46 percent in 2012, improving significantly to 63 percent in 2013, and again improved substantially to 67 percent in 2014. However, socio-economically privileged learners and schools tend to outscore their underprivileged colleagues by higher margins. This means teaching and learning should be properly administered, alongside interventions to ensure that all learners are at the same level in learning, irrespective of the school in which they learn.

Khun-Inkeeree, Omar-Fauzee and Othman (2016:41) investigated mathematics performance between public and primary school learners in Southern Thailand. According to Khun-Inkeeree et al. (2016:41), even though the Thai government made the efforts to increase the performance level of learners from public schools by increasing the budget allocation, the increase in performance is yet to be realised. They found that private school learners performed better than public school learners. According to Khun-Inkeeree et al. (2016:47), the outcomes may be due to fewer numbers of learners in each classroom at private schools, the accessibility of teaching resources, such as computer laboratories, projectors, learning resources, ceiling fans and air conditioners, whereas in public primary schools, the number of learners in each class are too high and the resources are limited.

Wheater, Durbin, McNamara and Classick (2016:2) examined mathematics performance in England compared to other countries. According to the authors, socio-economic background has an impact on performance, especially for learners who come from a disadvantaged background. They state that disadvantaged learners who perform better than average, are born gifted, are more self-confident in their capabilities, and are less likely to be absent from school. This means that learners' background may be a barrier to their learning, and attention should be paid to these learners to ensure that their performance is improved.

Ramirez, Chang, Maloney, Levine and Beilock (2016) in the United States of America (USA), explored the possibility that learners' mathematics anxiety negatively relates to mathematics achievement. According to Ramirez et al., (2016:84), mathematics nervousness has been discovered to be negatively associated with mathematics attainment. This is because it leads to avoidance and interrupts the working memory resources of learners to resolve complicated mathematics questions. Similarly, Prodromou and Frederiksen (2018:639) proclaim that when learners are quiet and relaxed, performance seems to come as anticipated, but when learners feel stressed, rushed, or anxious, the outcomes are different. This implies that learners' anxiety needs to be dealt with so that it does not interfere with their performance. It is important that learners always feel free when learning mathematics so that they are also free to participate and ask questions. Ramirez et al. (2016:97) found that with learners of higher working memory mathematics, nervousness is negatively correlated with their use of complex problem-solving strategies, which could have consequences for their long-term mathematical achievement. This implies that strategies for overcoming mathematical anxiety should be applied in the early grades so that mathematical understanding and achievement are not affected.

Simba, Agak and Kabuka (2016:164) explored the level of behaviour and the degree of influence of discipline on academic achievement between learners in the sub-county's public primary schools of Kenya. Simba et al. (2016:169) say that well-behaved learners are expected to stay focused, are great in time management, work hard academically and show determination to achieve. As early as in lower grades, learners need to be disciplined so that they can pay attention to their learning. Simba et al.'s (2016:169) study revealed that discipline improved learners' academic performance. This indicates that discipline is vital during teaching and learning so that learners can remain focused and develop an interest in learning.

Maimela and Monyatsi (2016:157), in their study, examine the strategies that could be employed to improve the performance of learners in primary schools in Botswana. They assert that the government should recruit qualified teachers, improve teacher-learner ratios, and involve the parents. The authors go further to indicate that the school learning environment, educational resources, English as medium of instruction, and school library are strategies that could be used to improve learner performance. However, for this to happen, qualified teachers who are knowledgeable about the subject, especially mathematics, are required in the classrooms.

The research findings of Maimela and Monyatsi (2016:176) revealed that parental involvement, coupled with parents' meetings, workshops and discussions to educate parents on the schools' expectations can play a significant part in their children's academic performance. They also found that suitable active teaching and learning situations such as teacher qualifications, teacher accessibility, class size, accessibility of teaching and learning resources, supervising, teaching hours, inspiration of teachers and teachers' non-attendance/obligation to duty; play a significant part in enhancing learners' performance. Teachers should always make themselves available to assist learners and the availability of teaching and learning materials also play a crucial role in learners' performance.

Arends, Winnaar and Mosimege (2017:6) employed a questionnaire as part of the Trends in International Mathematics and Science Study (TIMSS) of 2011, to examine the outcome of learners' performance in mathematics in SA. They found that good and untarnished teaching behaviour, involving skills such as interaction, accepting learner differences, understandable explanations and appropriate assessment approaches impact on learners' performance. This implies that teachers' knowledge of mathematics encourages self-confidence in engaging learners. They further found that teachers who provide a clear explanation have self-confidence in what they understand and involve learners, familiarise themselves with lessons to ensure that all learners continue to be interested, and are also able to answer all content-related questions that learners may have.

Naude and Meier (2019:1) assert that the physical learning atmosphere, such as noise or large class sizes, has an effect on learning and performance in mathematics classrooms and has an effect on learners' performance. In the same study, Naude and Meier (2019:9) found that noise, because of large class size and the outside environment, contributes to the overload of learners' working memory, which eventually influences undesirably on learning and performance. The authors found that large class size hinders teachers from supporting learners who are experience challenges. According to Naude and Meier (2019:10), attending to reducing the number of learners in FP will allow the teacher to move around and have time to support individual learners, which will lead to better performance. As such, instructional scaffolding methods where step-by-step guidance is offered to learners within a whole class set-up, should be examined as a more appropriate technique to that of teaching and learning FP classrooms in in SA (Naude & Meier, 2019:1).

3.16 CHAPTER SUMMARY

This chapter presented the importance of the problem by means of a literature review in relation to the study. Then the definition of strategies and their importance, other related concepts to the study and then literature from international countries, African countries and SA were discussed. The next chapter discusses the research methodology that was employed in the research study.

CHAPTER FOUR

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

This chapter presents the research methodology. The researcher presents the research paradigm, research approaches, research design, research methods, data collection procedures, location, population and sampling. Thereafter, data collection instruments and data analysis procedures are also discussed, along with ethical considerations.

4. 2 RESEARCH METHODOLOGY

Greener and Martelli (2018:10) state that methodology is the research plan, strategy or approach that shapes the choice and use of research methods that are applied and linked to the desired research questions and outcomes. Methodology refers to a wide general methodology for logical investigation stipulating how research questions should be raised and replied to (Besse-Biber, 2010:11; Greener & Martelli, 2018:11; Teddlie & Tashakkori, 2009:21). Methodology leads the researcher in prioritising the type and importance of questions to be asked in the research study (Bairagi & Munot, 2019:22). The study adopted a mixed method approach involving two approaches, namely qualitative and quantitative. The three forms of research approaches classified as qualitative, quantitative and mixed methods research, are discussed below.

4.2.1 Quantitative research method

Bairagi and Munot (2019:27) are of the opinion that quantitative research is established on the fundamental notion of a single reality that is independent of the opinion. Quantitative research is centred around the numbers and the quantification of perceptions or connections between ideas (Bergin, 2018:67). According to Creswell (2014:48), in quantitative research, the researcher analyses a theoretical proposition by stipulating slight propositions and the compilation of data to maintain or disprove the assumptions. Quantitative research operates under the notion of objectivity (Johnson & Christensen, 2020:86). Since quantitative research focuses on collecting and analysing numeric data, using it alone in this research study would not fully answer part of the research questions. Quantitative data is compared with qualitative data to enhance the research findings. A quantitative research method is used to collect information about learners' performance after writing the pre-test before applying the identified teaching strategy and the post-test after applying the teaching strategy. However, this approach addressed the quantitative arm of the study in confirming or disconfirming the hypotheses tested in the pre-test and post-test results and thus cannot address the qualitative arm of the study in answering the research questions of the study.

4.2.2 Qualitative research approach

The qualitative research approach takes place when the researcher gathers information in the area at the location where participants experience the matter or phenomenon being studied (Creswell & Creswell, 2018a:181). Johnson and Christensen (2020:82) cite that the purpose of qualitative research is to explain what is seen closely, to discover and learn more about the phenomenon or to understand the participants' experiences and perspectives. Qualitative research depends on data collected in a real situation where communication happens, observing public life in conditions of procedures that arise (Maree, 2016:53). Hence, the researcher sought to interpretate participants' teaching experiences of numbers, operations and relationships to understand how they make sense of those experiences. The researcher required the answers to the research questions by exploring participants' social settings, which, for this study, was the classroom.

This study investigated the effective strategies that can be used to enhance the performance of Grade 3 learners in diverse mathematics classrooms, thereby attaining an in-depth understanding of their viewpoints in teaching numbers, operations and relationships (NOR) in diverse classrooms. The research sought to understand the teachers' experiences in teaching NOR in Grade 3 diverse mathematics classrooms before applying the intervention strategies and how their practices changed after being exposed to new practices during the application of intervention strategies. To this study, this research approach appears to address one arm of the study. In other words, the approach cannot respond to the pre-test and post -test results which needed in a quantitative arm to confirm or disconfirm the hypotheses tested in the intervention.

4.2.3 Mixed methods research approach

Creswell and Creswell (2018a:3) present a mixed methods research approach as a technique requiring gathering both quantitative and qualitative data. According to Plano Clark and Ivankova (2015:3), the integration of research approaches helps in strengthening the research findings and minimising the weaknesses in helping the researcher to reach a justifiable conclusion, rather than using either quantitative or qualitative methods alone. Mixed method research allows for the effective and rapid accomplishment of a single research study, rather than performing various methods that necessitates a succession of associated research projects performed over time (Morse & Niehaus, 2016:14). Gathering several sets of data using different research methods, epistemologies and approaches help in mixing or generating the results, which generate numerous (convergent and divergent) corresponding strengths and non-overlapping weaknesses (Johnson & Christensen, 2020:107).

Employing mixed-method research offers the researcher many opportunities to deal with the research problem and find the answers that cannot be answered by quantitative or qualitative methods alone (Creswell, 2014:20; Creswell & Plano Clark, 2018:30). This research study intended to obtain the responses that meet the objective of the study that would not be achieved by using either quantitative or qualitative method alone (McMillan & Schumacher, 2014:425). The quantitative data were collected through tests while the qualitative data were collected through interviews and lesson observations. Data collected from tests could not be obtained through the qualitative method as well as data from interviews and lesson observations could not be obtained through the quantitative method. Cohen et al. (2018:32) agree that combining quantitative and qualitative approaches provide broad understanding, allow for a strong data analysis and answer complex research questions meaningfully. Employing a mixed method approach permitted the researcher to collect enough data to address the research questions and hypotheses tested in this study.

Plano Clark and Ivankova (2015:10) postulate that the quantitative method studies the relations amongst the variables by gathering and analysing numerical data stated in figures or scores, using consistent dimension tools, while the qualitative method emphasises discovering individuals' practices with the study of interest by gathering and analysing narrated data or writing expressed in arguments and pictures employing comprehensive, open-ended questions.

According to Creswell (2015:15), quantitative methods alone do not sufficiently explore individual stories and meaning or profoundly review the perceptions of individuals; and qualitative methods alone do not measure what people in general feel or permit the researcher to simplify from a small group of people to a greater population. Hence, the researcher employed mixed methods research for the study, so that the quantitative and qualitative methods supported each other during the process to accomplish the purpose of the study. Quantitative data were gathered and analysed, and then the results were used to collect qualitative data. Qualitative data were collected through open-ended interviews and lesson observations. Qualitative data were used to describe the quantitative outcomes. This means that elements of both quantitative and qualitative approaches were included to address the research problems in this research study.

The study was aimed at identifying the strategies that could be used to enhance the performance of Grade 3 Foundation Phase (FP) learners in diverse mathematics classrooms. A mixed method approach was used to address the aim of the research study. By employing quantitative and qualitative methods, the researcher was able to use assessments, open-ended interviews and lesson observations to fulfil the intended aim of the study. The researcher gathered quantitative data and then focused on qualitative, open-ended interviews to bring together comprehensive opinions from participants to assist in describing the preliminary quantitative results (Creswell, 2014:48). Quantitative and qualitative data were compared and incorporated to provide strong arguments to produce a better understanding of the research findings (McMillan & Schumacher, 2014:433).

A mixed method approach combines or mixes quantitative and qualitative research approaches and techniques to help improve the quality of research (Johnson & Christensen, 2014:648). Coe et al. (2017:161) proclaim that a mixed-method approach deepens interpretation and provides strong confirmation of the understanding acquired during data collection. A mixed method approach helped the researcher to understand how teachers were teaching NOR in their diverse mathematics classrooms, and the strategies they were using to enhance learners' performance. Maree (2016:312) is of the opinion that a mixed methods approach permits appropriate explanations, the usage of several techniques, and flexibility in employing the best strategies to address the research questions. According to Gray et al. (2017:489), researchers have moved away from the idea that one paradigm or one research strategy is important and instead have taken the position that knowledge can be acquired by using all available strategies. Hence, the researcher established evidence related to incidence, relationship or connection in quantitative data and then an explanatory description of the human experience characteristics from qualitative data (Gray et al., 2018:490).

4.3 RESEARCH PARADIGM

A paradigm is regarded as a set of uncomplicated principles (or metaphysics) that agrees with thoughtful perspectives and characterises a worldview that describes the life of the "realm", the person's place in it, and the variety of conceivable relations to that realm and its parts, as, for example, "cosmologies and theologies do" (Guba & Lincoln 1994:107). Creswell and Creswell (2018a:5) state that a paradigm is a moral alignment of the world and the kind of research that a scholar takes to the study. Similarly, Leavy (2017:12) supports the view that a paradigm impacts and becomes the lens through which a study is understood and executed. A paradigm signifies the principles and rules that outline how the researcher understands the world, and how s/he explains and performs in it (Kivunja & Kuyini, 2017:26). Attitudes and beliefs of paradigms influenced how the researcher saw or interpreted the strategies used by teachers in teaching NOR in Grade 3 FP classrooms. Du Plooy-Cilliers et al. (2014:19) indicate that knowledge of the paradigm to be assigned to the research study is essential because it regulates questions that are considered worthy of investigating, as well as the processes acceptable to answer the required questions.

Coe, Waring, Hedges and Arthur (2017:16) acknowledge that the research study is outlined by a series of connected traditions which are framed around four key questions outlined as follows:

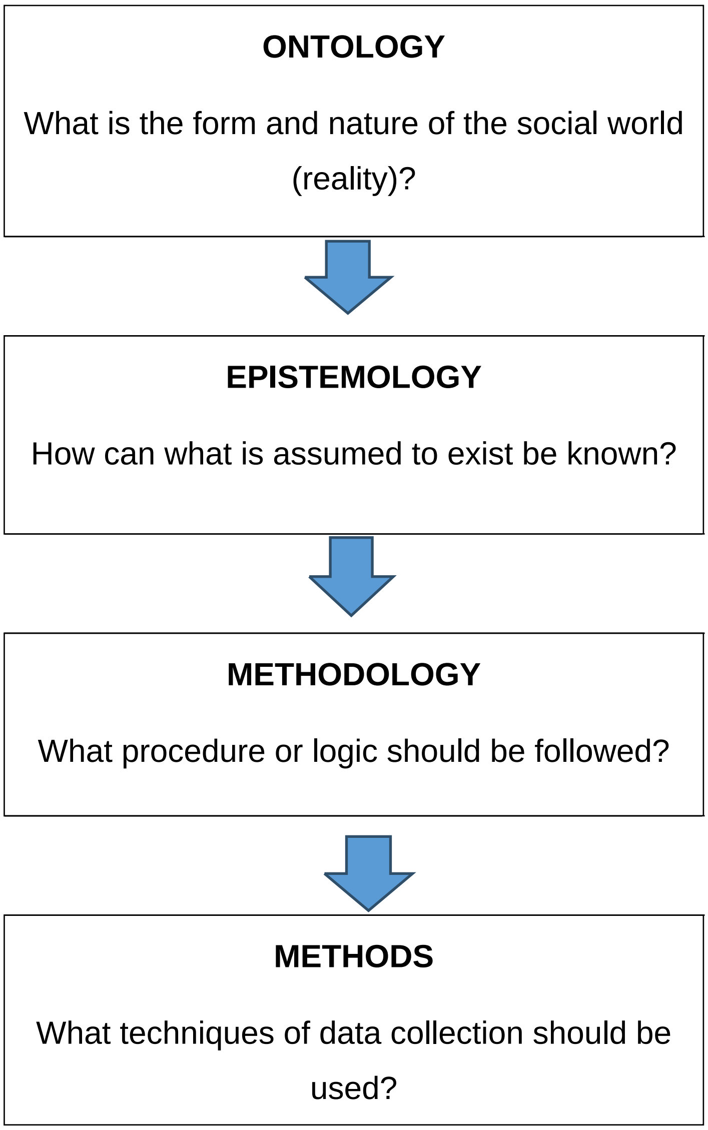


Figure 4.1: The relationship between ontology, epistemology, methodology and methods *(Adapted from Coe et al., 2017:16)*

Different paradigms encompass ontology, epistemology, methodology and methods applicable to the research study. Figure 4.1 illustrates the relationships involved in acquiring knowledge for the research study. The abovementioned related assumptions helped the researcher to understand the participants' views on teaching NOR in FP Grade 3 classrooms by acquiring information directly from them through interviews and observations.

Ontological philosophy believes that there are variances in the manner by which the world is viewed, and the significance and understanding of that world held by individuals (Leavy, 2017:12). Ontological philosophy helped the researcher to understand how teachers differ in their understanding of the teaching of NOR topics in Grade 3 diverse mathematics classrooms (Leavy, 2017:12; Hassan & Mingers, 2018:11). On the other hand, the knowledge was generated independently, using the test instruments. Open-ended interviews inform the researchers regarding what they can learn about the social world. The researcher learned how participants applied various teaching strategies in teaching NOR in Grade 3 in diverse mathematics classrooms. These helped in addressing whether the nature of reality is the result of individual interpretation or social construction (Burkholder, Cox, Crawford & Hitchcock, 2020:15). In this research study, the researcher learned and understood what the participants thought about their teaching practices and how they accommodated and supported different learners when teaching NOR in Grade 3 classrooms. Ontologically, the researcher understood teachers' knowledge concerning NOR, and how they interpreted the content.

Epistemology concerns knowledge and how it is acquired (Hassan & Mingers, 2018:11). It is about how research continues, what counts as knowledge, how the role of the researcher is endorsed and how to understand the relationship between the researcher and participants (Leavy, 2017:12). Lesson observations and open-ended interviews assisted the researcher in gaining and understanding participants' personal experiences in teaching NOR in diverse Grade 3 mathematics classrooms. It also assisted the researcher in understanding how teachers applied various strategies in helping learners to acquire knowledge about NOR.

Epistemology constitutes how the researcher considers the knowledge that is relevant to the study. It focuses on providing a moral foundation for determining the types of information that are feasible and how to make certain that it is verified and reasonable (Crotty, 1998:8; Pruzan, 2016:159). The researcher needed to determine the knowledge of NOR that is provided to Grade 3 or acquired by learners as the foundation of understanding the concepts that are to be applied when they advance to higher grades.

The researcher employed interviews and lesson observations to find out how teachers decide on the knowledge that should be acquired by Grade 3 learners when learning NOR. According to Burkholder (2020:15), knowledge can be generated through perceptions, experiential, inductive or deductive logical and reasoned analysis. The researcher acquired knowledge through the personal experiences of the participants and used her reasoning towards their responses to understand their experiences in relation to the study (Gray et al., 2017:41). Epistemological assumption was centred around perceiving and describing knowledge through observation on how teachers apply strategies in teaching NOR in diverse Grade 3 classrooms.

Greener and Martelli (2018:11) postulate that methods are techniques, procedures or activities engaged in gathering and analysing research data. Teddlie and Tashakkori (2009:21) also emphasise that techniques incorporate detailed strategies and processes for applying research design, involving sampling, data gathering and analysis and the evaluation of the research results. The researcher applied mixed methods research techniques, explanatory sequential design, and data gathering techniques to collect relevant data for the research study. The identified design for the study, sampling and data gathering techniques helped the researcher in exploring the study. The above-mentioned features of philosophy helped in defining the allocation or the limits of the research study. The limitations of the study were established to notify on what and how the researcher needs to focus to conduct successful research. The paradigms, which are discussed below, are identified as post-positivist, constructivist/interpretivist, and pragmatist.

4.3.1 Post-positivists

Post-positivism is associated with the quantitative approach in which the research makes assumptions of experience constructed on cause-and-effect thinking by tightening and concentrating on selected variables to measure and interconnect, comprehensive explanations, and the testing of theories (Creswell & Plano Clark, 2018:67). Bergin (2018:22) is of the opinion that in a positivist tradition, objective reality exists, in which researchers can study through direct, rigorous observation, which includes experiments or cause-and-effect relationships. Observing practical events can help researchers to analyse data, although the quantitative part is not interested in descriptions.

The challenges explored by post-positivists suggest the requirement to classify and assess the motives that impact outcomes (Creswell, 2014:12). Leedy and Ormrod (2015: 25) state that suitable measurement techniques help to uncover the reality of cause-and-effect relationships within the real world and human practices. The information that progresses through a post-positivist lens is centred on thorough observation of individuals and the reality of the objective that occurs “out there” in the world (Creswell & Creswell, 2018a:7). The researcher develops numeric measures of observations while studying participants’ performance (Creswell & Creswell, 2018a:7).

According to Creswell and Creswell (2018a:6), post-positivist represents the traditional assumptions that hold the qualities of quantitative research than qualitative research. Post-positivism was employed to address the qualities of the quantitative part of the research study. However, observation, which is addressed by post-positivists, could not, on its own, address in the research study. Hence, the gap between observed phenomenon and explanation could be bridged by also applying another paradigm from outside that observed phenomenon (Cohen et al., 2018:16), which is interpretivism since the study employs mixed methods research.

Different instruments for collecting data can be combined with other data gathering methods to accumulate more material about the topic under study. Combining the qualities of both the post-positivist paradigm and interpretive paradigm assisted the researcher in addressing the research questions and hypotheses tested and in closing the gap that might exist when observing a single paradigm in isolation.

4.3.2 Constructivism/Interpretivism

According to Maree (2016:60), interpretivism is occasionally described as constructivism, because it highlights the capability of a person to construct meaning and interpretation. Du Plooy-Cilliers et al. (2014:27) postulate that in interpretivism, a human being cannot be studied the same way as objects, because humans keep on changing with time, with the environment influencing changes. The researcher was immersed in the schools and observe the teachers applying their strategies in teaching NOR in diverse Grade 3 classrooms.

Bergin (2018:23) emphasises that under an interpretive paradigm, there is no unique, objective reality, as individuals recognise the world in their own way. Bergin (2018) further elaborates that the world is shaped by individuals' interpretations and by the societies in which they live. In the study, it is argued that individuals' perceptions are important and valid, according to the unique way they interpret information.

Creswell (2014:13) postulates that the researcher in constructivism seeks to understand the research phenomenon by relying on participants’ views. Hence, humans can be deeply understood by conducting the research in a normal setting, which was the classroom in this case (Pham, 2018:3). Similarly, Cohen et al.

(2018:34) emphasise that constructivists seek to understand the research as seen and interpreted by participants themselves. Like constructivism, Bergin (2018:23) also supports the view that in interpretivism, the objective of the researcher is to reveal the participants' various viewpoints. The researcher uncovered how participants taught learners in the diverse mathematics classrooms, and how they applied various strategies to enhance learners' performance.

4.3.3 Pragmatism

Teddlie and Tashakkori (2009:7) observe that "Pragmatism is a paradigm that reveals perceptions such as "reality" and "truth" and aims as a replacement for "what works" as the reality concerning the research questions under inquiry". Johnson and Onwuegbuzie (2004:18) meanwhile argue that the pragmatist views understanding as being both created and established on the reality of the world we live through and experience. According to Creswell and Plano Clark (2018:67), pragmatism is linked with mixed methods research, aiming at the question posed, instead of techniques employed and employs several methods of data gathering to inform the problems under the study. Cohen et al. (2018:3) indicate that the researcher concentrates on outlining and resolving the research question altered by procedures of data gathering and utilising their analysis. According to Johnson and Christensen (2020:26), pragmatists believe that what is considered significant and acceptable, is what answers the problems, what acts in a specific position in practice, and what endorses social justice.

The study acknowledges Creswell and Creswell's (2018b:10) argument that pragmatism welcomes the researcher's freedom to apply multiple research methods, different worldviews and different techniques for data gathering and examination. The researcher was independent of the knowledge that was generated from the tests administered to learners and she was also dependent on participants to generate knowledge through interviews and lesson observations. The researcher used open-ended questions to understand the participants' experiences and to construct meaning (Creswell & Creswell, 2018a:8). The researcher engaged with participants individually in their schools and formulated her own understanding and awareness of individual experiences about the phenomenon under study. Participants provided their own understanding, they spoke the meaning formed by their social collaboration with the researcher, and from their own experiences (Creswell & Plano Clark, 2018:67). It was important for the researcher to interact with participants to construct an understanding of their experiences and meaning towards the challenges they are experiencing when teaching learners in diverse classrooms. According to Leavy (2017:13), a constructivist worldview suggests that social learning is constructed and reconstructed through social interaction and communication while gaining insight into the meaning and thereby improving the researcher's comprehension.

This study explored the strategies that could be used to enhance the performance of Grade 3 learners in diverse mathematics classrooms in learning NOR, as well as to identify effective strategies for effective teaching and active learning. For this reason, pragmatism was employed in this study as the researcher believes in multiple realities which were imperative for this study (Creswell & Creswell, 2018a:8). Furthermore, the researcher sought to generate knowledge using different research instruments. The researcher did not employ either post-positivist or interpretivism paradigms on their own, because employing one paradigm would have left the qualities of another paradigm out.

Post-positivists emphases is on creating and probing for evidence that is effective and dependable in terms of the existence of phenomena (Maree, 2016:60). Meanwhile, an interpretive paradigm helps to uncover the meanings imparted, improve the researcher's comprehension, and helps to develop a sense of understanding of the phenomenon under study (Maree, 2016:60), as well as assisted the researcher in understanding what happens at one place at a particular time compared to what happens at different places and times (Creswell & Creswell, 2018a:8). However, pragmatism is characterised by the qualities of both interpretivism and post-positivism. Hence, pragmatism was employed in the study to include the qualities of interpretivism and post-positivism.

4.4 RESEARCH DESIGN

MacMillan and Schumacher (2014:28) state that a research design involves the plan for executing the research study, comprising time, participants and the method that is applied to accumulate data. The research design guided the researcher regarding the type of data that was collected, data collection methods that were used and finally, the ability to garner tangible information for the research study (Bairagi & Munot, 2019:71). Johnson and Christensen (2020:27) present that the research design should be formulated and performed in a way that assists in answering the research questions.

Ary et al. (2010:363) identify six research designs briefly described as follows: (a) concurrent design - qualitative and quantitative data are gathered distinctly but at almost the identical time. (b) Concurrent triangulation occurs when quantitative and qualitative data are gathered and examined distinctly but at a similar time, with the results meeting the conclusions in response to the research question. (c) Parallel design data are gathered and examined distinctly, like concurrent designs. (d) Fully mixed designs or fully combined designs include mixing of the qualitative and quantitative methods during the study. (e) Conversion designs encompass altering information, which means that collected information in one form (e.g., numbers or text) are changed to a unique arrangement, and afterward they are examined. (f) In sequential mixed methods design, data collected in the quantitative stage are examined and inform the data to be collected, which is qualitative. Sequential mixed-methods designs are explanatory sequential mixed-methods design and exploratory mixed-methods design, and convergent concurrent design, which are discussed below.

4.4.1. Exploratory sequential design

Exploratory sequential design is a three-phase mixed methods design according to which the scholar begins with the gathering and analysis of qualitative data that is then the advanced phase of interpreting the qualitative results into an approach or tool that is focused on participants' opinions and is verified quantitatively (Creswell & Plano Clark, 2018:105). They further explain that the researcher needs to develop a tool, mediation resource or electronic device that is appropriate and culturally sensitive. Creswell and Creswell (2018b:224) postulate that the purpose of exploratory sequential design is to first explore the sample so that the quantitative phase can then be personalised to meet the desires of the individual participants being studied. Qualitative data in exploratory sequential design are usually used to develop the quantitative phase (Gray et al., 2017:492). However, the design was not relevant to the study since the researcher intended to start by collecting quantitative data in the form of a pre-test and then utilise the pre-test results to compile the questions that were employed to collect qualitative data.

4.4.2 Convergent concurrent design

Creswell and Plano Clark (2017:496) present convergent concurrent design as a design used to collect quantitative and qualitative data simultaneously and the researchers try to verify, authenticate, or validate the outcomes. Gray et al. (2017:512) also confirm that the researcher uses convergent concurrent design to collect quantitative and qualitative information instantly, analyse each data set and integrate the results with one method weighted more than the other. However, the convergent concurrent design was not relevant to this study, because quantitative and qualitative data were not gathered at the same time. The researcher followed an explanatory sequential design because she started by collecting quantitative data in the form of a pre-test, with the view to conducting lesson observations and formulating open-ended interview questions to gather qualitative data.

4.4.3 Explanatory sequential research design

Explanatory sequential design is defined as a design that involves two phases of collecting data, whereby the researcher in the first phase starts by collecting quantitative data and analysing it, then uses the results to connect to the qualitative phase (McMillan & Schumacher, 2014:431; Johnson & Christensen, 2014:373). Similarly, Burns and Grove (2018:494) support the fact that in explanatory sequential design, the researcher gathers and analyses quantitative data, and then gathers and analyses qualitative data to describe the quantitative outcomes. According to Teddlie and Tashakkori (2009:26), in explanatory sequential mixed-methods design, quantitative and qualitative components of the study occur in a sequential order. The researcher collected the quantitative data first, which was used to develop unstructured interview questions used to gather qualitative data. Quantitative data provided the researcher with the general idea of learners' performance while solving NOR problems while qualitative results clarified and explained the challenges the teachers experience during teaching and learning (McMillan & Schumacher, 2014:431; Maree, 2016:316). The intention of this design was to gather quantitative data (through pre-test) that provided the researcher with an overview of what to observe during teaching and learning and the types of questions to be asked for collecting qualitative data.

Creswell and Plano Clark (2018:194) emphasise that in explanatory sequential design, data collections in quantitative and qualitative research are associated with each other. According to Creswell and Creswell (2018b:222), the purpose of explanatory sequential design is to have the qualitative data help explain in more detail the quantitative results from phase one, thus connecting the quantitative results to the qualitative data collection. The researcher collected phase one data in the form of a pre-test which was used to connect qualitative data in the form of interviews and lesson observations.

According to Creswell and Creswell (2018:494), conducting interviews to collect qualitative data helps to clarify confusing, contradicting or unusual responses. Gray, Grove and Sutherland (2018:494) postulate that explanatory sequential design is easier to implement than designs in which quantitative and qualitative data are collected at the same time. Even though the explanatory design is the easiest design to implement, a prolonged time for accomplishment is needed, the qualitative phase cannot be fully stated in advance, quantitative results to be followed up must be recognised and the researcher must choose who to sample in the second phase and identify the conditions for selecting participants (Creswell & Plano Clark, 2017:98).

4.5 PRE-TEST-TREATMENT-POST-TEST

Pre-test-post-tests include a pre-test that provides the measurement of some attributes for participants on a dependent measure before the introduction of the intervention strategy, followed by a post-test after introducing the intervention strategy in the experimental group (Bordens & Abbott, 2018:248). The researcher used the pre -test to evaluate Grade 3 learners' performance in NOR before the application of the identified strategy to understand the challenges learners are experiencing. Thereafter, the post-test was conducted in the experimental group, following the application of the intervention strategy after three cycles. The post-test was used to find out whether or not the identified strategies have brought improvement in learners' performance. It was also used to measure the effectiveness of the identified strategy used in the experimental group and compared the results of the control group to see if there was any impact. The researcher also compared the test results before and after the intervention in the experimental group.

Pre-test was conducted on the same day at both schools to ensure that uniformity was applied in both experimental and control groups. After the implementation of the intervention strategy which covered three cycles, the post-test also was conducted like the pre-test to maintain consistency. Since the study was conducted in Grade 3 classes, the researcher asked the teacher from the control group to supervise the writing since the researcher could not be in two places at the same time. The scripts of both tests were marked by the researcher to determine how learners responded to the questions and to see their overall achievements.

McMillan and Schumacher (2014:298) postulate that, during a study, the researcher uses established groups, provides a pre-test, applies the intervention to one group, and administers the post-test. The two identified groups were given a pre-test for the desired measurement in which the researcher was interested, whereafter one group was exposed to treatment, or a new teaching strategy (Leedy & Ormrod, 2015:196). Experimental and control groups were given both pre-test and post-test, however, the identified teaching strategy was applied to the experimental group before administering the post-test. Grade 3 learners from the two schools where the researcher conducted the research wrote the pre-test on NOR. After sharing their experiences of teaching NOR in diverse mathematics classrooms with the researcher, one participant was introduced to the identified strategy after the discussions with the researcher, while the other participant continued teaching the in the usual way.

The pre-test was used to measure the performance of Grade 3 learners in NOR before the application of the identified strategies to understand learners' challenges, whereas the post-test was used to measure learners' performance or any changes after the application of the strategies. Post-test was also used to determine whether the identified strategy made an impact on learners' performance in NOR and if learners' challenges were solved or not. One group of learners from one school was used as an experimental group and the other group from the second school was used as the control group. The teachers from both groups clarified questions to learners where needed from numbers, operations and relationships.

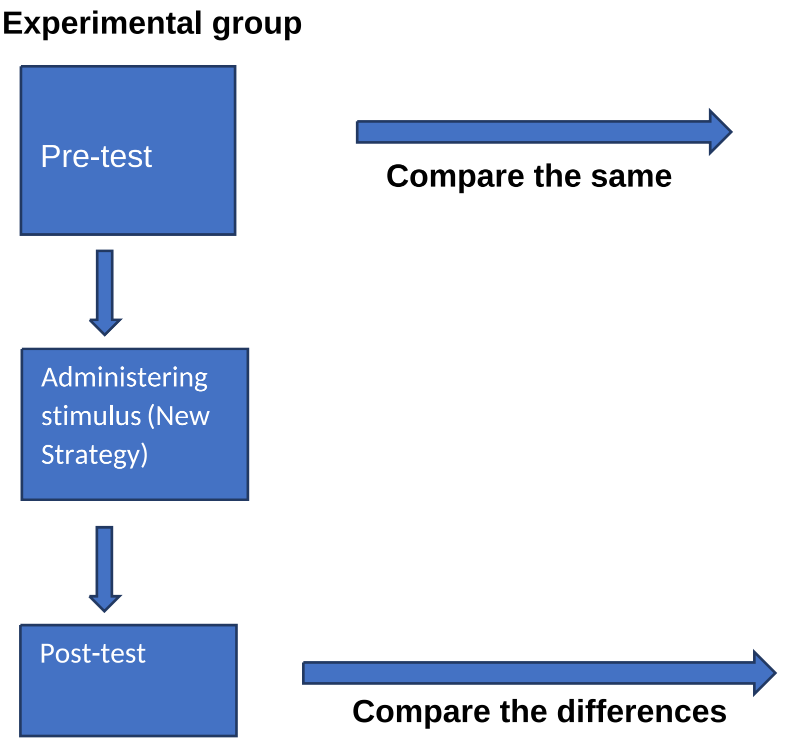


Figure 4.2: Diagram of basic experimental comparison design (*Adapted from Babbie, 2010:234)*

The diagram provides an overview of how both pre-test and post-test were administered in the experimental group and control group. The pre-test was administered at the same time for the experimental group and control group without the implementation of the intervention strategy. Subsequently, a post-test was conducted in both groups simultaneously after the application of the identified teaching strategy to the experimental group. Hence, the researcher embedded the action research method since it is cyclic in nature and encompasses qualities of applying pre-test, semi-interview, post-test and unstructured interviews. Incorporating action research methods in the study assisted in generating the strategy that can be used to enhance the performance of learners in the FP Grade 3 diverse mathematics classrooms and is discussed below.

4.6 ACTION RESEARCH

As noted earlier, the study embedded action research in the implementation of the intervention in the experimental group only. Action research is defined as a procedure used to enhance teaching and learning by integrating modification through the contribution of teachers working collectively to enhance their own teaching practices (Ary, Jacobs & Sorensen, 2010:514). Sagor and Williams (2017:1) support the opinion that action research assists in taking action to improve the situation at hand. The researcher incorporated action research into the study to collaborate with participants so that they can identify the strategies that can enhance learners' performance in NOR. In this study, participants were encouraged to work with the researcher, they discussed, talked together, planned what to do next and empowered each other in improving the teaching of NOR in diverse FP Grade 3 classes.

Action research can be applied anywhere apparently in a problematic situation concerning persons, assignments and techniques that need answers, or certain transformation of outcomes in the desired goal (Cohen, Manion & Morrison, 2018:440). According to Cohen et al. (2018:441), action research comes in a form of critical action research, participatory action research, practical action research, classroom-based action research, and many more. Critical action research is aimed at transforming and changing within existing conditions which is based on a body of critical theory to liberate individuals through knowledge gathering (Gay et al., 2012:510; Maree, 2016:137).

According to Maree (2016:137), participatory action research is an action research that studies social issues that pressures individual lives as well as improving current practices. Contrary to this, Cohen et al. (2018:444) argue that participatory action research seeks to create conditions for people to work together collaboratively to understand the world and participate in it. Practical action research emphasises more of a "how-to" approach to the processes underlying the assumption that individual teachers or teams of teachers are independent and can determine the nature of the investigation to be undertaken (Cohen et al., 2018:441, Gay et al., 2012:511). Efron and Ravid (2020:3) assert that classroom based action research occurs when an individual teacher's research focuses on a single issue in the classroom, such as classroom management, instructional strategies, use of materials, or learners' learning seeking solutions. They further postulate that a classroom based action researcher may have the support of their supervisor or principal, an instructor or parents for a course they are taking.

Reconnaissance is described as a diagnostic activity used to determine where the person is, what s/he hopes to achieve, and how to achieve what s/he wants (Dillon, 2008:5; Maxwell & Choeden, 2012:187). According to Maxwell and Choeden (2012:187), reconnaissance action research positions a teacher as a learner who seeks to narrow the gap between the practices and his/ her vision for education. Maxwell and Choeden further explain that this allows the teacher to reflect on his/her practices, subsequently promoting the process of testing new ideas and accommodates diverse background and experiences. Reconnaissance action research was used to identify the strategies that could assist to improve daily teaching practices in the experimental group during the cycles of the research study as well as helping in improving learners' performance of NOR. Furthermore, it was used to collect qualitative data which led to the quantitative data (post-test) to examine whether learners' performance had improved or not. Hence, reconnaissance action research was chosen in this study.

Critical action research, participatory action research and practical action research were not chosen for the research study because they were not relevant to the research study. The teaching strategies used by teachers, as well as how learners learn and how teachers constructed knowledge during teaching and learning, were identified following the cycles of action research through the discussion that took place between the researcher and participants. The researcher collaborated with participants to determine whether the identified strategy of presenting NOR concepts in Grade 3 diverse mathematics classrooms could be effective in improving leaners' performance.

4.6.1 Action research cycle

Pickard (2013:158) claims that in action research, the researcher studies processes that are being used, acts on improving them, then evaluates the results of the action. The researcher used action research to examine the strategies that were used by teachers with their Grade 3 learners, and then acted on them to improve the teaching with the intention of enhancing learners' performance in diverse mathematics classrooms. Since action research is cyclic in nature, the researcher conducted meetings with the participants before applying the strategies and had the meeting after the application of the strategies to evaluate their effectiveness or to adjust where necessary. The stages applied during the research process are outlined as follows and further discussed below: identifying the problem; action planning; implementation; evaluation; and reflection.

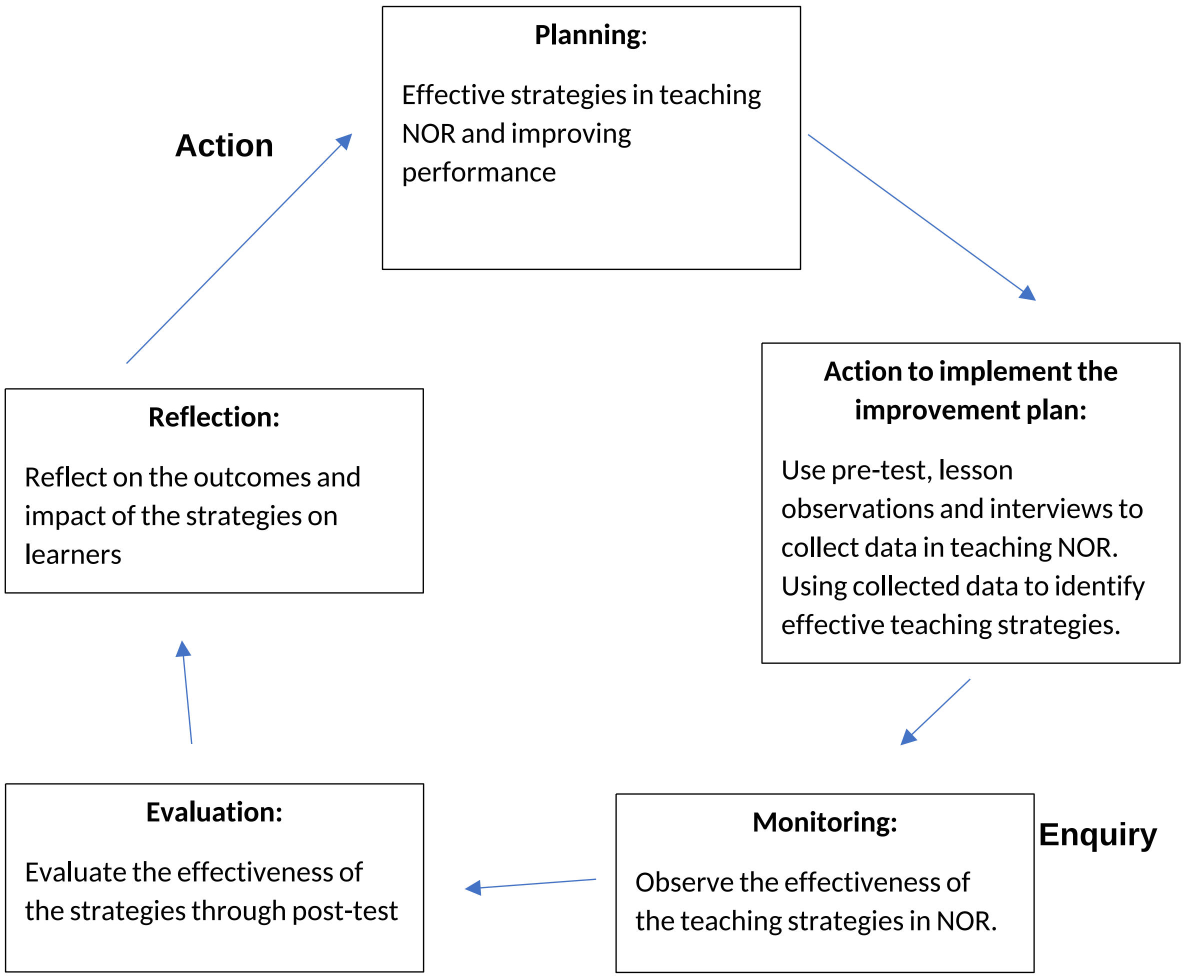


Figure 4.3: Action research cycle *(Adapted from Pickard, 2013:160)*

4.6.1.1 Identifying the problem

The researcher and the participants should identify the problem, examine it to help with the existing practices, and be adaptable to adjust to the unanticipated impacts (Putman & Rock, 2018:7). The researcher conducted a pre-test as baseline data collection from learners to assess their performance in mathematics NOR and to identify the challenges learners might be experiencing. Interviews with teachers were conducted to understand the challenges learners had experienced from the written pre-test. Both the pre-test results and interview data helped the researcher to identify challenges that may cause learners to perform poorly in Grade 3 NOR mathematics.

Burns (2015:190) specifies that applying different strategies during teaching and learning can help to identify the resources to remedy the problem of accommodating and supporting the needs of all learners and to predict the anticipated result. From numerous conceivable real resolutions, the researcher attempted to identify the challenges that might be the cause of poor performance of learners and discussed with participants how to modify their teaching strategy to determine whether it would be an appropriate solution in enhancing the performance of learners in diverse mathematics classroom (Cohen et al., 2018:449).

4.6.1.2 Action planning

At this stage, preliminary discussions with participants to determine the strategies the teachers were using and how they were applying them in their classrooms were discussed. The process of how the action should be employed, selection of time and identified strategies that could be put into practice were also discussed (Burns, 2015:190). The programme of the identified teaching strategies was grounded on the analysis of data gathered from the pre-test and the discussion amongst the participants and the researcher in the first stage (Pickard, 2013:160). The objectives, purposes and assumptions were presented to participants and the role of the key concepts stressed and how they should be carried out (Cohen et al., 2018:450).

4.6.1.3 Implementation

The application stage sees the structure or the action that will form part of the research method identified (Du Plooy-Cilliers et al., 2014:201). The participants applied the identified teaching strategies while the researcher observed how participants implemented them to find out if the identified strategies were controllable and connected to the problem (Du Plooy-Cilliers et al, 2014:201; Putman & Rock, 2018: 8). The researcher observed how participants were interacting with learners in the classrooms when applying the identified strategies (Johnson & Christensen, 2014:88). Lesson observations were used to determine whether the strategies were making any impact or not.

4.6.1.4 Evaluation

Du Plooy-Cilliers et al. (2014:201) argue that scholars should assess the development of the process by gathering information that should be used to establish or answer the research question. The researcher collected data through the writing of the post-test by learners and interviewing teachers to obtain feedback. Evaluation of data granted the researcher the chance to assess the development, problems, concerns and limitations that may have occurred during the implementation of the teaching strategy (Putman & Rock, 2018:8).

Putman and Rock (2018:8) argue that participants should do self-reflection to enhance or deepen their understanding of applying new strategies and their purpose. The success of the strategies was examined by assessing learners through post-test, where every teacher assessed themselves by conducting a self-evaluation (Pickard, 2013:161). Such an evaluation allowed the researcher to determine whether the employed strategy showed improvement in teaching and learning as well as performance.

4.6.1.5 Reflection

The researcher analysed the collected information and the results, understood them, and made a reflection on what they suggested (Johnson & Christensen, 2014:89). Post-test results and interview feedback from teachers were used to make a reflection on the achievement or disappointment of the implemented strategy. Conclusions were drawn based on the successes or failures of the strategies and the researcher looked at what happened and how it happened to consider what to do next (Pickard, 2013:161; Johnson & Christensen, 2014:89). The researcher, together with the participants, reflected on the results of the strategies and evaluation, to made sense of it (Pickard, 2013:162) and made an informed decision about the strategies. Both projected and unplanned outcomes were identified and reflected upon to adjust where necessary (Burns, 2015:190).

4.6.2 Benefits of action research

The action research method, as outlined by MacMillan and Schumacher (2014:478), helped the researcher together with participants to collaborate and meaningfully reflect on the outcomes obtained from the research study and their meaning to the practices. Action research helped in empowering participants and involved their personal experiences in teaching NOR in Grade 3 diverse mathematics classrooms. It also encouraged the participants to self-reflect, undertake self-assessment and instil dedication and constant improvement in teaching NOR in Grade 3 classrooms. The action research method assisted Grade 3 teachers to change the classroom climate to a more reflective atmosphere in which it is standard practice to openly examine instructional methods, take risks and work collaboratively for the benefit of the school (MacMillan & Schumacher, 2014:479).

4.7 LOCATION

The study was conducted in two primary schools in the Nylstroom Circuit, which is in the Waterberg District in the Limpopo Province of South Africa. It is a semi-urban area, with learners who speak different home languages, however, they learn mathematics in Sepedi (local language), the language adopted by the school. The learners in Grade 3 from the schools where the study was conducted, were not performing well in mathematics, especially in numbers, operations, and relationships.

4.7.1 The profile of the two participating schools

Participant 1(P1) is teaching at School A and Participant 2 (P2) is teaching at School B. The two schools are in the Waterberg district. Situated in the small town of Modimolle, at the Phagameng location. The distance between the two schools is about one kilometre. Both schools, during the time of data collection, had four Grade 3 classes each.

School A had 1179 learners from Grade R to Grade 7 during the time of data collection. The school had 32 teachers employed by the Limpopo Department of Education with a principal, one permanent deputy principal and one acting deputy principal, one departmental head and four acting departmental heads, 20 post level 1 permanent teachers, four temporary teachers and four early childhood (ECD) practitioners. The ECD practitioners were paid by the school governing body (SGB). Grade 3 learners in School A were 165 with four teachers, three permanent and one temporary. Two permanent teachers have mathematics in their qualifications, whereas the other permanent teacher had a degree in psychology and the temporary teacher did a single year in teaching methods. The school started teaching learners mathematics in Grade 3 in English in 2020 because they received mathematics learners' books in English. According to the teacher from School A, they notified the circuit manager and the Foundation Phase curriculum advisor about the books, who gave their consent.

School B had 1480 learners from Grade R to Grade 7 during data collection. The school had 38 permanently employed teachers with the principal, one permanent deputy principal and one vacancy, three permanent departmental heads and two vacancies, 33 post-level, one permanent teacher, one temporary employee in the space of vacant deputy principal, two teachers paid by the SBG, two ECD government paid practitioners and two ECD SGB paid practitioners. There were 180 Grade 3 learners in School B, with four permanent teachers and mathematics was being taught in Sepedi. The four Grade 3 teachers had done mathematics as specialisation during their teacher training.

4.8 POPULATION AND SAMPLING

Du Plooy-Cilliers et al. (2014:132) defined population as the entire cluster of people from whom data is collected. The primary schools belong to the previously disadvantaged community, with more than one thousand three hundred learners each. Sampling is defined as a procedure of choosing a subgroup from inhabitants to understand the features of a large group (Johnson & Christensen, 2014:343). Sampling consisted of the two schools from Nylstroom circuit in the Waterberg district of the Limpopo province. Johnson and Christensen (2014:373) remarked that in mixed research, mixed sampling design involves choosing the sample arrangement and a sample scope can be used. The researcher interviewed one teacher per school which meant that a total of two teachers from the Grade 3 teachers made up the sample, while the sampled learners from the two primary schools were 131 (Experimental group = 57 and Control group = 74). Table 4.1 below outlines the qualifications and teaching experience of the sampled teachers:

Table 4. 1: Profile of the two sampled teachers

P	Qualifications	Teaching experience
1	• Junior Primary Teachers Diploma (JPTD) with Mathematics I, II and III • Advance Certificate in Education (ACE) specialising in Educational Management	• 30 years of teaching experience • Taught all FP subjects: Sepedi HL, Maths in both English and then in Sepedi, English First Additional Language (EFAL) and Life Skills. • Taught Grade 2 for 10 years • Has taught Grade 3 for 20 years
2	• Junior Primary Teachers Diploma (JPTD) with Mathematics I, II and III • B.Ed. Degree in Foundation Phase with Mathematics • Advanced Certificate in Education (ACE) specialising in Educational Management • B.Ed. Honours Degree specialising in Educational Management	• 19 years of teaching experience. • She has been teaching Grade 3 since she started her career. • Taught Sepedi HL, Maths in both English and Sepedi, EFAL and Life Skills.

Participant 1 (P1) obtained her JPTD prior to 1994 and upgraded to ACE through correspondence while working. She then furthered her studies to obtain B.Ed. Honours in Educational Management. Then she was selected by the Limpopo Department of Education to be one of the teachers who upgraded their qualifications to teach in the Foundation Phase to study at the University of KwaZulu-Natal for four years.

Participant 2 (P2) obtained her JPTD post 1994 and was not employed immediately after completing, it due to the non-availability of teaching vacancies. She then was employed on a temporarily basis in 2002 and was granted a permanent post in 2005. After getting a permanent post, she upgraded her qualifications to ACE in teaching in the Foundation Phase through correspondence. Presently she is doing B.Ed. Honours in Education Management.

4.8.1 Purposive sampling

Purposive sampling was employed in identifying the participants for the research study. Purposive sampling is conducted because it comprised features that contain the qualities that serve the purpose of the research study (De Vos et al., (2011:232; Maree, 2016:198). According to Bryman (2012:416), purposive sampling deals with the selection of participants with the idea of answering the research question. Thus, the current study used teachers with knowledge and information that highlighted the strategy to be used to enhance the performance of FP learners in diverse mathematics classrooms. Johnson and Christensen (2012:231) proclaim that in purposive sampling, the researcher specifies the characteristics of a population of interest and then tries to locate individuals who have those characteristics to include them in the research study. The teachers sampled the group of learners who were attending on the days identified for the lesson observations since learners were divided into two groups in their classes and skipped a day when attending school due to COVID-19 regulations.

Maree (2016:79) describes that in purposive sampling, the researcher stipulates the features of people of interest and then attempts to find those features to incorporate them in the research study. Hence, sampling learners from the classes taught by the sampled teachers allowed the researcher to collect relevant data for the research study, unlike sampling learners who were not taught by the sampled teachers.

Before selecting participants, the researcher sought and secured permission from the Limpopo Department of Education at the district and circuit levels. Thereafter, the researcher used the list of schools obtained from the circuit office to identify the schools. Next, the researcher requested a list of teachers who are teaching Grade 3 classes to identify participants. Teachers’ list included their qualifications and teaching experience in Grade 3, or in the Foundation Phase. Cohen, Manion and Morrison (2018:219) postulate that purposive sampling includes selecting people with in-depth knowledge by virtue of their professional role, hence two teachers were selected the study.

Grade 3 classes represent the exit grade in the phase; hence the participants were able to provide information about the phenomenon being studied (McMillan & Schumacher, 2014:152). Teachers were also able to provide information on why learners were not performing well in mathematics in Grade 3, especially when they competed at the district and provincial levels. The tests that learners wrote provided information about their performance in mathematics. From their schools, Grade 3 mathematics is being taught in Sepedi, while starting from Grade 4, the subject is taught in English. Even though learners come from different backgrounds and speak different home languages, they are all taught mathematics in Sepedi. The researcher sought to determine how teachers applied their teaching strategies and actively involve learners in mathematics learning to improve their performance in Foundation Phase. Furthermore, the researcher needed to see how the teachers accommodated and supported all the teaching and learning of NOR concepts.

4.9 DATA COLLECTION INSTRUMENTS

Instruments refer to tools, procedures or practices used to enhance the process of collecting research information to respond to the research questions (Mligo, 2016: 48). Interviews, lesson observations, note-taking, audio recording and pre-test-post-test were employed in collecting data for the research study. Data collection instruments differ in complexity, interpretation, design and administration and their purpose is to guide the researcher in data collection and assessment (Pandey & Pandey, 2015:57).

4.9.1 Pre-test and post-test as data collection instruments

Pre-test and post-test are frequently applied in quantitative research to determine the attitude, behaviour, nature, awareness or achievement of participants (Johnson & Christensen, 2020:315). The researcher ensured that both tests were standardised and complied with the measurement specified in the Curriculum and Assessment Policy Statement (CAPS, 2012). Both pre-test and post-test questions comprised word problem-solving, number sentences, multiplication as repeated addition, using array and flow diagrams, and finding missing numbers using the four basic operations (+, -, x and ÷). As this study employed an explanatory sequential mixed-methods design, the results of the pre-test helped the researcher to prepare interview questions, which were administered to understand how teachers apply their teaching strategies.

Table 4. 2: The structure of the design of pre-test and post-test

ITEMS	MEANING
1. Number names	Writing numbers in words
2. Counting numbers	Finding the correct number by using the words such as less or more, before and after
3. Place value	Representing numbers as hundreds, tens or units
4. Word problems	To interpret the question and recognise the technique or the operation to be used to find the solution (for example, addition or subtraction)
5. Array and flow diagrams	Identifying numbers represented in base ten blocks
6. Missing numbers	Using either addition or subtraction to find the answer

The pre-test was aimed at assisting the researcher to measure learners' performance in solving NOR problems. The researcher used the pre-test to identify the challenges experienced by learners when solving different problems or questions of NOR in Grade 3 diverse classrooms. Answers identified from learners' work helped the researcher to identify the areas where learners might be experiencing challenges in solving the problems in NOR. Furthermore, the given responses helped the researcher to observe how the teachers supported learners during teaching and learning so that they understand the content being taught. Learners' experiences and challenges when solving NOR problems were taken into consideration during lesson observation and assisted in identifying the questions for the interviews.

The post-test which was conducted after the application of the intervention strategy was used to check if the intervention strategy had an impact or not in teaching and learning mathematics or in improving learners' performance. The researcher started with the collection of quantitative data because the study focused on strategies that might improve learners' performance.

4.9.2 Interviews

Interviews were used as data gathering instruments to comprehend how participants make meaning of their practices (Klein, 2012:21) concerning teaching NOR concepts in Grade 3 diverse classrooms. Creswell and Creswell (2018a:190) postulate that interviews are useful when the researcher requires the participants to provide their experiences of their own practices, while the researcher is controlling her way of questioning. Face-to-face interviews with the participants were conducted to observe their behaviour or reactions when responding to the research questions and to undertake follow-up questions when needed (Mligo, 2016: 51). The following questions were used during the interviews:

- *What are your opinions about teaching mathematics in diverse classrooms?*
- *Which factors affect the performance of Grade 3 learners in diverse mathematics classrooms?*
- *How can the learners' needs in diverse mathematics classrooms be accommodated?*
- *What kind of strategies are followed to make certain that teaching and learning in diverse classrooms takes place effectively?*
- *How can you be supported in teaching mathematics in Grade 3 diverse classrooms effectively and efficiently?*

The aim of conducting interview questions was to compare and contrast participants' experiences when teaching NOR in diverse mathematics classrooms. The researcher asked the participants open-ended questions to motivate participants to provide longer and richer answers (Klein, 2012:42). Open-ended interview questions allowed participants to respond freely and to obtain clarity where necessary. The open-ended interview questions the researcher used arose from the pre-test results and were employed to understand the challenges of the participants when teaching NOR in diverse mathematics classrooms. Open-ended questions allowed participants to provide knowledge established on questions that did not limit them to expressing a wider variety of ideas (McNiff & Whitehead, 2010:163; Creswell & Plano Clark, 2018:185). Since participants conveyed their ideas widely, this enabled the researcher to collect information from the answered research questions easily, thus enabling the researcher to explain how teachers applied their strategies.

Maree (2016:93) suggests that unstructured interviews allow certain questions to be followed up after the participant's response; in this study, the researcher used for probing and clarification. Hence, the researcher needed to be observant of the reactions of the participants to discover new developing areas of investigation that are precisely associated with the research study. The researcher had the opportunity to identify emerging information and be able to explore and probe this. Unstructured questions were used to understand how teachers applied their strategies and to ascertain how they dealt with challenges during teaching and learning.

Open-ended questions provided the researcher freedom to probe, with clarity seeking questions, prompt discussions or follow-up on answers (Mligo, 2016:52). The researcher ensured that she controlled her body language so that participants became aware of the fact that the researcher is interested in them and that she values their opinions (McNiff & Whitehead, 2010:164). Detailed clues were also given to encourage participants to speak easily. In this case, where the researcher was not allowed to make close contact with the participants due to COVID-19 measures, the researcher requested contact numbers from participants so that she could conduct telephone interviews. Prior arrangements were made with participants as to how and when the interviews could be conducted.

4.9.3 Lessons Observations

Lesson observations were employed as part of the data gathering method because the researcher wished to collect data from the classrooms and see how the teaching was done. The pre-test results assisted the researcher in identifying the area to be observed during lesson observation before the implementation of the intervention strategy. Johnson and Christensen (2014:327) are of the opinion that observation is watching the behavioural pattern of someone to collect data in connection with the phenomenon being studied. Lesson observations assisted the researcher in learning more about the teachers' and learners' behaviour in the classrooms and to understand how NOR was taught. The researcher observed how teachers accommodated and supported learners who experienced challenges during teaching and learning. Furthermore, the researcher observed how both teachers and learners interacted with one another during lessons. Three lesson observations were conducted before the application of the intervention strategy. Lesson observation as a method of collecting data was also employed by the researcher to make sense of what was naturally happening during the teaching and learning of NOR in the classrooms (McMillan & Schumacher, 2014:376; Mligo, 2016: 48).

The researcher conducted qualitative lesson observation two days after both experimental and control groups had written the pre-test and marking which was done by the researcher. The results assisted the researcher in identifying the areas to be observed during teaching and learning so that the researcher could understand the learners' performance concerning how the teaching and learning takes place in diverse mathematics classrooms. Further, the researcher needed to see how teachers applied their teaching strategies, the type of content in the classes and how they maintained their rapport with learners during teaching and learning. The qualitative observation was also used to determine how learners solve problems from NOR, as well as the challenges they experience in solving the given problems, and how the teachers attended to those challenges.

Prior to the implementation of the identified strategies, the researcher observed teachers teaching NOR. The researcher observed the strategies used during teaching and learning in teaching NOR, how the teachers interacted with learners, the kind of interventional support offered to learners who experience challenges or have learning barriers, how feedback was given to learners during teaching and learning and how learners were evaluated. The identified teaching strategy focused on teaching topics in NOR in Grade 3, especially with the teacher from the experimental group. The topics were identified as word sums, problem-solving, number names, number sentences, multiplication as repeated addition, using array and flow diagrams and finding the missing numbers using the four basic operations (+, -, x and ÷). The researcher observed the following during lesson presentations before introducing the new teaching strategy:

- how teaching and learning in mathematics diverse classrooms took place;
- the types of teaching strategies used during teaching and learning;
- how the teachers interact with learners and facilitate activities and the type of activities the learners are engaged with;
- the questions used to guide the learners towards the lesson involvement and assessment used;
- how teachers accommodate or support learners who experience learning barriers;
- the purpose of assessing learners during or after the lesson; and
- the type of resources used during teaching and learning.

The purpose of collecting lesson observational data was to generate first-hand information, to see, to hear, to feel and be there personally in the classrooms (Flick, 2018:314) when teaching and learning of NOR took place in diverse classrooms. Lessons learned was used to observe how teachers applied the teaching strategies in the classroom, how mathematics resources were used, and how learners participated during teaching and learning. Information, such as learners' behaviour that is not easily acquired through interviews, was accessed through observation (MacMillan & Schumacher, 2014:376; Creswell & Creswell, 2018b:188). The researcher also observed how teachers accommodated and supported the various learning needs of all learners, and how they helped learners who faced learning challenges. The lesson observation was also used to observe how learners solved problems and how they interpreted different questions.

Lesson observations were used to experience unexpected activities that may occur and assist in answering the research questions. Mligo (2016:48) postulated that observation can be used to acquire research information from people who cannot speak or write for themselves, or from people who do have not enough time to talk to the researchers or are not willing to participate in research through interviews and questionnaires. Lesson observation allowed the researcher to see the number of learners and classroom settings (Cohen et al., 2018:542).

The researcher took up the role of the participant as an observer to obtain data (Maree, 2016:91). Being a participant observer allowed the researcher to gather information by taking part with the participants in the activities as a regular member (McMillan & Schumacher, 2014:351). The role of participant observer allowed the researcher to discuss and plan with the participants how to identify the strategy that could be used to incorporate the diverse needs of all the learners during teaching and learning of NOR.

Johnson and Christensen (2014:327) remark that observation is important because people usually do not do what they say they will do, that is, attitude and behaviour do not always correspond. The researcher conducted three sessions of lesson observation, which were done before the implementation of the intervention strategy, during the intervention strategy and after administering the intervention strategy. The first session (three lesson observations) took place two days after administering the pre-test, before the implementation of the intervention strategy and the second session took place during the intervention strategy, while the third and final session was conducted after identifying the intervention strategy.

The second session with twelve lesson observations which were divided into three cycles during the action research process followed up after the researcher and participants had agreed on the teaching strategy that should be used for the teaching experimental group. The observations were employed with the intention of gauging the teacher's employment of the identified teaching strategy which was introduced after the discussion with the researcher and the one participant. This was aimed at allowing the teacher from the experimental group to share the experiences of using the identified strategy with the other teacher from the control group. The new teaching strategy in the diverse classroom was based on the factors outlined in the table below:

Table 4. 3: Classroom environment and inclusive practices to consider

Classroom environment	Inclusive practices to consider
Create a supportive and respectful classroom	Promote diversity and fairness by treating learners as individuals.
Establish a culture of learning	Have faith in learners' abilities, do not focus on their inabilities, and give support.
Create a supportive peer culture	Empower learners to support and encourage them to help each other. Show kindness, create friendship and have mutual respect.
Create an inclusive environment	Support learners, make them aware and open-minded, care for them and help them to understand each other.
Classroom organisation	Demonstrate a flexible classroom and create a welcoming environment.

These factors are important for teachers teaching in diverse classrooms to enhance teaching practices and improve teaching and learning to improve learners' performance. These factors will also help teachers to restructure their classrooms so that all learners can learn, participate together and create a supportive environment including those who experience barriers to learning.

4.10. NOTES TAKING AND AUDIO RECORDING

Field notes are undertaken in a natural surrounding so that the researcher can capture the normal flow of events without worrying about creating a rigorously controlled experimental setting (Bergin, 2018:57). The researcher used independent records during lesson observations so that she could gather sufficient information for the research study (Maree, 2016:91). The researcher captured the description of the observed lessons and undertook reflection about what happened during the observation (Maree, 2016:91). Immediately after lesson observations, the researcher wrote in detail her lesson observations so that all necessary information was included and to avoid forgetting important information that was not captured in detail. The researcher edited notes taken during and after lesson observations immediately when the memory was still fresh to avoid forgetting significant facts and ensure legibility (Johnson & Christensen, 2014:331).

The researcher also used the audio recording to ensure that all information is correctly captured during interviews with participants. Creswell and Creswell (2018b:189) posit that audio recording provides participants with the opportunity to directly share their truth and it also captures the participants' attention. Audio recording allowed the researcher to gather more information and capture information that might be missed during notes taking (De Vos et al., 2011: 359). The audio recording offered the researcher the opportunity to pay attention to what the participants were saying, following up on interesting points being made and not being distracted by concentrating on taking down notes on what is said.

In cases where the researcher was not allowed to enter the classroom to conduct lesson observations due to COVID-19, the researcher was allowed to observe through the window. The audio recording in this regard allowed the researcher to capture information where the researcher could not hear the communication during teaching and learning. In addition, video recording was used during the process with the permission of the teacher

4.11. DATA INTERPRETATION AND ANALYSIS

The researcher transformed data collected, such as audio recording, observation and field notes into text (Johnson & Christensen, 2014:725; Maree, 2016:115). The researcher included non-verbal cues in the transcript (Maree, 2016:115). The researcher identified the differences and similarities of each participant's perspectives and segmented them into meaningful analytic data (Johnson & Christensen, 2014: 725; Cohen et al., 2018:661) which were categorised into themes. Symbols, descriptive words, or category names were assigned to segmented data to identify them easily (Johnson & Christensen, 2014:725). The identified themes for qualitative data is explained in detail in chapter five.

Data analysis in mixed methods research entails evaluating quantitative or qualitative data independently or combining both data utilising methodologies that blend or incorporate quantitative and qualitative information and outcomes (Creswell & Plano Clark, 2018:212).

Table 4.4: Quantitative and qualitative data analysis procedure for mixed methods studies *(Adapted from Creswell and Plano Clark, 2018:212)*

Quantitative data analysis procedures	Procedure in analysing data	Procedures for analysing Qualitative data
• Assign a numeric code to every answer in the file • Record items and compute new variables • Establish a theme and description of each quantitative variable	Organise data for analysis	• Transliterate the data • Cross check transcriptions for truthfulness • Manage and sort the daily data type, participant or case • Structure the data to simplify and speed up the process of analysis
• Visually examine developments in the data and verify whether data are ordinarily spread • Perform descriptive analyses for every most important variable • Employ fundamental evaluation of the consistency and authenticity measures • Address any issues of missing data	Study the data	• Thoroughly read the data to make a perception of it all • Put in writing the memos regarding the early opinions • Establish a few preliminary codes (for all projects) and develop a qualitative codebook (only appropriate for some projects)
• Select suitable inferential statistical tests grounded on research questions, scale type, number of variables and spreading • Analyse data to answer the quantitative research questions • Conduct statistical analysis	Analyse data	• Select the analysis styles constructed on the research questions • Implement coding process o Code data o Develop descriptions and themes by grouping codes o Interrelate themes or categories based on

		the overall qualitative approach or develop abstract categories into a smaller set of themes

This table provides a view of how data collected using mixed methods research should be analysed. Quantitative and qualitative data were analysed separately and data were integrated by connecting quantitative results to qualitative findings (Creswell & Creswell, 2018b:222). Bazeley (2017:45) presents that data analysis involves a process of probing data and challenging ideas until an acceptable conclusion is reached. Quantitative results were applied to inform the categories of qualitative questions the researcher could use in the second phase (Creswell & Creswell, 2018b:223).

Bazeley (2017:46) maintains that the use of codes in data analysis to connect research findings represents and maintains links to the content of textual and other qualitative data. The researcher examined and organised collected quantitative data according to different categories, that is, collected data from the pre-test and post-test. The aim of categorising data was to obtain a clear picture of learners' responses to the assessment task. Qualitative data were also transcribed and assigned different codes, based on their descriptions, undertaking comparative data analysis that answers research questions about the differences and/or helps to discern deeper meanings (Bergin, 2018:56). Quantitative and qualitative data were compared to distinguish between or emphasise the deeper meaning and understanding of the study.

4.11.1 Statistical analysis

Statistical analysis was used to analysed quantitative data. According to Grove and Cipher (2017:68), statistical analysis is performed to decrease and categorise data, explain variables, scrutinise the relationships and establish the difference between the groupings. There are two major statistics classified by Gray et al. (2017:815) as descriptive and inferential. Gray et al. (2017:815) postulate that descriptive statistics are processed to uncover the qualities of the sample and to illustrate study variables, whereas inferential statistics are done to make inferences and draw assumptions regarding the people, according to the sampled data.

Descriptive statistical analysis was employed in the research study. After gathering and capturing data as numbers, the researcher started with the process of descriptive statistics, which was used to categorise and summarise data in a meaningful manner (Maree, 2016:204). The statistical analysis helped the researcher to organise and to interpret numbers resulting from determining characters (McMillan & Schumacher, 2014:163), thus in this study, it was the results for both pre-test and post-test. Statistical analysis was used to understand the relationship between the experimental group's performance in the pre-test and post-test after the implementation of the identified teaching strategy in relation to the performance of the control group in both tests.

4.12 TRUSTWORTHINESS

According to Teddlie and Tashakkori (2009:21), trustworthiness is defined as the degree to which a researcher can convince the readers that the discoveries are valuable and attractive. Trustworthiness was assessed by allowing participants or any person with interest in the research to make comments or assess the research outcomes. Maree (2016:114) points out that participants can be allowed to remark on whether the explanations of information connect with individual experiences that they tried to convey during the interviews. Yin (2011:19) says that in showing credibility and trustworthiness, the researcher should ensure that the outcomes are available to everyone and that the text is explained in a manner that allows other people to assess and comprehend it. The research study will be made available to the community once examined.

Teddlie and Tashakkori (2009:28) refer to triangulation as the mixing and evaluation of various foundations of data, data gathering and analysis processes, research techniques and propositions that arise at the end of the research study. According to Korstjens and Moser (2018:121), triangulation is using various data sources in time (collecting data at different times of the day or at different times in a year), space (collecting data on the same phenomenon in multiple locations) and person (gathering data from different types or level of people e.g., individuals or group of people). Different ways of data collection such as pre-test and post-test, interviews and lesson observations were used to collect data during the research study. Similarly, Burns (2015:193) supports the opinion that triangulation refers to applying various data-collection methods, such as observations followed by interviews or making comparisons across different types of data, such as comparing quantitative analyses with qualitative responses.

4.12.1 Validity

Cohen et al. (2018:245) point out that validity refers to how accurately a method assesses what it is supposed to assess. The test conducted during the research study was compiled from the tests database given by the teachers which came with lesson plans. The research ensured that all the concepts that were included in the tests were covered during teaching and learning by allowing teachers to verify them. The test conducted in the main research study was first piloted on the same population but not the sampled learners for the main study to ensure that it measured learners' performance from the intended sample. The researcher ensured that all the questions included in the test covered the items in NOR which were covered in Grade 2 and the first term of Grade 3 (Kumar, 2011:168).

The researcher established the legitimacy of the scores from quantitative results to ensure that they measured (Creswell & Creswell, 2018b:223) the performance of Grade 3 learners in NOR in mathematics in diverse classrooms. The researcher presented the scripts to the teachers after marking to ensure that they were marked accordingly. The statistical analysis was used to analyse data from the tests and it was conducted by a qualified professional statistician. Furthermore, results from the statistical analysis were also presented to the teachers to verify if they agree with the interpretation.

McMillan and Schumacher (2014:485) confirm that validity is shown by the viability and effectiveness of the action plan that emerges from the study. The researcher collaborated with participants to authenticate the relevancy of the outcomes of the research study to the context (Pickard, 2013:163) and to answer the research questions. Similarly, Maree (2016:114) agrees that participants can be given the chance to remark on whether the explanations of information are connected to the individual experiences that they conveyed through the interviews. Misunderstandings of data interpretation were cleared by sharing it with participants to verify their viewpoints (Johnson & Christensen, 2014:414).

The findings were presented to the participants to verify and remark on them. According to McMillan and Schumacher (2014:485), to ensure that the test reflected what was intended to measure in the research, there should be a relationship between the test and its objective. The researcher ensured that the test is relevant and valid by using question papers provided to the teachers with the lesson plans to ensure that the test is valid, it is the curriculum of Grade 3 and it assesses learners' performance in NOR.

4.12.2 Reliability

Du Plooy-Cilliers et al, (2014:253) present that the reliability of the results depends on similar findings from other or different researchers when repeating the same research. Similarly, Kumar (2011:168) confirms that reliability is well-maintained when the researcher acquires comparable results from the same or identical situation when employing the same method. To assess the reliability of the test, the same test (pre-test) was administered as a post-test to the same group of learners which was separated by six to eight week intervals to the extent that the scores on the two administrations of the test were positively correlated (Bordens & Abbott, 2018:131). The probability of the learners remembering the questions and the responses were rare because the time interval that separated the pre-test and post-test was long.

To maintain reliability, the researcher constantly checked transcriptions to make sure that there are no errors during the process of coding (Creswell & Creswell, 2018b:202). The researcher ensured the reliability of data by regularly checking and connecting data with the themes by composing explanations and descriptions about the themes. Furthermore, the researcher ensured that the pre-test and the post-test that were administered to the participants for the main study were first administered to the pilot study to ensure its consistency (Cohen et al., 2018:268). The pilot study was conducted on a similar group of participants by administering the test to the same population to ensure that the test would yield similar results.

4.12.3 DESCRIPTIVE ANALYSIS OF DATA FROM PILOT STUDY

Quantitative data for the pilot study were collected from Question 1 (Q1) to Question 10 (Q10). The researcher adopted the categories followed by Didis and Erbas (2015:1141), cited in Makgakga (2016:115), of learners' responses to analysing the pre-test results: Correct Answers (CA), Partially Answered (PA), Wrong Answers (WA), Number Reversal (NR) or Wrong Spelling (WS) and Not Answered (NA) for each question from Q1 to Q10. CA are all responses fully answered in relation to the questions, PA means that learners did not fully answer the questions, WA means the answers are all incorrect, NR means numbers written upside down, WS means the number names spellings are incorrect, and NA means that learners did not attempt to answer the questions at all. The purpose of conducting the pilot study was to acquire a descriptive view of learners' understanding when responding to NOR questions.

A pilot study was done to prepare for the main study and to assess its practicality or to make changes from the planned pre-test, where necessary, before applying it to the main study. Participants for the pilot study were selected from the population of the study, mainly participants who were not taking part in the main study. A pilot study was conducted to assess the suitability of the planned pre-test as a data collection instrument in the main study before it could be applied in the main study (Lowe, 2019:117). The pilot study provided the researcher with ideas to improve or maintain various aspects of the main study.

In addition, a pilot study was employed to ascertain whether the test would provide information on the causes of poor performance of learners in NOR concepts. The pilot study revealed that Q9 was confusing to learners because they kept on asking how they should write it. It was then adjusted to “a” and “b”, that is, writing “a” as addition only, and “b” as subtraction, to avoid confusion.

Prior to presenting the results of the core study, the researcher presented the outcomes of the pilot study, which was conducted in one of the schools that did not participate in the main study. The researcher administered the test instruments to check whether they gauged what was intended. The test was administered to 64 learners, who were invigilated by the researcher and who also marked the scripts.

Table 4. 5: Distribution of learners' results from a pilot study

QUESTIONS	PRE-TEST									
	CA		PA		WA		WS/RN		NA	
Q1	16	25,0%	13	20,3%	31	48,4%	1	1,6%	3	4,7%
Q2	21	32,8%	13	20,3%	30	46,9%	0	0%	0	0%
Q3	3	4,7%	10	15,6%	39	60,9%	3	4,7%	9	14,1%
Q4	4	6,3%	19	29,7%	36	56,3%	5	7,8%	0	05
Q5	17	26,6%	8	12,5%	33	51,6%	1	1,6%	5	7,8%
Q6	25	39,1%	17	26,6%	18	28,1%	2	3,1%	2	3,1%
Q7	19	29,7%	2	3,1%	40	62,5%	0	0	3	4,7%
Q8	26	40,6%	15	23,4%	21	32,8%	0	0	2	3,1%
Q9	11	17,2%	25	39,1%	25	39,1%	0	0	3	4,7%
Q10	19	29,7%	21	32,8%	18	28,1%	0	0	6	9,4%

Table 5.1 in the pilot study showed that learners' percentages for the correct answers for Q1 to Q10 ranged from 6,3% to 40,6%. The percentages of the correct answers suggest that few learners can use their logical reasoning in finding the solution to the problems and in applying their number sense knowledge. According to the DBE (2011), the results showed that most learners lack number sense, that is, most do not know about the relationship between numbers and their mathematics operations. The lowest and the highest percentage of correct answers were for Q3 and Q8, respectively. Even the percentages of learners who attempted to give the correct responses to questions 1, 2, 4, 5, 6, 7, 9 and 10 were not impressive because the percentages were lower than 40. Moreover, more than a third of learners partially answered questions 9 and 10, at 39,1% and 32,8% respectively.

The results from the pilot test's percentage from Q1 to Q10 for the WA ranges from 28,1% to 62,5%, which indicates that most learners experienced difficulties in answering the questions, an indication that most learners lacked conceptual and procedural knowledge for solving NOR problems. A higher percentage of WA (62,5%) suggests that learners lack understanding of making sense of numbers on sequencing them from smallest to largest. This contradicts what the DBE (2011) has noted when indicating that, by the time learners reach Grade 3, they should be able to know or count numbers both forwards and backward, up to two hundred. This represents the actual developmental level of the learner, according to Vygotsky's ZPD. Based on the results from Table 5.1 above, it is evident that learners were not able to demonstrate the understanding of NOR and could not make sense of numbers.

4.13 CREDIBILITY

Taking the research results to the participants for validation, congruence, endorsement and justification help to ensure credibility (Kumar, 2011:172). The researcher took the results to participants to ensure that they confirmed the research findings and allowed them to verify their authenticity. Questions used for data collection were reasonable to generate credibility for the study. Maree (2016:123) stipulates that the researcher can exercise credibility by presenting the transcriptions or field notes to the participants to rectify the mistakes. The application of open-ended questions during interviews permitted participants to articulate and elaborate on their experiences in teaching NOR in Grade 3 diverse mathematics classrooms. Data were interpreted in a way to allowed participants to recognise that the interpretations were manifestations of their experiences.

4.14 TRANSFERABILITY

This is the degree to which the results and the analysis of research can be applied to other contexts or situations with other participants (Korstjens & Moser, 2018:121). The researcher ensured transferability by describing the behaviour, experiences and context of the research to ensure that they become meaningful to the readers. Maree (2016:124) proclaims that transferability involves inviting the readers of the research to make the connection between the elements of a study and their own experiences. The researcher ensured that the readers were provided with meaningful and purposeful results emanating from the study to be able to make their own decisions concerning transferability. Consequently, the researcher explained data in such a way that would enable the reader to determine whether the outcomes are transferable or not.

4.15 DEPENDABILITY

The researcher ensured dependability by interpreting the collected data in line with the theory presented in the research study. According to Korstjens and Moser (2018:121), dependability encompasses participants' assessment of the outcomes, analysis and suggestions of the study such that all are endorsed by the information collected from participants during the study. Dependability was addressed by presenting the outcomes to the participants to ensure that the researcher interpreted the information the way they presented it during data collection.

The researcher also used tutorial lessons conducted every Tuesday and colloquiums organised by the UNISA North-Eastern region to present her research study for critical analysis to ensure dependability. The researcher kept a notebook and observation tool throughout the research study to note information related to the study. Cohen et al. (2018:159) proclaim that to establish the value of the research, the researcher should keep the complete records in an accessible manner so that participants are able to verify whether the correct information had been conveyed.

4.16 CONFIRMABILITY

Bryman (2012:392) pointed out that the researcher must not permit individual beliefs or observable emotions to affect the outcomes arising from the research. The researcher established that the collected information and interpretations of the results are not her own creations but are clearly obtained from participants. The researcher always checked the notes from interviews and lesson observations, voice recordings from unstructured interviews as well as video recordings from lesson observations to confirm the accuracy of the interpretation of the collected data. The researcher presented the views of the participants fairly and used them to arrive at a better understanding of their environment. Lincoln and Guba (1994), as cited by Maree (2016:125), define confirmability as the degree of impartiality or the degree to which the results of the study are influenced by participants and not by the researcher's prejudice, enthusiasm, or curiosity. The researcher tried to be as neutral as possible during the research process to avoid bias and misinterpretations.

4.17 ETHICAL CONSIDERATION

Johnson and Christensen (2020:266) state that educational research conducted within the confines of the school requires approval and co-operation of different levels, such as province or district, circuit, SGB and principals, as well as teachers who participate in the research study. The researcher applied to the Limpopo Department of Basic Education at the district level to request permission to conduct the research from schools in the Nylstroom circuit. The researcher sought permission from the circuit office and applied to the principals and school governing bodies (SBG) where the research study was conducted. The researcher also applied for the ethical clearance certificate from the College of Education (CEDU) at UNISA.

The researcher handed out letters requesting the participants' involvement in the research study (McNiff & Whitehead, 2010:76). The researcher, in writing, explained to the principals of the schools where the study was conducted about any changes during the collection of data. The researcher ensured that all participants received the same treatment (Creswell & Creswell, 2018a:93). Where the researcher was not permitted to enter the classroom due to COVID 19 regulations, observations were conducted from the outside to ensure that both the pre-test and post-test were administered fairly from the two groups. The researcher was responsible for marking the scripts of both groups and submitting the results to the teachers.

4.17.1 Informed consent

The researcher clarified the purpose and nature of the study to participants, who were requested to participate allowing them to assess the processes to be followed which would enable them to make an informed decision as to whether they wanted to participate in the study or not (Johnson & Christensen, 2014:164; McMillan & Schumacher, 2014:135). The researcher did not compel participants to sign the consent forms but informed them that participation was optional, and they could opt out if/when they chose to do so (Creswell & Creswell, 2018a:93). Participation in the research study was voluntary and participants were notified of their right to stop participating from the study if they wanted to do so. Learners were given consent forms to be completed by parents or legal guardians to write the pre-test and the post-test since they are minors (Johnson & Christensen, 2014:206; McMillan & Schumacher, 2014:131).

4.17.2 Confidentiality and anonymity

The researcher protected the confidentiality of both participants and data and respected their privacy (Johnson & Christensen, 2014:165). The researcher ensured that participants’ confidentiality and privacy principles were applied by using code names for the place and participants to avoid identification by readers (McMillan & Schumacher, 2014:363). The researcher did not report anything of a personal or compromising nature but only reported information that was in the public domain

(McNiff & Whitehead, 2010:78). The researcher prevented the information from being accessed by other people before being published, however, she involved participants to verify the time and the situations under which knowledge was communicated or denied to the researcher (Johnson & Christensen, 2014: 211).

It is required that copies of the gathered data be protected in a cupboard/locker for five years for academic and further research. Similarly, soft copies of the data should be protected by utilising a code word protected computer. Upcoming application of the accumulated information is subject to further Research Ethics Review and endorsement if applicable. The hard copies will be destroyed and/or electronic copies will be completely erased from the hard drive of the computer through the utilisation of an appropriate software programme after five years.

4.18 CHAPTER SUMMARY

This chapter discussed the research approach employed in this study. The chapter also discussed the research design, research methods, location, population and sampling. Thereafter data gathering techniques and data analysis procedures were also deliberated on. The subsequent chapter presents and discusses the collected data.

CHAPTER FIVE

PRESENTATION OF THE FINDINGS

5.1 INTRODUCTION

This chapter presents and discusses the findings on the quantitative data from the pre -test and post-test and the qualitative data from lesson observations and interviews. As this is an intervention study, the research encompassed sub-sections of analysis of pre-test; lesson observations and interviews; post-test and interviews; statistical analysis and conclusion of the chapter.

This study intended to explore the effectiveness of using strategies to improve Grade 3 learner performance in numbers, operations and relationships (NOR). The study also tested the hypotheses formulated:

H_0: There is no significant difference between the two study groups when using teaching strategies employed in this study.

H_1: There is a significant difference between the two study groups when using teaching strategies employed in this study.

H_0: There is no significant difference between the pre-test and post-test when using teaching strategies employed in the experimental group

H_1: There is a significant difference between the pre-test and post-test when using teaching strategies employed in the experimental group

The purpose of data collection was to answer the following research questions:

- How are teachers applying their teaching strategies to enhance the performance of the Grade 3 Foundation Phase learners in diverse mathematics classrooms?

- What challenges are experienced by teachers when using those strategies in enhancing the performance of Grade 3 Foundation Phase learners in diverse mathematics classrooms?
- What teaching practices can be employed to improve the performance of Grade 3 Foundation Phase learners in diverse mathematics classrooms?

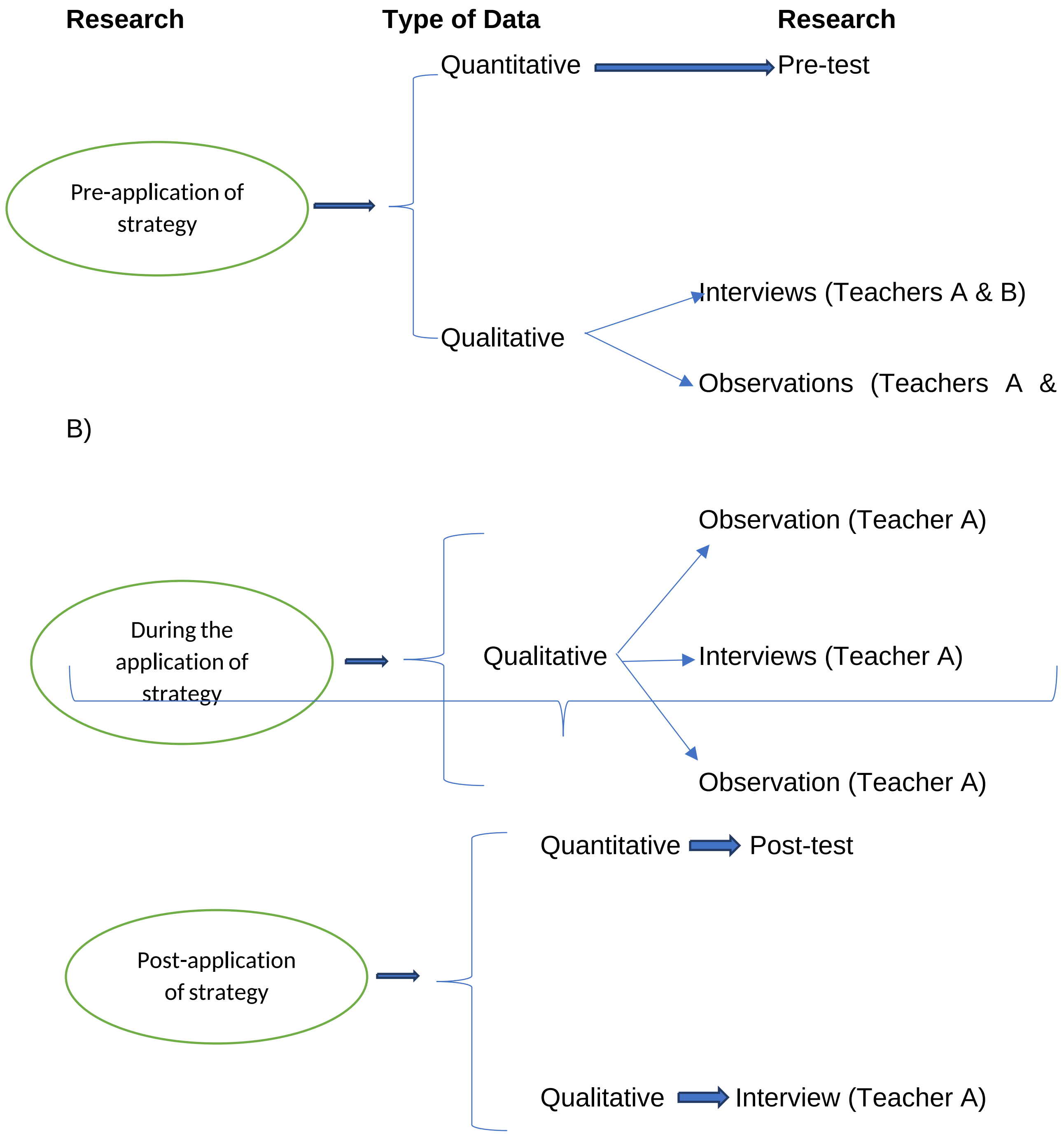


Figure 5.1: Analytic structure: Mixed methods (Quantitative-Qualitative) embedded Action research *(Adapted from Makgakga, 2016:114)*

5.2 SUMMARY OF THE INDICATORS/DESCRIPTORS FOR ANALYSING DATA FROM THE THEORETICAL FRAMEWORK

Table 5.1 provides the comprehensive constructs from the theoretical framework. The constructs were used to discuss quantitative and qualitative data collected in the form of pre-tests, post-test, unstructured interviews and lesson observations.

Table 5. 1: Summary of constructs from the theoretical framework

Construct	Definition	Descriptors
Providing multiple means of representation corresponding to the Recognition network – what of learning (Conceptual understanding)	What are the words and what do they mean	-What is the relationship between mathematical concepts, for example, addition can be reversed through subtraction - Represent or recognise or link mathematical concepts with different symbols, pictures, base ten blocks, diagrams, etc.
Providing multiple means of action and expression corresponding to strategic networks – the how of learning (Procedural fluency)	How to make sense of the text/what learners are taught	- How is information presented to learners - How do learners engage with information or grasp knowledge - How do learners demonstrate their understanding or express themselves

Providing multiple means of engagement corresponding to the Affective network – the why of learning	Why should learners be engaged in learning	- Providing choice in presenting text to learners - Recognising the learning abilities and needs of all learners
ZPD Level of actual development Level of potential development	 What the learners have already mastered What the learner can achieve when provided with educational support	 - Demonstrate the ability to link prior knowledge with new knowledge -Slowly assist the learner to develop knowledge - Show development of understanding by being able to perform challenging activities individually - Interpret and answer simple word problems by themselves - Develop fluency and independence
Ubuntu African philosophy	Focuses on the attention a person gives to another, which includes humanity towards one another, the type of behaviour and attitude to other people and towards teaching and	Demonstrate kindness, friendliness, care, respect, compassion, support and mutual communication during teaching and learning

	learning	

5.3 PRE-TEST RESULTS IN QUANTITATIVE ANALYSIS

The main study included 131 Grade 3 learners from two public schools in the Waterberg district of Limpopo province. Both are in the Nylstroom circuit (Experimental group = 57 and Control group = 74) and learners' ages ranged from 8 to 10. The number of learners is based on those being taught by the teachers who participated in the study; hence it was not possible to sample an equal number of learners. The study was aimed at gaining insight and exploring the challenges learners experience in mathematics. A pre-test was conducted in both the experimental and control groups prior to the intervention strategy. Quantitative data analysis of the pre-test from Table 5.3 to 5.7 represents the performance of learners in numbers, operations and relationships in Grade 3 classes generated from the experimental group and control group. The experimental group is called School A, while the control group is called School B. The schools were identified as Schools A and B to shield the distinctiveness of the schools participating in the research.

Collected information was categorised according to the codes to understand the general performance of both experimental and control groups from the administered pre-test. The percentages of the coding from the pre-test were calculated based on the number of learners in each category. The pre-test was conducted to measure the performance of Grade 3 learners in NOR in diverse classrooms. A quantitative analysis of the responses from the learners was conducted to identify the challenges experienced by learners that cause their performance to be poor.

The pre-test was aimed at assessing learners' knowledge about solving numbers, operations and relationships in writing numbers in words, identifying small and big numbers, arranging numbers from the smallest to the biggest, writing the value "amount" of the underlined digit and breaking or building the numbers according to their different values. Additionally, it was aimed at assessing learners' understanding of the usage of base ten blocks "smallest tiny cubes arranged in a straight row to make a small, long rod or smallest tiny cubes arranged in singles" to represent numbers and identifying family numbers by using addition and subtraction, that is using subtraction as an inverse operation of addition. Finally, it was aimed at assessing learners' knowledge of solving word sums. The questions from the test were compiled following the structure used from the provided lesson plans by the Department of Basic Education (DBE) and NECT. For presentation purposes, the questions were grouped according to similar content, hence Q1 was grouped with Q3, Q2 was grouped with Q7, Q4 alone, Q5, Q6, and Q8 and finally Q 9 and Q10.

5.3.1 Learners' responses to Q1 and Q3

In table 5.2 are analyses of Q1 and Q3 results. Question 1 was used to assess knowledge of writing numbers in words or writing the number names of the given numbers, such as sixty-eight. Question 3 learners were expected to identify the number that is between two given numbers, identify a number that is one bigger and one less, and write them in words (e.g., write a number between 178 and 180, a number that is one more than 199 and a number that is one less than 100). Q1 and Q3 are grouped together because the questions are related in such a way that they needed learners to write the answers in words.

Table 5. 2: Distribution of learners' responses to Q1 and Q3

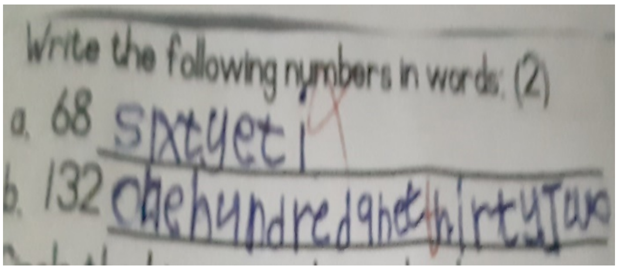
QUESTIONS	GROUPS	PRE-TEST									
		CA		PA		WA		NR/WS		NA	
Q1	Experimental	14	24,6%	20	35,1%	14	24,6%	3	5,3%	6	10,5%
	Control	13	17,6%	19	26,7%	41	55,4%	0	0	1	1,3%
Q3	Experimental	7	12,3%	17	29,8%	33	57,9%	0	0	0	0
	Control	8	10,8%	13	17,6%	42	56,7%	0	0	11	14,9%
TOTAL	Experiment	21	18,4%	37	32,5%	47	41,2%	3	2,6%	6	5,3%
	Control	21	14,2%	32	21,6%	83	56,1%	0	0	12	8,1%

Table 5.2 above indicates that the experimental group in category CA for the experimental group was 24,6% and for the control group is 22,8%. Question 1 had two items in which learners were expected to write the numbers in words and Q3 had to identify the number and write it in words.

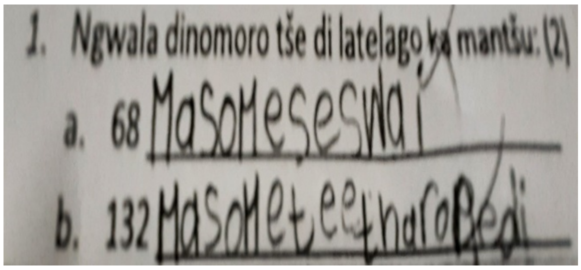
The results revealed a higher percentage of wrong answers in Q1 and Q3 in the control group and Q3 in the experimental group. This revealed that learners are not able to compare the numbers using more than, less than, or between, from different given numbers and to write their number names. It is evident that learners lack the conceptual understanding to comprehend mathematical concepts, operations and relations (Kilpatrick et al. 2001:5). This revealed that there was no significant difference between the performance of the experimental and control groups in Q3.

It is also revealed that learners in Q3 are not able to identify the or might not be able to count the numbers either forward or backward. As indicated by CAST (2011:5), learners showed a lack of conceptual knowledge to be able to create the relationship between the ideas of the numbers and their names. Learners were unable to connect the names of the numbers and their meanings to write them correctly. The 18,4% and 14,2% overall performance of experimental and control groups for Q1 and Q3 revealed that learners are unable to establish a sense of what numbers mean and are not flexible in using numbers in mental mathematics, estimations and comparisons (Adler, 2017:1). This also revealed that learners lack counting skills or the ability to produce in a speech a correctly ordered string of numbers. Samples 1 and 2 below indicate that learners were unable to write the numbers in words in both English and Sepedi.

Learner's response: Sample 1



Learner's response: Sample 2



Both learners from samples 1 and 2 above spelled the numbers incorrectly. Sample 1 was able to write sixty correctly, but could not spell eight, where even one hundred and thirty-two was misspelled. Sample 2 wrote the wrong answer where he wrote "masome seswai" (eighty) instead of writing "masome tshela seswai" (sixty-eight). The learners' response on Q1 revealed a lack of basic conceptual understanding of numbers, which is developed by a recognition network (Hall et al., 2012:79). The data revealed that some learners were unable to connect the sounds of numbers to their names.

Partial answers for experimental groups numbered 35,1%, wrong answers were 24,6%, which is equivalent to the correct answers, not answered learners numbered 10,5% and incorrect spelling or reversed numbers, numbered 5,3%. Learners should be able to connect the number of names that are written in the way they are articulated. These showed that 35,1% of partially answered (PA) items in Q1 propose that most learners were unable to connect the sounds of numbers to their number names. Learners' skills of counting, comparing and computing numbers fluently proved lacking (NCTM, 2020a:3).

5.3.2 Learners' responses to Q2 and Q7

Question 2 was about finding the smaller and bigger numbers, while Question 7 required learners to arrange the numbers from the smallest to the biggest numbers. The two questions are grouped together because they are similar in such a way that they are about small and big numbers. If learners can identify small or big numbers, then they will be able to arrange them in order. Learners needed to demonstrate their understanding and knowledge of numbers.

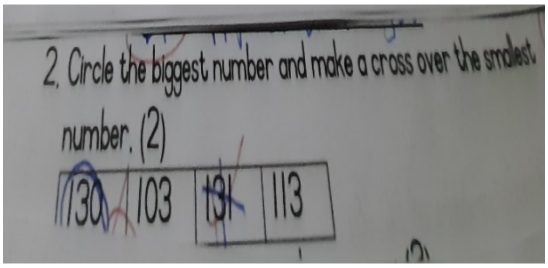
Table 5. 3: Distribution of learners' responses to Q2 and Q7

QUESTIONS	GROUPS	PRE-TEST									
		CA		PA		WA		NR/WS		NA	
Q2	Experimental	12	21,1%	13	22,8%	32	56,1%	0	0	0	0
	Control	23	31,1%	16	21,6%	35	47,3%	0	0	0	0
Q7	Experimental	25	43,9%	0	0	21	36,8%	0	0	11	19,3%
	Control	29	39,2%	1	1,3%	42	56,8%	0	0	2	2,7%
TOTAL	Experimental	37	32,5%	13	11,4%	53	46,5	0	0	11	9,6%
	Control	52	35,1%	17	11,5%	77	52,0%	0	0	2	1,4%

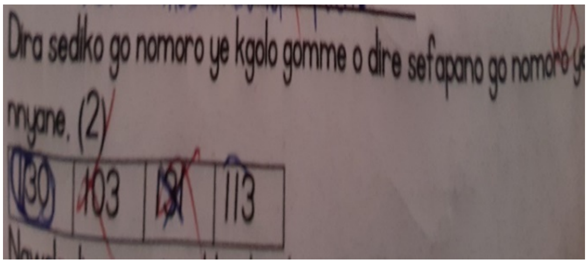
Table 5.3 above displays the results of Q2, which was about identifying the smallest and the biggest number, while Q7 required learners to arrange the numbers from smallest to biggest, as earlier noted. Results from data collected in Q2 above indicate that CA for the experimental group was 21,1% of learners managed to identify the biggest number and the smallest number, while the control group obtained 31,1%. However, WA for the experimental group of 56,1% and the control group of 47,3% suggested that learners had inadequate skills to identify the number, as well as to

interpret and analyse the facts and mathematical ideas (Sharma & Verma, 2017:22298). This implies that the actual level of development of most of the learners is lacking (Vygotsky) so that learners can recognise numbers from zero to at least two hundred before entering Grade 3. The samples below showed how learners were unable to identify the biggest number and the smallest number. For example, the samples below are taken from two different learners who answered Q2 by circling the biggest number and making a cross over the smallest number from the given numbers: 130; 103; 131; 113.

Learner's response: Sample 3

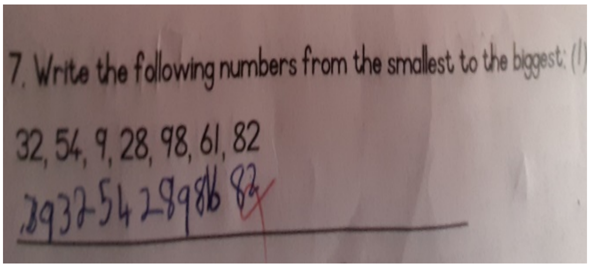


Learner's response: Sample 4

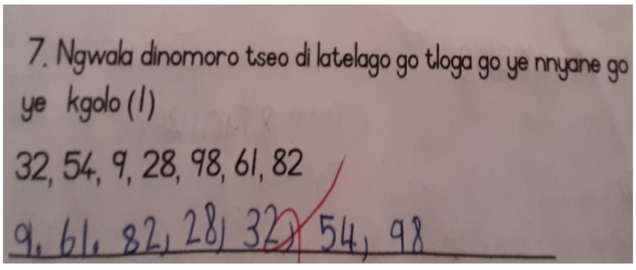


The samples above show that learners in Q2 lack the number sense of differentiating between the small and big numbers, that is, they are unable to order the numbers according to the sequence. According to the DBE (2011:17), learners should at least be able to count numbers forward and backward up to at least two hundred. Higher percentages of WA for both groups revealed that learners lacked a conceptual knowledge of numbers, hence they were not at the level where they were supposed to be in terms of identifying smaller and bigger numbers up to one hundred. This indicates that the actual knowledge of learners has not yet been fully developed, because they cannot identify the smallest and the biggest numbers. In relation to Q2, learners were expected to sequence the numbers: using the following numbers from the smallest to the biggest: 32; 54; 9; 28; 98; 61; 82. The samples below indicated that learners cannot write numbers that are less than 100 in order from the smallest to the biggest.

Learner's response: Sample 5



Learner's response: Sample 6



In Q7, learners in the experimental group obtained 43,9%, while the control group obtained 39,2% of CA. The outcomes showed that fewer learners in the control group were able to order numbers from the smallest to the biggest. Based on the samples above, learners lack conceptual understanding of numbers and recognition networks (Hall et al., 2012) to identify how numbers follow each other from the smallest to the biggest. Sullivan (2011:7) postulates that if learners do not know or can hardly recall the meaning of terms such as smallest or biggest, then it will be difficult to facilitate the working memory of such learners to solve the problem. The evidence of this is shown by the fact that 56.8% of learners in the control group could not recognise how numbers follow each other as compared to the experimental group of 36,8% of learners.

5.3.3 Learners' responses to Q4

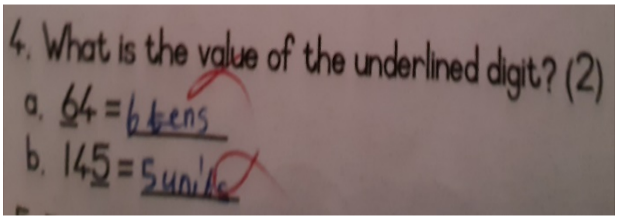
Question 4 intended to assess learners' understanding concerning finding the values of the underlined digit, that is, the amount of a digit based on the position where it is from a given number (e.g., <u>6</u>4). The pre-test results from the experimental group showed that 14,0% of learners identified the values of numbers, whereas 70,2% could not identify the values of numbers. The higher percentage from the experimental group of wrong answers shows that learners experience problems in identifying the meaning of different kinds of numbers and stating their values. Based on the results from the table below, learners from the experimental group were unable to demonstrate and apply the understanding of major mathematical concepts, applications of numbers and using real numbers in context (NCTM, 2020b).

Table 5. 4: Distribution of learners' responses to Q4

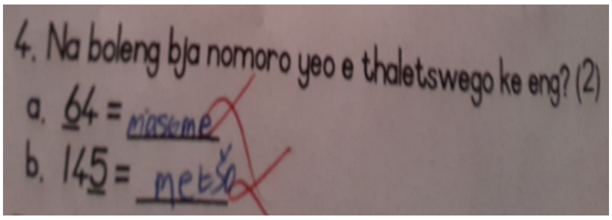
QUESTIONS	GROUPS	PRE-TEST									
		CA		PA		WA		NR/WS		NA	
Q4	Experimental	8	14,0%	7	12,3%	40	70,2%	0	0	2	3,5%
	Control	21	28,4%	16	21,6%	35	47,3%	0	0	2	2,7%
TOTAL	Experimental	8	14,0%	7	12,3%	40	70,2%	0	0	2	3,5%
	Control	21	28,4%	16	21,6%	35	47,3%	0	0	2	2,7%

From Table 5.4 above, the control group showed that 28,4% (CA) of learners were able to identify the values of underlined digits, whereas 47,3% (WA) failed to identify them. The quantitative results propose that the control group performed better than the experimental group. However, the higher percentage of WA in the experimental group obtaining 70,2% suggests that most learners lack conceptual knowledge to organise their knowledge logically to be able to connect new ideas with what they already know with reference to Math Assessment Resource Service (2017:5). Kilpatrick et al. (2001:117) propose that once learners completely comprehend concepts and procedures, such as place values and operations with one-digit numbers, they can expand these ideas and processes to dissimilar areas. This implies that learners are unable to understand that the value or quantity of the numeral depends on the position where that digit appears in the given numbers. The samples below showed that most learners cannot differentiate between the place value and the value of the underlined digit from a given number.

Learner's response: Sample 7



Learner's response: Sample 8



The preceding samples showed that learners were incapable to respond to the question appropriately. The answers suggest that the learners cannot differentiate between the place value and the value of a digit from a given number. Both learners wrote the place of value (e.g., 64 = tens) instead of writing the value (e.g., 64 = 60), which indicates that learners lack a basic understanding of the number concepts (CAST, 2011).

5.3.4 Learners' responses to Q5, Q6 and Q8

Q5 required learners to break the number, while Q8 required learners to build up the number. Breaking and building numbers are the reverse of each other (e.g., 254 will be broken to become 200 + 50 + 4 while the number 200 + 80 + 1 will be built to become one number as 281). Q6 required learners to show their understanding of the relationship between small blocks lined up in a straight row placed side by side and small blocks placed next to each other "base ten blocks" and the numbers they represent. Learners were expected to write the number sentence and the answer represented by the base ten blocks.

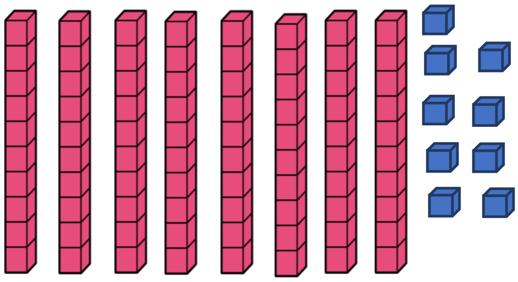


Table 5. 5: Distribution of learners' responses to Q5, Q6 and Q8

QUESTIONS	GROUPS	PRE-TEST									
		CA		PA		WA		NR/WS		NA	
Q5	Experimental	30	52,6%	3	5,3%	21	36,8%	0	0	3	5,3%
	Control	29	39,2%	14	18,9%	30	40,5%	0	0	1	1,4%
Q6	Experimental	12	21,1%	20	35,1%	17	29,8%	0	0	8	14,0%
	Control	28	37,8%	22	29,7%	21	28,4%	0	0	3	4,1%
Q8	Experimental	24	42,1%	18	31,6%	12	21,1%	0	0	3	5,3%
	Control	23	31,1%	13	17,5%	31	41,9%	0	0	7	9,5%
TOTAL	Experimental	66	41,0%	41	25,5%	40	24,8%	0	0	14	8,7%
	Control	80	36,0%	49	22,1%	82	36,9%	0	0	11	5,0%

In Q5, 52,6% of learners in the experimental group were able to respond to the question correctly, while only 39,2% of learners from the control group were also correct. Learners from the experimental group showed a deeper understanding of mathematical concepts and the ability to make connections between the relationship of different digits from a number and their quantity (Sharma & Verma, 2017:22298). However, in the control group, there was a slight difference between learners who managed to write the correct answers and the learners who wrote the wrong answers with 39,9% and 40,5%, respectively. This presented that there is little understanding of how to connect the relationship of the quantity of each digit from a given number.

The Michigan Department of Education (2020:14) proposes that for learners to demonstrate conceptual knowledge, they should be able to make sense of numbers and be able to compose and decompose numbers. On the contrary, around 36,8% to 41,9% of learners from both groups were unable to decompose the three-digit numbers according to their value or quantities in Q5, and in Q8 they were unable to compose the different numbers to become one number with three digits. It is evident that learners lacked knowledge of identifying the quantity of every digit from a given number by breaking it down according to different values (e.g., breaking down a number like 209). Learners were unable to break up numbers into different values, such as hundreds, tens, and units, e.g., 209= 200 + 9 or 200 + 0 + 9. Some learners' conceptual understanding in relation to Q5 and Q8 still required development to enable them to answer similar questions correctly.

The percentages of the experimental group from Q6 were 35,1% for PA, 29,8% WA and 14,0% for NA, while control group from Q6 ranges from 37,8% for CA; 29,7% for PA; 28,4%, and 4,1% for NA. These results are inconsistent with moving smoothly between several illustrations of numbers comprising pictorial representations and concrete materials in making relationships of numbers (NCTM, 2020a:9). The results suggest that most learners require support in interpreting the relationships when using different representatives, such as pictures or building blocks for real numbers.

In Q8, 42,1% of learners from both experimental and 40,4% of learners from control groups showed that fewer learners were able to build the number or add correctly to find the answer. Learners were able to put together hundreds, tens, and units so that they become a three-digit number. However, 31,6% of PA and 21,1% from experimental and 22,8% and 54,4% showed that some learners are unable to use base ten blocks to understand the importance of tens and units and their meaning from a number (Kilpatrick, 2001:99). The learners struggled to determine the values of the base ten blocks and to represent them symbolically by writing the number sentence thereof. The results suggest that learners lacked the skills of operating mathematical knowledge and ideas in a way that changes their implication and meaning (Sharma & Verma, 2017:22298).

5.3.5 Learners' responses to Q9 and Q10

Question 9 was about addition and subtraction as inverse operations. An inverse operation reverses the effect of the first operation, that is, if we start by doing addition, we can rearrange the numbers in the addition sentence to make two different subtraction sentences (e.g., start with 13, then add 1 we get 14, now subtract 1 from 14 and we get back to 13).

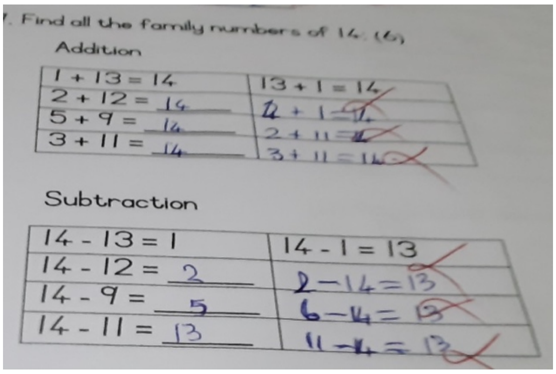
Question 10 was a word sum, in which learners were expected to interpret the question with understanding and apply the correct operation to find the solution to the problem (e.g., in the morning Lebo has 19 apples. During lunch, she eats six apples. How many apples are left?). Q9 and Q10 were grouped in the table below, due to the need for learners to use addition and subtraction.

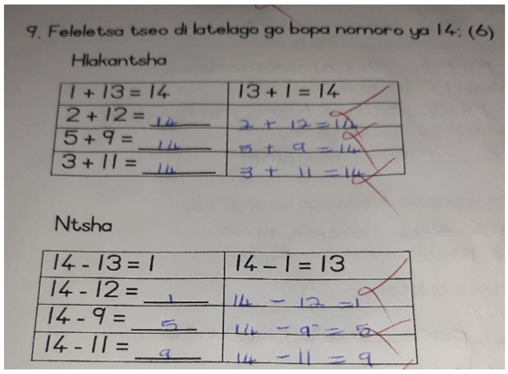
Table 5. 6: Distribution of learners' responses to Q9 and Q10

QUESTIONS	GROUPS	PRE-TEST									
		CA		**PA**		**WA**		**NR/WS**		**NA**	
Q9	Experimental	6	10,5%	28	49,1%	18	31,6%	0	0	5	8,8%
	Control	2	2,7%	29	39,2%	41	55,4%	0	0	2	2,7%
Q10	Experimental	14	24,6%	23	40,4%	9	15,8%	1	1,8%	10	17,5%
	Control	4	5,4%	20	27,0%	33	44,6%	0	0	17	23,0%
TOTAL	Experimental	20	17,5%	51	44,7%	27	23,7%	1	0,9%	15	13,2%
	Control	6	4,1%	49	33,1%	74	50%	0	0	19	12,8%

The results from Table 5.6 above showed that learners lacked knowledge that addition and subtraction are inverse operations and that there are different ways of doing the sum to reach the same answer (Kilpatrick, 2001:76). Learners were expected to use family numbers to add the two small numbers to get the bigger number (e.g., 2 + 12 = 14 or 12 + 2 = 14). Learners were also expected to use the same three numbers for subtracting to prove that if you subtract any of the two small numbers, the answer is the other small number (e.g., 14 - 2 = 12 and 14 – 12 = 2). The Math Assessment Resource Service (2017:7) assumes that knowing multiple approaches, choosing a suitable approach and applying it to solve or double check the problem demonstrates the practice of procedural fluency. If learners had grasped the knowledge of addition, they would have used the reversal rule to rearrange the numbers to form subtraction. Samples 9 and 10 below showed that learners struggled to use different numbers to build 14 and to use the same numbers by subtracting each number to check if the answer is correct.

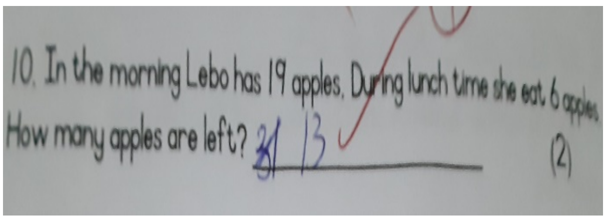
Learner's response: Sample 9 **Learner's response: Sample 10**

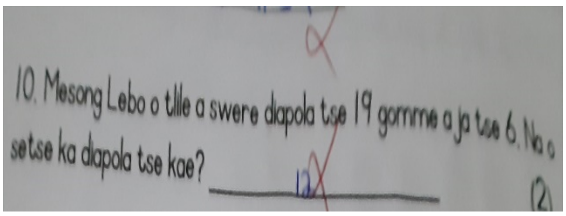




In Q10, learners were required to interpret the word problem and use the correct mathematical operation to find the solution to the problem. Most learners with 40,4% from the experimental group partially answered the question, 24,6% were able to provide an accurate response, 15,8% wrote the reversed number, and 17,5% left the question unanswered. The samples below for Q10 signify that the learners were unable to answer word problems in context and enlighten their results to problems concerning subtraction. Even though the learner in Sample 11 has written the solution to the problem, he or she did not show how he or she arrived at the answer.

Learner's response: Sample 11 **Learner's response: Sample 12**





As pointed out by CAST (2011), these suggest that some learners lack a strategic network to generate the strategy to solve problems. Similarly, Smith, Bill and Raith (2018:37) agree that being unable to solve problems suggests that learners do not possess the strategic competency that would allow them to come up with different tactics to choose flexibly the method that might suit the challenge at hand. Learners require scaffolding to be able to reach their potential to allow them to identify the strategy to solve word problems on their own. According to Math Assessment Resource Service (2017:5), learners who do not possess procedural fluency have difficulties expanding their comprehension of mathematical concepts or interpreting mathematical questions. Hall et al., (2012:76) are of the opinion that to be an effective learner and problem solver, the learner should frequently apply basic skills and processes that will allow them to place more attention and determination into applying conceptual knowledge.

5.4 PRE-INTERVENTION UNSTRUCTURED INTERVIEW AND OBSERVATION

As mentioned in Chapter 4, unstructured interviews and lesson observations were conducted with two teachers from the two schools, after administering the pre-test. The purpose of conducting the interview was to understand their perspectives on learners' performance in numbers, operations and relationships (NOR) in diverse classrooms in the two schools.

Unstructured interviews were conducted immediately after administering the pre-test and before the application of the identified strategy to the experimental group. Unstructured interviews were conducted with one teacher from each group, that is, experimental and control groups. The same questions were asked from both teachers, in the same order to understand the challenges they might be experiencing in teaching and learning NOR in mathematics Grade 3 classes. Participants are identified as participants 1 and 2, where participants are represented with the letter "P" and the numbers will be in numerical order is "1" and "2". The participants are "P1" and "P2".

5.4.1 Analysis of unstructured interviews with teachers after administering pre-test

Some of the extracts from the teachers used as an example are presented below. The participating teachers from experimental and control groups were asked the following questions:

Challenges in diverse classrooms: What are your opinions about teaching mathematics in diverse mathematics classrooms?

Challenges in mathematics: What do you think affects the performance of Grade 3 learners in diverse mathematics classrooms?

Accommodating and supporting learners' needs: How can the learning needs of all learners in diverse mathematics classrooms be accommodated?

Teaching and learning strategies: What kind of strategies do you follow to ensure that effective teaching and learning in diverse classrooms takes place?

Learner assessment: How do you assess your learners?

Teacher's support in the diverse classroom: How can you be supported in teaching mathematics in Grade 3 mathematics classrooms effectively and efficiently?

General comments: Is there anything that was not asked but you will like the researcher to know?

Transcript 1: What are your opinions about teaching mathematics in diverse mathematics classrooms?

The question was posed to participants to understand how teaching and learning take place in diverse classrooms and the possible challenges they might be experiencing during teaching and learning. All responses are transcribed verbatim.

> P1: *It is challenging, and it slows the teaching and learning process. It does not allow the teacher to meet the learning needs of all learners in the classroom.*

Researcher: How does it slow teaching and learning?

> P1: *We* are *teaching learners who speak different languages, and we have learners who come from other African countries who can't even speak Sepedi, so it is difficult when teaching in the classroom. Because we also teach learners with different abilities, it is not easy to pay attention to "slow" learners and if we try to focus on them, we delay other learners who "catch" very fast.*

> P2: *Teaching in a diverse classroom can be challenging because learners who are admitted to this school speak different languages and some of them are immigrants. We do not have enough time to teach learners so that they understand the content clearly or to attend to learners who are slow.*

The findings revealed that P1 experiences a challenge in meeting the needs of all learners when teaching in a diverse classroom. Based on the statement above, it seems that the teacher experiences challenges teaching in a diverse classroom. The statement "*It does not allow the teacher to meet the learning needs of all learners in the classroom"* shows the concern of the teacher. P1's reaction before answering the question indicated that she experiences difficulties on how to accommodate different learners in a diverse classroom. Contrary to this, Goepel, Sharpe and Childerhouse (2015) indicated that the teacher should support all learners in the classroom in their daily progress and development. The teacher appears to have a problem supporting learners in a diverse classroom, which might cause learners who experience learning difficulties to be left behind in their learning. Similarly, CAST (2011:32) from the universal design for learning (UDL) emphasises that learners should be offered support to be able to deal with interference when learning in a diverse classroom.

The findings revealed that teachers experience challenges in teaching learners with different learning abilities, and who speak different languages, in the same classroom. This was evident from the words of P1: "*Because we teach learners with different abilities and who speak different languages."* This was affirmed by P2: "*Teaching in a diverse classroom can be challenging because learners who are admitted at this school speak different languages and some are immigrants."* Even though teaching in a diverse classroom can be challenging, it can promote inclusion and encourage learners to work together to promote positive learning. This confirms what Foreman and Arthur (2017:19) noted, namely that teaching and learning in a diverse classroom prepares learners for diverse opportunities, responsibilities, and life experiences.

The findings revealed that teachers find it difficult to support all learners who experience challenges during teaching and learning. For example, P1 further said: "*It is not easy to pay attention to "slow" learners and if we try to focus on them, we delay other learners who "catch very fast"."* This indicates that learners might not receive the necessary support they need during teaching and learning. Based on the statement by P1, learners who do not experience learning barriers might be neglected by the teacher while trying to support those with learning barriers in class. The teacher needs to understand that in order not to delay learners who do not experience learning, extra activities should be prepared to keep them busy and focused. According to CAST

(2011:1), universal design for learning (UDL) encourages teachers to meet the learning difficulties of learners with learning needs, while enhancing learning for all and presenting alternatives for displaying what learners know. Teachers might be lacking the skills to provide various learning opportunities that would cater to the needs of all learners in the classroom.

Transcript 2: What do you think can affect the performance of Grade 3 learners in diverse mathematics classrooms?

> P1: *Most learners cannot read and write properly. When we give them homework, they don't do the work. Some parents write homework for their learners in their books instead of helping them to do the work.*
>
> P2: *When we give learners homework to do at home, most of them do not write. Parents write homework for their children, and some do not bring the books back to school when we give them to write the work at home.*

The extract above revealed that learners have difficulties in reading and writing, which appears to derail the teaching and learning of mathematics. This can also appear to affect the performance of the learners. According to Hall et al. (2012:29), in providing multiple means of representation, learners should be able to identify simple words written on the page or screen and understand their meaning. This implies that learners who do not know how to read and write experience difficulties in expanding their comprehension of mathematical concepts or understanding mathematical questions. CAST (2011) postulates that at a certain level, learners should be able to know "how" to make sense of the text, identify the strategy they could employ and how express what they know about the text (strategic network in UDL). The findings revealed that reading and writing play a crucial role in doing the given work because if learners cannot read, they will not know or understand how to do the activities that they are given.

P1 was concerned about those learners who cannot read and write because their parents write homework for them. Similarly, P2 pointed out that parents write homework for their children, which might have a negative influence on some learners for not finishing activities that are done in the classroom. This shows that learners lack conceptual knowledge of the subject which needs serious attention to support them.

This implies that parents are not giving their children the necessary support they should be providing them with. Hence, if parents write homework for their children and do not assist them, they will not see the importance of writing at school and will not be able to comprehend information when reading. According to Hall et al. (2012:29), learners will not see the importance of the “why” of reading, or care about the text, and “why” they should continue engaging with it (affective network of UDL). They are discouraging self-regulated learning towards their children (Behnsen, 2018:6), where the learners should take control of their own learning and evaluate themselves. Parents are putting their children in a passive learning role and denying them the chance to demonstrate their knowledge and skills in learning.

The findings revealed that learners may not be able to take control of their own learning and develop the learning skills that they have. Though the teachers say parents write homework for learners, this cannot be true for all parents. It may be true if they say some of the parents write homework for their children. Parents might not be following mediation as stipulated by Donal et al., (2009:87) when explaining that teachers, parents, peers, and other mentors assist learners in slowly developing their knowledge. As noted, by Vygotskian theory, the enhancement of the learner’s upper intellectual procedures depends on the existence of mediation so that they can gain confidence to become independent, especially in comprehending problems of numbers.

> P1: *Pushing learners to the next grade even if they have failed or because they cannot repeat the grade more than two times or be in a phase for more than four years, causes learners to be in Grade 3 without enough knowledge.*

The statement by P1 above indicates that promoting learners to the next grade, even though they have not met the passing requirements, creates a challenge for the next teacher on how to accommodate them. This may in turn, create a poor performance for learners in mathematics because some learners are promoted to the next grade, disadvantaging fellow learners from developing their knowledge. This supports what Spaull and Kotze (2015:15) stipulated, when stating that for learners who attain learning deficits early in their schooling careers, the results would be the cause of underachievement in the following years. This means that those learners might be unable to cope with the work of the higher grades, being pushed to the next grade without fully grasping the knowledge of the previous grade. This concurs with Spaull et al. (2016:6) who stated that early learning determines matriculation results. This means that such learners who are always pushed from one grade to the next might end up not performing well in Grade 12 or might drop out of school in the future because of being pushed to the next grade, even if they do not meet the requirements of being promoted.

> P1: *Some of the learners do not pay attention during teaching and learning, some of them cannot concentrate in class and they don't finish classwork.*

> P2: *The issue of admitting learners at the age of four and half years at Grade R is "killing" us because some of the learners reach Grade 3 without being fully developed*.

Reflecting on learners' attention and concentration during teaching and learning, P1 said: "*Some of the learners do not pay attention during teaching and learning, some of them cannot concentrate in class, and they don't finish classwork."* P2 also supported this when noting: *"The issue of admitting learners at the age of four and half years at Grade R is "killing" us because some of the learners reach Grade 3 without being fully developed*." This indicates that learners who are not fully developed might not be able to pay attention during teaching and learning, creating a problem for teachers unable to support them. However, according to CAST (2011), teachers should be able to plan and adjust their teaching experiences to meet the developmental needs of all learners in the classroom. This revealed that teachers might be experiencing challenges in planning their activities or teaching, based on the needs of all learners in the classroom. This might in turn, contribute to some learners not performing well in mathematics, because the teacher might disadvantage other learners when trying to accommodate them.

> P*2: Learners are failing because there is too much work to teach in a short space of time. As teachers, we are forced to do "microwave" teaching because we must finish the curriculum. It is not possible to set questions according to learners' abilities because we do not have time to do so.*

The curriculum requires the teachers to cover a certain amount of work by the end of the term. This compels teachers to rush when teaching, so that they have covered the amount of work stipulated from the curriculum while disadvantaging learners who experience learning difficulties. This might create challenges for teachers in supporting learners with learning barriers. These indicate that most learners do not have enough time to comprehend what they are being taught, because the teacher moves from one concept to another for the sake of covering the stipulated curriculum. Hence, learners with learning challenges may end up being neglected, or not given the support that they need. Learners will experience barriers to learning, especially those who take the time to understand because certain concepts were taught to them in a rushed manner and support was not administered to them.

> *P2: The Sepedi language structure that is used in the books sometimes is difficult or not easy to explain the concepts clearly. Like when they say even number in Sepedi is "Palotekanelo",* (even number) *and sometimes some learners get confused in writing a number like 134, they will write in word "makgolo tee tharo nne," (hundred-one-three-four) where hundred is in plural instead of writing "lekgolo masome tharo nne"* (one hundred and thirty-four)*. Learners usually become confused in writing singular and plurals in writing numbers in words when the tens or hundreds are more than one.*

Based on the statement from P2, learners who are taught a language that is not their home language might experience difficulties in grasping the content or following instructions, due to confusion over meaning. This was also revealed by Chitera et al. (2016:313) in their study, namely that teachers and learners faced a major challenge regarding the mathematical content during teaching and learning of mathematics taught in African languages. This indicates that teachers are unable to adapt the information for multilingual learners to boost the atmosphere of learning in the classroom according to UDL principles (CAST, 2011). Hence, P2 indicated that some of the concepts like "*palotekanelo*" (even number) are difficult. This may cause learners to be mistaken for having learning barriers or as being slow learners, forgetting that learners who speak Tsonga, Shona, Tshivenda and Portuguese are learning mathematics in Sepedi. This is likely to contribute to the poor performance of learners in mathematics because certain words are difficult for them. The language of learning and teaching might be holding the learner back and he or she might take some time to develop an understanding of mathematics concepts.

Transcript 3: How can the learning needs of all learners in diverse mathematics classrooms be accommodated?

> P1: *Getting to know all the learners in the classroom is important so that I know who does well and who does not do well in class. Also, the use of teaching and learning resources helps to accommodate all learners in teaching and learning.*

Most classes in South African schools consist of learners who differ in terms of their learning level and needs. P1 pointed out that it is important to know every learner's ability in the classroom. This supports literature by Baglieri and Shapiro (2017:12); Engelbrecht et al. (2014:132), and Suh and Seshaiyer (2017:4) who note that knowing learners' abilities will develop their understanding of how they learn while providing the teachers the opportunity to change their teaching strategies, curriculum content, teaching resources, and classroom grouping to deal with educationally significant differences. Knowing the different abilities of every learner in the classroom will assist the teacher in accommodating their learning needs and giving them the necessary support during teaching and learning.

> *P2: Using resources when teaching will help to accommodate all learners in the diverse classroom.*

This support was noted early on when indicating that the application of resources during teaching and learning assists learners in understanding the concept being taught. Learners, especially in the FP, understand concepts better when these are presented to them practically through the help of resources. CAST (2011) and Hall et al. (2012:15), when providing multiple means of representation in UDL, emphasised that offering learners information presented only in the textual form will eventually generate a barrier for learners who are struggling readers. This means that the application of resources plays an important part in promoting positive and effective learning in FP. Similarly, La et al. (2018:8) stated that concrete objects offer learners several ways to participate and understand information and practices ("how" of learning in UDL providing multiple means of expression).

Transcript 4: What kind of strategies do you follow to ensure that effective teaching and learning in the diverse classroom takes place?

P1: *Because we are teaching learners maths in English, I sometimes switch to Sepedi to explain some of the words to help them understand. I use number cards, word cards, and number charts to help learners in counting and write numbers. Since learners are few in class, I can pay attention to learners who are not doing well in class by moving around and helping them individually.*

The findings reveal that it is vital for teachers to accommodate the learning needs of different learners in their classrooms during teaching and learning. P1 from the statement above indicated that, since they are teaching mathematics in English, she sometimes switches to Sepedi to explain some of the difficult words. However, some of the learners who do not speak Sepedi or understand the language well are still neglected. Mupa and Chinooneka (2015:127) have suggested that teachers should prepare various teaching and learning resources to use to accommodate the needs of all learners. It is the responsibility of the teacher to go the extra mile in their classrooms to ensure that learners receive education equally regardless of the language they speak.

P1 also indicated that she used number cards, word cards, and number charts to help learners in counting and writing numbers. This indicates the commitment of the teacher and the efforts she applies to assist them in understanding the concept that she is teaching during that time. The statement above from P1 of moving around to assist individual learners concurs with Pellegrini et al. (2018:14), who indicate that one -on-one contact with learners allows teachers to adapt their instruction to the needs of the learners, and to support them during teaching and learning. Some learners require individual support to understand what is being taught.

P2: *Before I start with my lesson, I do mental maths with learners by asking them to count forward and backward in twos or fives, depending on the lesson of that day. I let my learners count in English because counting is easier in English than in Sepedi. I always start from what they know and move to what they do not know to help them understand what they are learning. I always treat them as my own children so that they can be free to talk and participate in class. Because of COVID-19, it is easy to move around because half of the class comes to school every day, and it is also easy to identify learners who are not doing well in class.*

Speaking is vital in teaching and learning mathematics. Mental mathematics assists in encouraging communication between the teacher and the learners. The DBE (2011:8) emphasises that mental mathematics develops learners' communication skills and the ability to make sense of numbers. Similarly, Chinn (2016b:10) supports that a diverse classroom needs teachers who encourage learners to develop their knowledge of number sense by involving them in mental mathematics every day. This will help to develop learners' knowledge of numbers and enable them to perform simple calculations with numbers easily.

Transcript 5: How do you assess your learners?

> *P1: I do both informal and formal assessments. I give learners classwork and homework every day to write as informal assessments. Learners do continuous assessments in the form of oral and written tasks that come with lesson plans that we are provided by the National Education Collaboration Trust (NECT) programme. The planner and tracker have the tasks that are ready to be used to assess after completing a topic.*

> *P2: Learners write classwork and homework every day as part of informal assessment. We all follow the assessment which is provided with lesson plans from NECT. The continuous assessments are both written work and oral or mental maths for boosting their marks.*

As pointed out by Marinho, Leite and Fernades (2017:185), assessment is administered to measure the effectiveness of teaching strategies and to evaluate the learners' knowledge and skills. Both P1 and P2 indicated that they give learners classwork and homework daily as a means of informal assessment. Giving learners classwork and homework support the principle of UDL (multiple means of presentation), which indicates that learners should be engaged in activities that elicit writing, doing, or reflecting (CAST, 2011; Hall et al., 2012). However, Puigserver (2017:42) pointed out that it is unrealistic to disregard diversity in the educational setting by administering generalised activities with fixed, uniform criteria. This indicates that activities given to learners to engage with should accommodate the needs of all learners in the classroom. Teachers should ensure that the learning abilities of learners in the classroom when preparing the activities are considered so that no learner is left behind.

P1 and P2 also indicated that they use the assessments provided with NECT lesson plans. This implies that teachers do not prepare their own assessments to assess the learners, which might not be prepared according to the needs of their learners. It also indicates that teachers use the same assessment tools in assessing learners formally. Even though assessments are both oral and written, both assessments are administered to all learners in the same manner. The learners' different learning abilities are not taken into consideration, because the teachers used the assessments provided to them with lesson plans. This contradicts what was indicated by the DBE (2014b:16) and the Teaching and Education Standards of New South Wales (2016:18) when presenting that assessment should be multi-dimensional and differentiated, and should include different forms from different perspectives, which reflects the diverse needs of all learners.

Both P1 and P2 indicated that they administer continuous assessment provided with lesson plans by NECT. Continuous assessments enable teachers to give regular feedback to learners and measure their learning levels. Van Den Berg, Bosker and Suhre (2018:341) stated that continuous assessment prevents learners from developing knowledge gaps, and eventually enhances performance if properly administered. If learners are given continuous assessment, the teachers would be able to monitor the learners' progress and plan accordingly to support them.

Transcript 6: How can you be supported in teaching mathematics in Grade 3 mathematics classroom effectively and efficiently?

> P1*: If we can have enough teaching aids to put on the walls to help learners in learning, it can assist us. I also think that slow learners starting from Grade 1 should be in one class so that the teacher teaches them at their own pace and support them according to their learning needs.*

The use of teaching aids in a diverse classroom is essential in promoting understanding of core concepts. It also promotes active learning, gives a practical meaning to content, and assists learners to construct their own knowledge through manipulation of interactive materials and the use of primary data sources (Janney & Snell, 2013:37). As pointed out by P1, by providing enough teaching and learning resources, the FP classes can assist learners in learning. Parker and Thomsen (2019: 33) confirm that teaching aids make the subject and every aspect of the lesson very clear and make learners successful in learning mathematics. The findings revealed that the accessibility of different teaching and learning materials will assist in accommodating the different learning abilities of learners, hence their needs should be taken into consideration.

P1, from the statement above, reveals that if learners who experience learning difficulties can be in one class in each grade, it will help in supporting them during teaching and learning. This separation of learners with different abilities may label them and create a problem for those learners. On the contrary, Foreman and Arthur (2017:19) state that teaching and learning in a diverse classroom prepares learners for diverse opportunities, responsibilities and life experiences. Teachers should consider teaching learners with different abilities to be an opportunity to develop learners learning. Teachers need to be supported to know how to accommodate learners with different learning abilities so that they do not feel frustrated about how to support them in the classroom.

> P2: *Mathematics curriculum is too much for learners because sometimes in a week it requires us to teach two different concepts and it becomes too much for the learners. If the curriculum can allow us to focus on one concept at a time to avoid confusion for learners, it might be better.*

Teaching too much content in a short space of time might create challenges for learners to comprehend what they have learned. Based on the statement of P2, teachers are expected to teach learners more than one concept within a week, which creates a challenge for teachers and learners. This might have a negative influence on learner performance because they have limited time to learn two or more concepts. As noted earlier, some learners reach Grade 3 without being fully developed, this might create a challenge for them to master the concepts with ease.

Transcript 7: Is there anything that was not asked but you will like the researcher to know?

> *P1: Like now, with Education Assistances (EAs), if they were appointed permanently, it would be better, because they can help learners who learn fast,*

and I can focus on the learners who are struggling.

The need to have support for learners with learning difficulties is essential in a diverse classroom. However, P1 finds herself in a situation in which she is unable to support learners who experience challenges because other learners who learn quickly might be neglected. As such, teachers become frustrated and helpless without the help of education assistance in their classrooms so that they can focus on supporting learners who experience learning difficulties. Haug (2017:208) argues that teachers should ensure that all learners are actively and positively involved in teaching and learning so that no one is left behind. To involve all learners actively and positively during teaching and learning, teachers should know the strengths and weaknesses of their learners, to allow them to accommodate their learning needs (Hall et al., 2012:82).

> P2*: If maths concepts can be reduced and given the priority it can help in reducing poor performance.*

According to Hall et al. (2012:81), teachers should present learners with less information, to ensure that learners stay focused and do not get confused. P2 emphasises the need for reducing the amount of work expected in mathematics as a subject. As noted earlier, teaching more concepts within a short space of time might confuse mastering what they have learned. Learners need to be allowed to process and comprehend what they have learned so that they can apply that knowledge in a similar situation.

5.4.2 Data presentation from lesson observations after pre-test

As noted earlier, the researcher has conducted three classroom observations to understand how teachers teach NOR in diverse classrooms. P1 was teaching learners to break numbers into different values, based on their positions from a three-digit number. She first used 126 as an example and asked learners to read the number out. P2 was teaching learners about identifying the number by using the words before, between, and after. She gave learners number charts, with numbers up to one hundred to use as their resources.

5.4.2.1 Teaching strategies and techniques

Both P1 and P2 started their lessons by asking learners to count forward and backward from zero to two hundred. According to CAST (2011:18), constructing useable knowledge relies not upon simply observing information, but also through information processing skills, such as listening, mixing new information with prior knowledge, strategic classification, and active memorisation. P1 asked learners to count forward in 5s from their number charts, starting from zero to two hundred and backward from two hundred to zero. Xu Hua Sun, Chambris, Sayers, Siu, Cooper, Dorier, González de Lora Sued, Thanheiser, Azrou, McGarvey, Houdement and Ejersbo (2018:99) postulate that counting up and down is the easiest number system, which plays the significant role in the essential counting action of building one-to-one correspondence between objects and names, creating a set of narrating numbers in ascending or descending order. This could be the way of developing learners' conceptualisation of numbers in a set of numerals being learned. Learners were counting in English, instead of using Sepedi, whereas P2 asked learners to count in twos, they also counted the numbers in English. According to Meyer, Rose, and Gordon (2014:122), knowledge is created when learners are actively engaged, not passively absorbing, where not all learners can accomplish this independently.

The teacher also applied the question-and-answer method as a central method in teaching and learning NOR in Grade 3 classrooms. P1 mostly asked learners to build numbers by using their number cards. Even though P1 involved most learners, she did not follow ZPD in guiding learners who were unable to answer the questions correctly. Instead of guiding the learners in finding the correct answer, she asked the class whether the answer is right, and they said that it was wrong or right. She then proceeded to another learner to answer the question. According to ZPD from Vygotsky (1978), learners can solve problems outside their actual development level if they are offered guidance from a more proficient person or able peer. According to CAST's principle of providing multiple means of action and expression (the "how" of learning) (2011:5), learners differ in "how" they learn content, which indicates that the teacher's guidance should have been provided to help those learners who need support. The teacher should have guided the learner by asking why he or she thinks the answer is right or asked the learner to check if the answer was right.

P2 also used the question-and-answer method during her lesson. Unlike P1, P2 did not involve learners showing the answer to the whole class on the chalkboard. Learners were given the answers while sitting in their chairs. The teacher did not involve learners by identifying the numbers from the chart but was using them on the chalkboard. CAST (2011:50) emphasises that learners need multiple means of engagement so that they become motivated to reflect on their own learning. Similarly, Rose and Gordon (2014:122) note that knowledge is created when learners are actively engaged, not passively absorbing and that not all learners can accomplish this independently. Learners should be actively involved during teaching and learning to develop their understanding of the content being taught.

5.4.2.3 Resources on the walls of the classroom

Learning resources and adequate use of resources during teaching and learning encourage positive learning and help learners to understand the concept being taught. Parker and Thomsen (2019:33) postulate that the obtainability of teaching and learning materials makes the subject and every aspect of the lesson much clearer and makes them successful in learning mathematics easily. The researcher observed that different teaching and learning resources in the classrooms of both teachers were displayed on the walls according to their subjects. The researcher noticed that mathematics resources were related to the topic being taught during that day. This is confirmed by what was indicated by Davin (2013), emphasising that creating an environment that is rich with mathematics activities and tools can stimulate learner curiosity. Similarly, UDL emphasises that a learning environment with a variety of learning resources supports the development of effective learning for all. According to Meyer et al. (2014:95), classrooms with learning resources on the walls intrigue learners, providing support for exploration and inquiry, and help learners to think critically while learning.

5.4.2.4 Learner involvement

Learner involvement during teaching and learning is vital for developing understanding of the concepts. P1, during teaching in the classroom, involved all learners because she was not only focusing on the learners who raised their hands, but also on those who were not raising their hands, to answer the questions. This was seen when she asked one learner to go to the chalkboard and use number cards to break 125. The learner used number cards marked 100, 20, and 5. Learner involvement used by P1 followed a strategic network in UDL, which involves motivating and engaging learners in active learning (Meyer, Rose & Gordon, 2014:54). Learners also had their A4 number charts from zero to one hundred, and the learner pointed at 88 from the number chart on the chalkboard.

The teacher needs to find a way to motivate learners when asking questions to participate in teaching and learning. According to Hall et al. (2012:72), good teaching is the art of involvement in discovering what will inspire a learner to learn mathematics and to feel assured in his or her capabilities. Contrary to how P1 involved learners, P2 mostly focused on learners who were only raising their hands. This might cause those learners who did not raise their hands as they did not pay attention or show an interest in learning to be neglected. Teachers need knowledge of strategies to be able to reorganise the understanding of learners (Koponen et al., 2017; Shulman, 1986:9). Excell and Linington (2015:130) elaborate that the teachers should be able to enhance learning opportunities produced by learners. The teacher should always encourage learners, realise their needs and motivate them in taking part in class so that they are not left behind or lose interest in learning.

5.4.2.5 Application of teaching and learning resources

The importance of having the correct teaching and learning resources to encourage learning for all learners cannot be overlooked in teaching mathematics in diverse classrooms. The application of suitable and correct resources enables teachers to accommodate the needs of learners with different learning abilities. P1 used number cards for teaching learners to do addition, using the breaking method. Learners each had number cards from one to nine and ten to ninety, in multiples of ten and a card of one hundred. This concurs with La et al. (2018:8) in UDL's Principle number two when indicating that the application of resources provides different ways of participation.

P2 was teaching learners to identify the number that comes before, between, or after a given number, using a number chart. Each learner had an A4 laminated number chart on the table, while the teacher was using an A3 number chart on the chalkboard. P2 teacher used number charts to help learners understand how numbers followed each other either counting forwards or backward. According to Meyer et al. (2014:101), the principal of UDL emphasises that supporting learners in a meaningful way assists learners to develop their learning skills and eventually becoming experts. Similarly, Alshatri et al. (2019:448) emphasise that the use of teaching aids facilitates the understating of learners in learning mathematics and improving their grade performance.

By using number charts, learners were able to name the number before, the number between, and the number that comes after. This emphasises the findings of Parker and Thomsen (2019:33), who note that learning by using teaching aids makes the subject and every aspect of the lesson very clear and makes them successful in learning mathematics.

5.4.2.6 Classroom assessment

As noted in Chapter Three, Ever (2011:9) and Marinho et al. (2019:188) have indicated that assessment procedures should support teachers and learners in understanding where they have been, where they are, and where they might go next. Both P1 and P2 gave learners small exercises to write as classwork, to see if they understood what they were learning. This supports what Van Den Berg, Bosker and Suhre (2018:341) stated, namely that continuous assessment prevents learners from developing a knowledge gap, and eventually enhances performance if properly administered. However, the assessment given to the learners was not differentiated based on their learning performance. On the contrary, Van Den Berg, Bosker and Suhre (2018:341), emphasise that assessments given to learners should be differentiated, and include different perspectives, to accommodate and provide support to learners who experience learning challenges. The teachers might not have enough time to differentiate their assessment activities since they are teaching four subjects on a daily basis, and they must finish the curriculum provided to them. In addition, P1 did not follow scaffolding as a strategy to assist learners who experience problems while writing classwork (Vygotsky, 1978:88). Similarly, CAST (2011) emphasises that the teacher can apply scaffolding by motivating learners to find keywords and relationships through highlighting them. P2 followed scaffolding as a strategy by moving around, while learners were writing classwork and guided those who experienced difficulties. Learners were given feedback individually as they were bringing the written activity to P2.

5.5 INTERVENTION STRATEGY: GROUP WORK

The researcher, together with P1 of the experimental group, discussed a day after the interview pre-intervention, the strategy that can be applied to enhance learners' performance. As noted in the methodology chapter, identifying the strategy was grounded on the analysis of collected data from the discussion between the P1 and the researcher in the first stage (Pickard, 2013:160; Burns, 2015:190). Based on the way the teacher was applying group work during teaching, both the researcher and the teacher agreed on adjusting the strategy in a way that will accommodate the learning needs of the learners. Baines, Blatchford and Webster (2015:19) emphasise that teachers should support the groups’ capability, rather than leading them to do the activity by supervising, guiding (by asking open-ended questions, presenting suggestions), demonstrating, and strengthening. According to Mallipa (2018:192), group work can help to support learners to learn in efficient ways and give them the capability to learn in their own ways.

The researcher followed a reconnaissance stage (Arnold, 2015:6) by gathering data about the learners' performance in Grade 3 numbers, operations and relationships in mathematics, using unstructured interviews and lesson observations, with the participating teachers from the experimental group and control group. After intensive discussions with P1 and possible changes to presenting the group work strategy applied during teaching and learning, together with the application of resources such as counters and word cards to try to improve learners’ performance in mathematics, we agreed on applying the small group work during teaching and learning. A small group is understood as two to five learners working together to discuss a particular task and to share ideas to generate the solution for a given problem, which incorporates terms such as co-operative learning, shared learning, peer learning, or team learning (Cox & Grove, 2012:33; Kenta, 2017:40). Based on the theory of UDL, teaching and learning should be changed to accommodate or to offer all learners equal chances to access information and to establish their knowledge and skills (CAST, 2011:11).

Prior to the intervention strategy, the teacher was using group work with eight to nine learners from the group (three groups: two groups with nine learners each and the third group with eight learners), where learners were not given roles during group activities. Some of the learners from the groups were not actively participating and were depending on other learners for the answers. Retnowati, Ayres, and Sweller (2017:667) emphasise that the teacher should be aware of the way the groups are structured, including the size, how learners should behave, individual and group responsibilities, monitoring both the process and the outcomes of the group experience. According to Molina et al. (2018:11), an ideal group should be distributed between three to five learners, so that every learner can participate and focus their attention on the assigned activities.

The teacher used most of the activities from the lesson plans that are prepared by the National Education Collaboration Trust (NECT). and some from the DBE books provided for learners. One learner from a group would come and write the answer for their group on the chalkboard, where if the answer was correct, another would do the same without asking how the group arrived at the answer. P1 did not actively engage learners in active questioning to reflect on their own learning to develop mathematical content knowledge (Cotton, 2016:2), by asking the learner or group questions on how they arrived at the answers to the problems. For example, in lesson one, the question done by Group 1 was: "*Thato has 45 marbles and Lerato has 36 marbles. How many marbles do they have altogether*?" The answer from Group 1 was: 45 + 36 = 81, which was correct but the learners from other groups were not encouraged to engage in asking the questions, and even the teacher did not ask the learners to explain how their group arrived at the answer. Instead, she proceeded to the second group by asking them to also write their answer on the chalkboard. Learners should be allowed to demonstrate what they have learned by presenting them in different ways such as writing, explaining the answer to other learners, or demonstrating; this can be transformed to meet acknowledgment patterns and the learning level of the individual to clear any misconceptions if any (CAST, 2011; Hall et al., 2012; Meyer et al., 2014). Providing multiple means of presentation addresses motivation and encourages learner engagement by accommodating varied means of learner response (Molina al., 2018:11). Teaching and learning of NOR, were guided and influenced by following the timetable, as explained: "*we have to teach Maths, Home Language (Sepedi), English First Additional and Life Skills every day so that no subject is left behind.*" This suggests that the teachers are under pressure to ensure that learners do all four subjects to cover the work of the other subjects.

5.5.1 Implementation of group work as intervention strategy

The implementation of group work was done to answer the following research questions: 1) how are teachers applying their teaching strategies to enhance the performance of the Foundation Phase learners in diverse mathematics classes; and 2) what challenges are experienced by teachers when using those strategies in enhancing the performance of FP learners in diverse mathematics classes? Three action research cycles were followed during the implementation to ensure the successful implementation of the intervention strategy. These three action research cycles are discussed in detail below:

The learners from the class were divided into two groups, that is, Group A (26) and Group B (25), that is, (51 in class) and attending every second day due to COVID-19 regulations. During the first cycle, learners from Group A were divided into small groups of five, and only one group with six learners (as those who were attending that day), and the researcher, together with P1, agreed on using the same group for the research study. This was done to reduce the number of learners in a group to see how it would affect their participation if they were few in each group. However, prior the implementation of the intervention strategy, learners were grouped according to their learning abilities.

In the first cycle of the implementation of the intervention strategy, learners were selected by counting numbers from 1 to 5, and learners who counted the same number formed a group (for example, all learners who counted 1 were grouped together, the same as other numbers). The teachers explained to all the learners that they should respect one another, that all learners should participate in the group, and that they should ask each other questions to understand what they are doing, or how to answer questions that are raised (Retnowati et al., 2017:668). While the teacher was teaching, the researcher moved around the groups to determine how learners were interacting with one another. The researcher also observed how the teacher interacted with the learners in the process.

P1 actively involved most of the learners by asking them questions, giving them the opportunity to make sense of the concepts and related support (Schwarzer & Grinberg, 2017:17). The teacher prepared most of the worksheets with mathematical problems that learners were working on. Learners were assigned different roles, so that they could all take part and not wait for others to provide them with answers. The teacher used an example to demonstrate to learners how they should approach their activity. She provided multiple means of engagement by encouraging critical thinking to learners (for examples, the teacher used the question*: "Sipho has 68 marbles. He gives his friend Kagiso 27. How many marbles are left for Sipho?"* The teacher further said: "*How do you think we are going to find the answer? Seeing that learners seemed confused, she said: Are we going to add, or subtract, or multiply or divide the marbles?"* The teacher was guiding learners by giving them explicit instructions and trying to accommodate individual learners (UNICEF, 2014:17) so that they might understand how to solve the problem. Thabiso [pseudonym] said: *"We are going to subtract 27 from 68. The teacher did not say the learner was right or wrong, but instead she asked Thabiso: Why do you think that we are going to subtract the two numbers? Thabiso said that because Sipho gives Kagiso 27 marbles."* The teacher explained to the learners that for the word problems there are always words that guide them on how to work out the answer. The teacher pasted words cards on the chalkboard that explain that the learners should subtract to find the answer from the question that is given when the words such as, left, remaining, or less than are used in the sentence.

Most of the learners experienced a challenge in discussing their activities in English. As noted earlier, the learners started doing mathematics in Grade 3 in English, and the teacher allowed the learners to also speak in Sepedi from their groups to give everyone the opportunity to participate actively. This is consistent with Maluleke (2019:1), who found that home language can be used to clarify some content being learnt in English to teach mathematics in multilingual classes in South Africa. Some learners also found it a challenge to read, as noted prior to the intervention strategy during the interviews with the teachers. However, the teacher tried to accommodate all learners by asking them to read the questions first aloud before distributing the questions to every group, while supporting them where necessary. As noted earlier, P1 and the researcher reflected on the success or failure of the strategy after each cycle to enhance or deepen the understanding of the process of applying group work and its purpose (Pickard, 2013:161; Du Plooy-Cilliers et al., 2014:201: Putman & Rock, 2018:8). The researcher and P1 also realised that some groups had the same abilities while others were mixed.

During the second cycle, the researcher and the teacher, after discussion, agreed that learners would be grouped into mixed learning abilities, so that those who are more knowledgeable will be able to assist the less able (Vygotsky, 1978). The groups were also reduced to three members, except for two groups with four members (total twenty -six learners), to ensure that every learner participated actively during teaching and learning. The teacher used the worksheets that she had prepared and the worksheets from NECT lesson plans to give learners. Unlike in the first cycle, where learners read the questions on their own, the teacher asked learners to repeat the questions after her. P1 asked learners to explain what the question means, for example, the teacher asked questions. The researcher was moving around to check whether learners were reading with the teacher the question.

The teacher was not transferring information to learners but offered them the opportunity to express their understanding (Kortjass, 2019:4). Learners were encouraged to ask questions if they did not understand, and to explain how they found the solution to the problem. While attempting the problems in groups, the researcher moved around the groups to ascertain how they were working in their groups, while the teacher was supporting them by asking them questions. According to Gamlem (2019:3), a supportive learning environment encourages positive learning towards the learners and improves intergroup relations by increasing trust and friendliness. The teacher also supported learners by giving them clues as to how to tackle problems such as “how many are left”, this means they should subtract the numbers to get the answer, “altogether”, they should add the numbers to get the answer (CAST, 2011:32, Hall et al., 2012:81).

In cycle three, the teacher emphasised what she was doing in cycle two, because the approach worked better than in cycle one. The teacher was no longer reading the questions with the learners. because in the second circle, she explained to the learners that they should identify the key words that would assist them in finding a solution to the problem. Teaching should be sensitive during the process of scaffolding or helping the learner to achieve that which is just out of reach, while stepping back w hen the learner can do it on his or her own (Gouws, 2019: 47). All the groups were given the same worksheet with four questions, but each group was expected to complete only one question that they would then present to the class. Two groups were working on the same question and the teacher wanted to see how each group solved the given problem. Each group presented how they solved their question, and the other groups were provided with the opportunity to ask questions and provide clarification in relation to the answers. The teacher allowed each group to explain their answers and then she gave them the support where it was needed. During the interactions, learners respected one another and listened to each other's opinions.

5.6 POST-INTERVENTION LESSON OBSERVATIONS

Post-intervention lesson observation was conducted in order to reflect on the strategy, whether learners were able to participate actively in the group, whether P1 has paid attention to offering learners different ways of presenting the information and knowledge acquired, whether learners were provided with alternative ways (viz., written, oral, presenting to the class, pictures or application of concrete materials) to present what they knew or whether learners' learning interests were captured or motivated during teaching and learning (CAST, 2011: Hall et al., 2012:10). Similarly, Morris (2016:3) emphasises that learners can be given the opportunity to present or demonstrate their understanding of the given problem using written words, pictures, spoken words, gestures, or using tangible material.

5.6.1 The teacher-learner interaction

Data collected during lesson observation revealed that P1 was able to transform information towards well-suited knowledge, that is, the "what" of learning (comprehension of mathematical concepts, operations and relations), in preparing and organising determined procedures in the classrooms, and in motivating and engaging learners in active learning (Meyer, Rose & Gordon, 2014:54). A question-and-answer method was used to link learners' prior knowledge to the new knowledge to understand what they understood about the concepts of NOR. However, prior to the intervention, the teacher did not use questions and answers to support learners' development, or as a form of scaffolding as Vygotsky (1986) argued. Learners would give the answer, and if it is correct, the teacher would continue without perhaps questioning the learner's reasoning skills or understanding. Learners were not given the opportunity to expand their knowledge and understanding by asking each other questions to clarify their answers (Kato, Bolstad & Watari 2016:23). Learners would respond to the question, and if the answer was correct, the teacher would continue to the next group.

CAST (2011:5) proclaims that using multiple representations allows for the conveyance of learning, which happens when numerous representations are employed, because this permits learners to create relationships based on what they are learning. Learners were provided with worksheets, where the first question asked was also written on the chalkboard. Unlike before the intervention, P1 asked learners to read the question on the chalkboard while pointing at each word with a pointer when learners were reading. For example, "*Tshepiso has a packet of sweets with 40 sweets inside. She gives 17 sweets to her friend. How many sweets are left?"* The teacher wanted learners to explain how they would work out the answer to the problem, that is, to articulate the mathematical operation (addition, subtraction, multiplication, or division) they were going to use to find the sweets that are left. Before answering the question, P1 asked learners to identify key words from the question that is guiding them as to how to work out the solution to the problem. Prior to the implementation of the intervention strategy, the teacher did not ask learners to explain how they worked out the solution to the problem.

The teacher actively involved the learners (Rose & Gravel, 2010:7; Rose & Gordon, 2014:14), by allowing them to identify key words that could help them solve the problem. According to Rose and Gravel (2010:7), and Rose and Gordon (2014:14), providing learners with the opportunity to highlight important information allows learners to comprehend the information effectively, and to apply it accordingly. Before the intervention, learners were not given time to identify key words that could help them to understand or to solve the problem. P1 was eager to draw learners' attention to useful information and to demonstrate their understanding of the problem (CAST, 2011:10). She offered advice and scaffolding, through prompting those questions that made them realise where they went wrong, and to rectify their mistakes (Hall et al., 2012:15).

5.6.2 Learner-learner interaction

Learners were grouped into small, mixed learning abilities so that those who are more knowledgeable could assist those who are less knowledgeable. Grouping learners into different abilities provided them the opportunity to work with peers with different abilities, enabling more diverse learning experiences and motivation to learn (University of Suffolk, 2019:4). Each group consisted of three learners and the teacher provided them with guidance as to how each learner should take part in teaching and learning. Abubakari (2020:25) postulates that grouping learners assists in improving their performance, while narrowing the gap that might exist between learners of different abilities. The teacher encouraged learners to work together and to participate actively during the lesson, by giving them problems to solve together.

Each group was given enough counters to use for the activities. The teacher encouraged learners to work out the solution to the problems practically in their groups, before writing on the chalkboard. This supports the findings of Cox and Grove (2012:33), who have noted that small groups encourage learning by doing, learning by trial and error in a safe environment, learning through interaction, and learning as communication and teamwork. Learners were not sitting passively and listening to the teacher, but they were demonstrating their understanding, by practically solving the problem with their number cards in groups, and on the chalkboard. Cohen and Lotan (2014:2) state that giving learners group tasks allows them to struggle on their own and make errors, and it makes learners responsible for specific parts of their work.

5.6.3 Teacher-group interaction

The results obtained from the lesson revealed that the teacher was able to create the mathematics inquiry classroom by building trust and encouraging positive engagement during teaching and learning mathematics (Steyn & Adendorff, 2020:40).

The teacher encouraged all the learners to share their ideas and to listen to each other, without any interruption, so that they could understand their ideas during the post intervention teaching strategy lesson observation.

The teacher moved around the different groups as learners were discussing the solutions to the problems, gauging their understanding, noting the use of their mathematics vocabulary, and their conception of the mathematics operation to be applied. The teacher observed the learners' behaviour from their groups and encouraged them by praising their positive participation and their creative thinking (Molina, Pushparatnam, Rimm-Kaufman & Ka-Yee Wong, 2018:11). According to Gamlem (2019:5), one characteristic of positive classroom ethos involves expressing respect and kindness toward all the learners. The teacher checked each group's understanding, offering appropriate support and appropriate feedback where needed.

5.6.4. Group-group interaction

The group work method followed the method of writing on the chalkboard and explaining to the whole class how the group arrived at the answer. Since there were eight groups, the teacher gave each group a worksheet that she had prepared with four questions. Each group worked on one question, but groups 1 and 5 did question 1, groups 2 and 6 did Question 2, groups 3 and 7 did Question 3, while groups 4 and 8 did Question 4, in their respective groups. P1 encouraged all learners to ask each group the questions related to their answer to understanding how they found the solution to the problem, and other members from the group presenting were all required to participate in answering the questions. According to Vygotsky (1978), encouraging social communication in the classroom helps the learners to share ideas, develops their language, and increases their confidence.

Learners from different groups took part by asking the group that presented their results how they arrived at the answer. The teacher noted that, by encouraging the groups to ask each other questions, she hoped that learners would learn from each and to respect each other's ideas. Allowing interaction between the groups gives learners the opportunity to borrow knowledge from the other groups and reorganised links to present knowledge, with prior knowledge stored up in their long-term memory

(Retnowati et al., 2017:668; University of Suffolk, 2019:4). The learners were able to share knowledge on how to solve word problems from NOR related to addition and subtraction, and they were able to use the counters to help them find the answers, unlike before the application of the intervention strategy. This is consistent with Parker and Thomsen (2019:34), who note that using different resources and real objects when teaching different numbers helps learners to improve their understanding and performance.

Group 1 presented the answer to the question: "*Lesedi's group have a bag of oranges to raise the funds for their class. The bag has 60 oranges. In the morning they sold 16 oranges and during lunch break they sold 38 oranges. How many oranges are left?* Group 1 said that they worked out the answer as follows: 60 – 16 = 44 and then 44 – 38 = 6 (using the counters to find the answer). Group 1 said that they subtracted 16 from 60 first, because the group sold 16 oranges first and found 44, then they again subtracted 38 from 44 to find the answer of 6. Unlike Group 1, Group 5 noted that they worked the answer as: 16 + 38 = 54 and 60 – 54 = 6. They explained that they added the oranges that were sold together that is, 16 + 38 = 54, then subtracted what the group sold from the oranges that Lesedi's group came with in the morning, that is, 60 – 54 = 6. The findings from the explanations from the two groups revealed that learners have different ways of solving problems and reasoning skills. This is consistent with Mutara (2016:241), who notes that learners need to understand that finding the correct answer is not the only objective, however, discussing different ideas, questioning, and simplifying each other's strategy and creating a common understanding constitute essential learning objectives, where all learners should invest time and effort in this process (Mutara, 2016:241). Similarly, Gamlem (2019:2) notes that learners who are engaged in mathematical argumentation, write in the manner that show their reasoning to one another, and to their teacher.

5.6.5 Teaching and learning resources

The use of teaching and learning resources were emphasised and there were enough counters, since P1 asked learners to always bring bottle caps in so that they can use them in the classroom. Hall et al. (2011:81) emphasise that teaching and learning resources give every learner reasonable accessibility to learning opportunities through material and activities in numerous arrangements and multiple means for engagement, expression, and learning. The teacher mostly gave learners worksheets sourced from the NECT lesson plans that she had prepared to write in their exercise books. These were mostly used during teaching and learning to work out the solution to problems. CAST (2011:22) states that textbooks or workbooks layout offers inadequate methods of navigation or practical representation, such as handwriting, in spaces supplied that may create barriers and discourages navigation and interaction for some learners during writing.

The workbooks were also utilised where the activities relevant to the lesson being taught are available. The teacher would pick any question from the worksheet and ask learners, "*Thabo has 56 pan cakes in her lunch boxes to sell at school. In the morning she sold 14 and during break she sold 28. How many pan cakes are left?"* P1 realised that learners sometimes required challenging questions that would develop their critical thinking to understand that teaching aids facilitate the understating of learners in learning mathematics and improving their performance (Alshatri, Wakil, Jamal & Bakhtyar, 2019:448).

5.6.6 Classroom assessment

P1 gave learners classwork and homework after every lesson in order to assess their understanding and monitor their progress in learning NOR concepts. Assessment should be done to support teachers and learners in understanding where they have been, where they are, and where they might go next (Ever, 2011:9; Marinho et al., 2019:188). Even though learners were working in groups during teaching and learning, as before the intervention, each learner had to write classwork in his or her exercise book after every lesson. The teacher prepared some of the worksheets for classwork activities, however, for homework, she mostly used the activities from DBE. This was unlike the previous process, where the intervention saw P1 mostly use the activities from NECT lesson plans for classwork and for homework only the DBE book was utilised. The teacher moved around to assist learners who were experiencing problems and to ensure that they were writing the classwork. Vygotsky and CAST (2011:25) emphasise that the teacher should offer advice and scaffold learners towards emerging new skills intended for setting effective objectives. Maghfirah and

Mahmudi (2018:6) supported that the teacher should provide a supportive learning environment through ongoing assistance. Even though the teacher was giving individuals feedback while marking the books of those who finished fast, she also gave feedback to the whole class so that they might understand where they had made mistakes.

5.7 PARTICIPANT 1 UNSTRUCTURED INTERVIEW AFTER INTERVENTION STRATEGY

The unstructured interview with Participant 1 was conducted immediately after classroom observation of the intervention strategy. Due to COVID-19 regulations and the way in which learners were attending, two lesson observations were conducted after the intervention strategy, because the group was attended two days since they had to do continuous assessments. The transcripts below are the examples from the unstructured interview with P1 of the experimental group to create the insights about the benefits of the intervention strategy.

Transcript 1: Do you think group work was implemented according to your plan and why?

> P1: *Yes, learners were grouped according to different levels of performance (mixed abilities) in threes (six groups) and two groups in fours, due to the number of learners in class (26 learners attending), so that they are able to assist each other where possible*. *Previously, I used to put learners in groups of eight to ten and it was not easy to manage. The use of resources and assigning roles to the group members assisted in encouraging positive participation for all learners from the groups.*

The extract from the P1 above describes that putting learners into small groups facilitated teaching and learning of mathematics in the classroom. Kenta (2017:44) state that allowing learners to work together in small groups to solve problems and share ideas not only leads to a more profound learning and understanding; it also shapes the critical teamwork abilities that employ a desire to learn. P1 also noted: " *Previously I used to put learners in groups of ten and it was not easy."* This indicates that large groups are no easier to manage than smaller groups and it is also important to assign a role to each member of the group so that they all participate actively. La et al. (2018:8) support the fact that assigning role and multiple means of engagement link learners' welfare, backing self-reflection of learning and adopting teamwork with different levels of learning, lead to active involvement in learning. Working in small groups encourages communication among the learners and reduces peer competition and isolation (Cohen & Lotan, 2014:5; Backer, Miller & Timmer, 2018:4).

The interview also revealed that the use of resources during teaching and learning encourages positive involvement. This was confirmed by P1 thus: "*The use of resources such as counters and number cards and assigning roles to the group members assisted in encouraging positive participation for all learners from the groups".* As noted earlier, Cox and Grove (2012:33) stipulate that small groups and the use of resources encourage learning by doing, learning by trial and error in a safe environment, learning through interaction, as communication and teamwork. Learners should be encouraged to work together so that they develop different learning skills and to use resources to understand what they are learning.

Transcript 2*:* Do you think that group work is appropriate for teaching mathematics, and did it work in the diverse classrooms and why?

> P1*: Yes, I think it is appropriate in teaching mathematics, because I was able to attend to learners who experienced problems was easy and even from the groups some were able to help each other to solve the problems. Changing the members of the group after completing a topic worked because it helped learners to understand each other and to be able to work together actively.*

The interview results revealed that group work helped the teacher to attend to learners who experienced challenges during teaching and learning. According to Vygotsky (1978), group work allowed the teacher to scaffold less competent learners so that they can achieve beyond their capabilities. The teacher saw group work as an important strategy, because it encourages social interaction, learners' cognitive development occurs, and not all learners can accomplish this independently. Some can perform better when assisted by their peers or their teachers (Meyer et al., 2014:122). Furthermore, learners shared resources, treated each other with respect, supported each other and behaved well towards each other during teaching and learning (Letseka, 2016:6; Müller, Eliastam & Trahar, 2019:26).

The interview results also revealed that changing the groups frequently assist learners in understanding each other and to learn from each other. CAST (2011:31) postulated that changeable rather than static grouping permits improved differentiation and various roles, as well as delivering prospects to acquire how to work most successfully with others. This indicates that changing groups also assists the teacher in varying teaching and learning activities by integrating discussions in the classrooms and the application of resources support learners to understand their learning (La et al., 2018:11).

Transcript 3: Do you think group work can be used in future for teaching mathematics in diverse classrooms?

> *P1: I think it can be used because it encourages interaction among the learners. And small groups help learners to participate actively, respect each other and to learn from each other.*

Based on the statement from P1, small groups develop communication among the learners. According to Meyer, Rose and Gordon (2014:122), knowledge is created when learners are actively engaged, not passively absorbing. This implies that if groups are large, some learners end up not participating actively. Maghfirah and Mahmudi (2018:3) proclaim that groupwork assists in addressing common classroom management problems such as keeping learners involved with their work and developing skills of working together. If learners can work together and respect one another during teaching and learning, it will promote diversity and to accept other learners for who they are. Similarly, Cohen and Lotan (2014:6) emphasise that working in small groups improves intergroup relations by increasing trust and friendship, they learn creative problem-solving skills and develop academic language proficiency.

Transcript 4: What do you think can be the challenges of using group work in teaching mathematics?

> P1*: I think the challenge is that if learners are many in class, groups end up being large in numbers and some learners will sit and not do the work. Large groups make it difficult to identify learners who experience problems and to support effectively.*

Researcher: What do you think could be done to address the challenges?

> P1: *If there can be Education Assistance (EA) to assist us in classes, it will be easy to identify learners with learning difficulties. The EA monitors learners who write faster in class while I work with the ones who write slowly and check if all of them have learning difficulties or some just write slow but do not experience learning difficulties.*

Teaching in large classes can be challenging to teachers because it does not allow them to form small groups in their classes. Teachers also experience challenges of identifying learners with learning difficulties due to the large number of learners in their classrooms. This was revealed by P1 when saying: "*if learners are many in class, groups end up being large in numbers and some learners will sit and not do the work."* This might result in some learners getting bored in class and not performing well. On the contrary, Small (2017:17) proclaims that the teacher should create a learning atmosphere that provide learners with the opportunity to engage with each other and with him or her.

Some learners experience barriers to learning because they are not successfully supported during teaching and learning. P1 pointed out that large groups make it difficult for teachers to recognise and support learners with learning challenges. This indicates that EAs can assist teachers in their classes so that teachers can have time to support learners who experience learning difficulties. Some learners require special attention from the teacher to be accommodated into teaching and learning so that they are not left behind. CAST (2011:32) postulated that learners are required to be offered support so as to be able to deal with hindrances and to side-step nervousness during the process of achieving their objectives. Supporting learners who experience learning difficulties at all times will encourage positive involvement in class and help to improve learner performance.

5.8 POST-TEST ANALYSIS

The results generated from the post-test are discussed below in relation to the objectives of the research, with the aim of exploring group work in Grade 3 numbers, operations, and relationships. The data collected from the post-test followed categories of learners' responses for analysis. Didis and Erbas (2015:1141) and Makgakga's (2016:115) techniques were applied in the pre-test results: Correct Answers (CA), Partially Answered (PA), Wrong Answers (WA), Number Reversal (NR) or Wrong Spelling (WS) and Not Answered (NA).

Table 5. 7: Distribution of learners' responses to Q1 and Q3 post-test

QUESTIONS	GROUPS	POST-TEST									
		CA		PA		WA		WS/RN		N/A	
Q1	Experimental	33	60.0%	13	23.6%	3	5.5%	6	10.9%	0	0%
	Control	27	48.5%	17	25.0%	24	35.3%	0	0%	0	0%
Q3	Experimental	16	29.1%	11	20.0%	28	50.9%	0	0%	0	0%
	Control	11	16.2%	21	30.9%	36	52.9%	0	0%	0	0%
Total	**Experimental**	**49**	**44.5%**	**24**	**21.8%**	**31**	**28.2%**	**6**	**5.5%**	**0**	**0%**
	Control	**38**	**27.9%**	**38**	**27.9%**	**60**	**44.1%**	**0**	**0%%**	**0**	**0%**

The results in Table 5.7 shows that the percentages for CA ranges from 29.1% to 60.0% for the experimental group, and 16.2% to 48.5% for the control group. The experimental group showed an improvement for CA in Q1 by obtaining 60.0%, as compared to the 48.5% of the control group. However, both groups performed poorly in Q3 by obtaining 50.9% experimental and 52.9% control of WA. This indicates that learners still lack conceptual understanding to comprehend mathematical concepts, operations, and relations (Kilpatrick et al., 2001:5). According to NCTM (2020a:7), learners lack conceptual understanding to be able to look forward and backward along mathematical perspectives. Learners who can count numbers should be able to identify the number between, one more, or one less. The percentages of WA for experimental and control groups indicate that learners still need to establish the relationship between the number and the name given to it and to be able to make sense of numbers (Adler, 2017:1).

Table 5. 8: Distribution of learners' responses to Q4 post-test

QUESTIONS	GROUPS	POST-TEST									
		CA		PA		WA		WS/RN		N/A	
Q4	Experimental	18	32.7%	15	27.3%	22	40.0%	0	0%	0	0%
	Control	15	22.1%	14	20.6%	39	57.3%	0	0%	0	0%
	Experimental	**18**	**32.7%**	**15**	**27.3%**	**22**	**40.0%**	**0**	**0%**	**0**	**0%**
Total	**Control**	**15**	**22.1%**	**14**	**20.6%**	**39**	**57.3%**	**0**	**0%**	**0**	**0%**

Table 5.8 above shows that CA for learners ranges from 32.7% and 22.1% for experimental and control groups, respectively. The findings for PA displayed 27.3% for the experimental group and 20.6% for the control group. Higher percentages are shown for the WA at 40.0% for the experimental group and 57.3% for the control group. Higher percentages of WA for both groups indicate that learners do not yet comprehend the concepts and procedures (Kilpatrick et al., 2001:117), such as place values and values of a digit from a number. Furthermore, it also indicates that learners still lack the basic understanding of the number concepts (CAST, 2011).

Table 5. 9: Distribution of learners' responses to Q2 and Q7 post-test

QUESTIONS	GROUPS	POST-TEST									
		CA		PA		WA		WS/RN		N/A	
Q2	Experimental	23	41.8%	7	12.7%	15	27.3%	3	5.5%	7	12.7%
	Control	15	22.1%	15	22.1%	37	54.4%	0	0%	1	1.5%
Q7	Experimental	35	63.6%	0	0%	19	34.6%	0	0%	1	1.8%
	Control	50	73.5%	0	0%	18	26.5%	0	0%	0	0%
	Experimental	**58**	**52.7%**	**7**	**6.4%**	**34**	**30.9%**	**3**	**2.7%**	**8**	**7.3%**
Total	**Control**	**65**	**47.8%**	**15**	**11.0%**	**55**	**40.4%**	**0**	**0%**	**1**	**0.7%**

The results from data collected in Q2 from Table 5.9 above show that the experimental group obtained 41.8% and the control group was 22.1% for CA. More learners were able to identify the smallest and the biggest number in Q2 as compared to the WA answers of 27.3% for the experimental group. The responses of the control group in Q2 for WA were 54.4% as compared to the CA of 22.1%, which indicate that most learners still experience difficulties in identifying the smallest and biggest numbers. However, the percentages for Q7 of 63.6% and 73.5% for experimental and control groups respectively showed that most learners were able to recognise numbers from zero to at least one hundred. This suggests that most learners have adequate skills to interpret and arrange number in order up to one hundred (Sharma & Verma, 2017:22298).

Table 5. 10: Distribution of learners' responses to Q5, Q6 and Q8 post-test

QUESTIONS	GROUPS	POST-TEST									
		CA		PA		WA		WS/RN		N/A	
Q5	Experimental	34	61.8%	6	10.9%	15	27.3%	0	0	0	0
	Control	30	44.1%	7	10.3%	31	45.6%	0	0	0	0
Q6	Experimental	19	34.5%	30	54.6%	6	10.9%	0	0	0	0
	Control	24	35.3%	28	41.2%	16	23.5%	0	0	0	0
Q8	Experimental	42	76.4%	8	14.5%	5	9.1%	0	0	0	0
	Control	42	61.8%	17	25.0%	9	13.2%	0	0	0	0
	Experimental	**95**	**57.6%**	**44**	**26.7%**	**26**	**15.8%**	**0**	**0**	**0**	**0**
Total	**Control**	**96**	**47.1%**	**52**	**25.5%**	**56**	**27.4%**	**0**	**0**	**0**	**0**

The results in Q5, Q6 and Q8 revealed that knowledge in breaking numbers, identifying numbers from base ten blocks and building number from different values have improved. Learners' responses for CA were 61.8% and 44.1% in Q5 for experimental and control groups respectively, and 76.4% and 61.8% in Q8 for experimental and control groups. Even though in Q6 the experimental group received 34.5% and control group 35.3%, WA for learners in both groups were not higher. The WA of 10.9% for experimental group and 23.5% for both control group suggest that a few learners still lack the ability to make connections between the relationship of different digits from a number and their quantity (Sharma & Verma, 2017:22298). Learners lack knowledge of using base ten blocks to make connections to the numbers they represent for the development of conceptual understanding (NCTM, 2020a:9).

Table 5. 11: Distribution of learners' responses to Q9 and Q10 post-test

QUESTIONS	GROUPS	POST-TEST									
		CA		PA		WA		WS/RN		N/A	
Q9	Experimental	11	20.0%	31	56.4%	13	23.6%	0	0	0	0
	Control	12	17.6%	38	55.9%	12	17.6%	1	1.5%	5	7.4%
Q10	Experimental	15	27.3%	27	49.1%	10	18.2%	0	0%	3	5.5%
	Control	0	0%	39	57.4%	26	38.2%	0	0%	3	4.4%
	Experimental	**26**	**23.6%**	**58**	**52.7%**	**23**	**20.9%**	**0**	**0%**	**3**	**2.7%**
Total	**Control**	**12**	**8.8%**	**77**	**56.6%**	**38**	**27.9%**	**1**	**0.7%**	**8**	**5.9%**

The results from Table 5.11 above for Q9 depicts that learners still lack conceptual knowledge to show their understanding that addition and subtraction are the reverse operations of each other. The CA for the experimental group was 20.0%, and 17.6%. for the control group. The highest percentages for learners in both Q9 and Q10 were shown in PA, which were 56.4% for the experimental group, and 55.9% for the control group in Q9, while the experimental group obtained 49.1% and 38.2% for PA in Q10. However, the percentages for the CA were not pleasing for the experimental group, which were 20.0% for the experimental group, and 17.6% for the control group in Q9. Additionally, in Q10, the experimental group obtained 27.3%, while the control group obtained zero percent. Most learners still lack knowledge to understand that addition and subtraction are inverse operations, and that there are different ways of doing the sum to get the same answer (Kilpatrick, 2001:76).

The results in Q10 from Table 5.11 above for the control group suggest that most learners lack strategic networks to generate the strategy to solve problems (CAST, 2011). However, the higher percentages in Q9 and Q10 for PA indicate that most learners are developing procedural fluency and are expanding their comprehension of mathematical concepts or interpreting mathematical questions to find the solution to the problem (Math Assessment Resource Service, 2017:5). Higher percentages for both experimental and control groups in PA suggest that most learners' knowledge and capability to employ the mathematical procedures in problem solving; reason and communicate, still need to be developed to achieve better results (NCTM, 2020b:16).

5.9 STATISTICAL ANALYSIS

The descriptive analysis of data collected from both pre-test and post-test are presented below in relation to the objectives of the study. Excel was used for data management, and Stata Release 15 was used for statistical data analysis. T-test was used to compare the two study groups, the experimental and the control groups. The results were interpreted at 95% confidence limit (2-sided). In other words, the results were declared significant if the p-value was less than 0.05.

Note:

- If $p < 0.05$ results are significant

- If $p \geq 0.05$ then the results are not significant

5.9.1 Analysis of pre- and post-tests results

The analysis of the pre- and post- tests are deliberated separately per question, Q1 to Q10, by comparing the Mean ($\bar{x}$) score testing the statistical significance between the two groups.

Table 5. 12: Analysis of pre- and post-tests results to Q1: Stata Release 15 and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion
Question 1	Pre-Test	Control	74	0.8918919		
		Experimental	57	0.9473684		
		Combined	131	0.9160305	0.7129	**No significant**
	Post-Test	Control	68	1.264706		
		Experimental	55	1.454545		
		Combined	123	1.349593	0.1972	**No significant**

The analysis for the results of Q1 revealed that there was no significant difference in the performance of control and experimental groups in Q1 in the pre-test ($p - value = 0.7129$), which is greater than 0.05 at 95% confidence limit (two-sided). This suggests that learners from both control and experimental groups struggled in writing the given numbers in words. However, the experimental group performed better as compared to the control group, as it recorded higher ($\bar{x} = 0.9473684$) in Q1.

The outcomes from the post-test also displayed that there was no significant difference in performance of control and experimental groups, with the ($p - value = 0.1972$), which is also greater than 0.05 at 95% confidence limit. The control and experimental groups showed some improvement from the post-test as compared to the pre-test, as they each recorded the ($\bar{x} = 1.264706$) and ($\bar{x} = 1.454545$) respectively, which is higher than the pre-test mean scores. This suggests that learners in both groups showed a slight improvement in writing the given numbers in words.

The experimental group, however, recorded the higher scores ($\bar{x} = 1.454545$) in the post -test, which disclosed an improved scores as compared to the pre-test results ($\bar{x} = 0.9473684$) For this reason, the intervention strategy might had improved the experimental group's mean, as learners performed better in the post-test as compared to the pre-test. Therefore, there is a significant difference between the pre-test and the post-test when using teaching strategies employed in the experimental group.

Table 5. 13: Analysis of pre- and post-tests results to Q2: Stata Release and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion
Question 2	Pre-Test	Control	74	0.7567568		
		Experimental	57	0.7192982		**No significant**
		Combined	131	0.740458	0.7963	
	Post-Test	Control	68	0.9117647		
		Experimental	55	0.9636364		**No significant**
		Combined	123	0.9349593	0.7453	

The results in Table 5.13 above for Q2 in the pre-test showed that there was no significant difference between the control group and the experimental group, namely $(p-value\ =\ 0.7963)$, which is greater than 0.05 at 95% confidence limit (2-sided). Even though the control group recorded the higher mean $(\bar{x}\ =\ 0.7567568)$ than the experimental group $(\bar{x}\ =\ 0.7192982)$, the difference between the two groups was too limited to produce the significant difference in Q2. The higher mean from the control group showed that learners' performance has improved even though they were not exposed to the intervention strategy. The outcomes revealed that both groups struggled in writing the given numbers in words.

The analysis of the outcomes in Q2 after the post-test also yielded no significant difference between the two groups for Q2 with the $(p-value\ =\ 0.7963)$, greater than 0.05 at 95% confidence limit. The control and experimental groups' performance from the post-test showed a slight improvement, with the $(p-value\ =\ 0.7453)$ greater than 0.05. However, the experimental group obtained $(\bar{x}\ =\ 0.9636364)$, slightly higher than the control group $(\bar{x}\ =\ 0.9636364)$, which indicates some improvement from the experimental group.

The experimental group recorded a higher score $(\bar{x}\ =\ 0.9636364)$ from the post-test as compared to $(\bar{x}\ =\ 0.7192982)$ from the pre-test, which indicates learners' improvement in identifying the smallest and biggest numbers. Therefore, the intervention strategy had an impact on the experimental group, as the experimental group performed higher in the post-test as compared to the pre-test.

Table 5. 14: Analysis of pre- and post-tests results to Q3: Stata Release 15 and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion
Question 3		Control	74	0.5135135		
		Experimental	57	0.9649123		**Significant**
	Pre-Test	Combined	131	0.7099237	0.0120	
		Control	68	1.058824		
		Experimental	55	1.127273		**No significant**
	Post-Test	Combined	123	1.089431	0.7492	

The results for the pre-test in Q3 showed that there was a significance difference between control and experimental groups $(p-value = 0.0120)$, at less than 0.05. The experimental group recorded a significantly higher score $(\bar{x} = 0.9649123)$ than the control group $(\bar{x} = 0.5135135)$, which suggests poor performance of the control group in identifying the number between the two given numbers, the number that is one more than a given number and the number that is one less than a given number.

The results in Table 5.14 above for the post-test illustrates that there was no significant difference in Q3 for both groups $(p-value = 0.7495)$, which is greater than 0.05. However, both groups showed improvement in their mean in the post-test, as compared to the pre-test's mean. In particular, the experimental group showed a higher score $(\bar{x} = 1.127273)$ than the control group score $(\bar{x} = 1.058824)$.

The experimental group recorded a high score from the post-test result $(\bar{x} = 1.127273)$ as compared to the pre-test results score $(\bar{x} = 0.9649123)$, which suggest that the intervention strategy in the experimental group had a positive impact.

Table 5 15: Analysis of pre- and post-tests results to Q4: Stata Release 15 and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion
		Control	74	0.7027027		
		Experimental	57	0.6140351		**No significant**
	Pre-Test	Combined	131	0.6641221	0.5047	
		Control	68	0.75		

Question 4		Experimental	55	0.9272727		**No significant**
	Post-Test	Combined	123	0.8292683	0.2271	

The results from Table 5.15 above showed that in the pre-test, the performances of the control and experimental groups were not significantly different *(p – value* = 0.5047*)*, greater than 0.05 at 95% confidence limit. However, the higher score *(*$\bar{x}$ = 0.7027027*)* for the control group than experimental group *(*$\bar{x}$ = 0.614035*)* was not enough to yield the significant difference. The lower mean score for the experimental group suggests that learners struggled in identifying the number value of the underlined digit from the given numbers.

The analysis of the findings from the post-test revealed that the control and experimental groups' performances were not significantly different *(p – value* = 0.2271*)*, higher than 0.05. However, the experimental group scored higher *(*$\bar{x}$ = 0.9272727*)* than the control groups *(*$\bar{x}$ = 0.75*)* in the post-test in Q4. The findings revealed that the experimental group showed improvement when compared to the control group.

Furthermore, the experimental group displayed improvement from the post-test results, with *(*$\bar{x}$ = 0.9272727*)*, as compared to the pre-test results with *(*$\bar{x}$ = 0.6140351*)*. This suggests that the intervention strategy had enhanced the experimental group's performance in the post-test in identifying the number value of the underlined digit from a given number.

Table 5. 16: Analysis of pre- and post-test results to Q5: Stata release and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion
Question 5		Control	74	1.135135		
		Experimental	57	0.9649123		**No significant**
	Pre-Test	Combined	131	1.061069	0.2988	
		Control	68	0.8823529		
		Experimental	55	1.327273		**Significant**
	Post-Test	Combined	123	1.081301	0.0071	

The results from Table 5.16 above indicates that in the pre-test, the control and experimental groups' performances were not significantly different $(p-value = 0.2988)$, greater than 0.05 at 95% confidence limit. The higher mean of the control group $(\bar{x} = 1.235135)$ in Q5 showed that the control group performed better than the experimental group $(\bar{x} = 0.9649123)$ in Q5. The results suggest that the experimental group struggled in breaking the given number, according to their number value, as compared to their control group.

The experimental group in post-test scored higher $(\bar{x} = 1.327273)$ than the control group $(\bar{x} = 0.8823529)$ in Q5. The analysis of the post-test results in Q5 yield a significance difference $(p-value = 0.0071)$, at less than 0.05 at 95% confidence limit. The results of the control group from the post-test revealed a decline in performance, whereas the experimental group showed improvement.

The results from Table 5.16 further revealed that the experimental group's score in the pre-test $(\bar{x} = 0.9649123)$ improved in the post-test $(\bar{x} = 1.327273)$, which suggests that the intervention strategy had an influence in the experimental group in breaking the numbers into different values.

Table 5. 17: Analysis of pre- and post-tests results to Q6: Stata Release 15 and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion
Question 6		Control	74	1.121622		
		Experimental	57	1.175439		**No significant**
	Pre-Test	Combined	131	1.145038	0.7883	
		Control	68	1.470588		
		Experimental	55	1.745455		**No significant**
	Post-Test	Combined	123	1.593496	0.1545	

Analysis of the findings for the pre-test in Q6 above, display that there was no significance difference between the control and experimental groups $(p-value = 0.7883)$. The experimental group recorded a higher mean $(\bar{x} = 1.175439)$ as compared to the control group $(\bar{x} = 1.121622)$ in the pre-test. Even though the experimental group recorded the higher mean than the control, both groups seem to be struggling in identifying and writing the number sentence represented by base ten blocks.

The results in Table 5.17 above further displayed that there was no significant difference from the post-test $(p-value = 0.7883)$, greater than 0.05, for both control and experimental groups in Q5. However, the experimental group presented higher development in the post-test as compared to the control group.

Though the results did not show a significant difference between the two groups from the post-test, the experimental group showed some improvement in the post-test score ($\bar{x}$ = 1.745455) as compared to the pre-test score ($\bar{x}$ = 1.175439). The results showed learners' improvement in identifying the numbers represented by base ten blocks.

Table 5. 18: Analysis of pre- and post-tests results to Q7: Stata Release 15 and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion
Question 7	Pre-Test	Control	74	0.4864865		
		Experimental	57	0.4736842		**No significant**
		Combined	131	0.480916	0.8888	
	Post-Test	Control	68	0.7647059		
		Experimental	55	0.6181818		**No significant**
		Combined	123	0.699187	0.0793	

The data in Table 5.18 for Q7 indicates that there is no significant difference $(p-value = 0.8888)$ between the performances of the control and experimental groups in the pre-test. The experimental group recorded lower mean scores than the control group in the pre-test in Q7 with the mean score of $(\bar{x} = 0.4736842)$ and $(\bar{x} = 0.4864865)$, respectively. This suggests that both groups struggled in sequencing the numbers from the smallest to the biggest.

The post-test analysis results for Q7 also revealed that there was no significant different $(p-value = 0.0793)$, greater than 0.05. The mean score of the experimental group $(\bar{x} = 0.6181818)$ was lower than for the control group $(\bar{x} = 0.7647059)$ after the intervention strategy. However, the results revealed a slight improvement for both experimental and control groups.

Though the analysis of the results from the experimental group displayed some improvement from the post-test score ($\bar{x} = 0.6181818$) as compared to the pre-test ($\bar{x} = 0.4736842$), the results suggest that learners are still struggling in writing the numbers from the smallest to the biggest from Q7 after the application of the intervention strategy.

Table 5. 19: Analysis of pre- and post-tests results to Q8: Stata Release 15 and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion
Question 8		Control	74	0.8108108		
		Experimental	57	1.245614		**Significant**
	Pre-Test	Combined	131	1	0.0045	
		Control	68	1.529412		
		Experimental	55	1.672727		**No significant**
	Post-Test	Combined	123	1.593496	0.2350	

The analysis of the results in Table 5.19 for Q8 in the pre-test presented the statistically significant difference between the control and experimental groups ($p-value = 0.0045$), less than 0.05. The experimental group scored a higher mean than the control group, which yielded the significant difference in Q8. The results revealed that learners in the experimental group were able to add different value numbers to build a three-digit number.

The information subsequent the intervention strategy in the post-test for Q8 designated no significant difference between the control and experimental group ($p-value = 0.2350$), greater than 0.05. Even though the experimental group recorded the higher score ($\bar{x} = 1.672727$) as compared to control group ($\bar{x} = 1.529412$), the score was not high enough to yield a significant difference between the two groups. However, both experimental and control groups displayed improvement from the post-test results.

The outcomes further revealed that the experimental group from the post-test scored ($\bar{x} = 1.672727$)as compared to the pre-test ($\bar{x} = 1.245614$). The findings revealed that the experimental group performed better from the post-test than they did from the pre-test, which suggests that the intervention strategy had some effect in enhancing learners' performance in the post-test.

Table 5. 20: Analysis of pre- and post-tests results to Q9: Stata Release 15 and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion
Question 9		Control	74	0.972973		
		Experimental	57	2.052632		**Significant**
	Pre-Test	Combined	131	1.442748	0.0004	
		Control	68	2.441176		
		Experimental	55	2.890909		**No significant**
	Post-Test	Combined	123	2.642276	0.2240	

The findings before the intervention strategy for Q9 in the pre-test from Table 5.20 above revealed that there was a significant difference between the control and the experimental groups $(p-value = 0.0004)$, at less than 0.05. The experimental group scored a higher mean $(\bar{x} = 2.052632)$ as compared to the control group $(\bar{x} = 0.972973)$, which was enough to yield the significance difference in the pre-test. The pre-test outcomes displayed that the experimental group performed better in using subtraction as the reverse operation of addition from the given numbers.

The results from the post-test between control and experimental groups for Q9 revealed that there was no significance difference $(p-value = 0.2240)$ greater than 0.05. However, the performance of the two groups in the post-test improved, even though the score did not yield the significance difference between the two groups.

The experimental group exhibited some improvement from the post-test score $(\bar{x} = 2.890909)$ as compared to the pre-test score $(\bar{x} = 2.052632)$, which suggests that for the experimental group, the intervention strategy improved learners' performance in recognising the relationship between addition and subtraction as inverse operations in number concepts.

Table 5. 21: Analysis of pre- and post-tests results to Q10: Stata Release 15 and T-test (Excel)

Item	Setting	Group	Obs	Mean	p-value	Conclusion

Question 10		Control	74	0.5205479		
		Experimental	57	1.017544		
	Pre-Test	Combined	131	0.7384615	0.0001	**Significant**
		Control	68	0.5		
		Experimental	55	1.036364		
	Post-Test	Combined	123	0.7398374	0.0000	**Significant**

Table 5.21 indicates that in the pre-test, the control and experimental groups' performances were significantly different ($p-value = 0.0001$), at less than 0.05. In particular, the experimental group scored a higher mean ($\bar{x} = 1.017544$) as compared to the control group ($\bar{x} = 0.5205479$), which yielded the significance difference for Q10 in the pre-test. The results suggest that the experimental group performed better in solving the word problem as compared to the control group.

The results further revealed that there was a significance difference between the control and experimental groups ($p-value = 0.0000$) from the post-test, at less than 0.05. The results showed a slight increase in performance of the experimental group, which scored ($\bar{x} = 1.036364$) as compared to the control group, revealing a slight decline to the score of ($\bar{x} = 0.5$).

The experimental group from the post-test results showed the slight improvement score of as compared to the pre-test score ($\bar{x} = 1.017544$). Even though the results showed some improvement for the experimental group, this suggests that the learners are still struggling to identify the technique or mathematical operation to solve the word sums problem after the intervention strategy.

Table 5. 22: Summary of the mean or average comparison of pre- and post-tests results from Q1 to Q10 for control and experimental groups

Comparisons between two groups pre- and post-test

	Control			**Experimental**		
Item	**Pre-test**	**Post-test**	**p-value**	**Pre-test**	**Post-test**	**p-value**
	74	**68**		**57**	**55**	
Q1	0.8918919	1.264706	0.0112	0.9473684	1.454545	0.0009
Q2	0.7567568	0.9117647	0.2597	0.7192982	0.9636364	0.1499
Q3	0.5135135	1.058824	0.0012	0.9649123	1.127273	0.4833
Q4	0.7027027	0.75	0.7070	0.6140351	0.9272727	0.0446
Q5	1.135135	0.8823529	0.0914	0.9649123	1.327273	0.0447

Q6	1.121622	1.470588	0.0546	1.175439	1.745455	0.0088
Q7	0.4864865	0.7647059	0.0008	0.4736842	0.6181818	0.1270
Q8	0.8108108	1.529412	0.0000	1.245614	1.67272	0.0025
Q9	0.972973	2.441176	0.0000	2.052632	2.890909	0.0383
Q10	0.5205479	0.5	0.8232	1.017544	1.036364	0.8955

The results from the table above indicate the performance of control and experimental groups from Q1 to Q10 in both pre- and post-tests, respectively. The outcomes revealed different mean or average scores between pre-test and post-test in Q1. The outcomes exhibited the significant difference score between pre- and post-tests from the control group (p-value = 0.0112) and the experimental group (p-value = 0.0009), at less than 0,05. The results from both groups in Q1 of the post-test showed that learners improved significantly in writing the given numbers in words.

The analysis outcomes for the control group in both pre- and post-tests for Q2 showed no statistically significant difference $(p-value = 0.2597)$, greater than 0.05. Similarly, the outcomes for the experimental group also showed no significant difference $(p-value = 0.1499)$ in Q2. However, the results from both groups in the post-test revealed some improvement in identifying the smallest and the biggest numbers, suggesting that the intervention strategy had a positive influence.

The data for Q3 for control group revealed a significant difference (p-value =0.0012) at less than 0.05 at 95% between the pre- and post-tests. On the contrary, the analysis of the experimental group's results showed no significance difference $(p-value = 0.4833)$, above the value of 0.05. Nevertheless, the experimental group exhibited enhancement in the post-test in Q3 in identifying the number in between, one more and one less from the given numbers.

The analysis of the outcomes from the table above for Q4 displayed no significant difference for the control group $(p-value = 0.7070)$, more than the p-value 0.05 from the pre- and post-test, while the experimental group indicated the significant difference $(p-value = 0.0446)$ lower than the p-value 0.05. Moreover, the experimental group displayed the statistical improvement from the post-test with the mean score that yielded the significant difference in Q4.

The analysis of the findings for Q5 revealed no significant difference between the pre- and post-test of the control group $(p-value = 0.0914)$ above the p-value 0.05. On the other hand, the experimental group recorded the statistical significance difference between the pre-test and the post-test $(p-value = 0.0447)$ below 0.05, suggest some improvement in the post-test.

The data for Q6 that were analysed for the control group revealed no statistically significant difference between the pre-test and the post-test, with a $(p-value = 0.0546)$. On the contrary, the results between the pre-test and the post-test from the experimental group displayed a statistically significant difference $(p-value = 0.0088)$ lower than the p-value 0.05. Though the two groups showed some improvement, the experimental group improved more than did the control group, which suggests that the intervention strategy had a positive influence, improving learners' performance towards identifying the numbers represented by base ten blocks and their sum.

The analysis of data for Q7 from the table above showed a significance difference between the pre-test and post-test for the control group $(p-value = 0.0008)$ lower than the p-value 0.05. In contrast, the analysis of the experimental group's outcomes showed no significant difference, with a $(p-value = 0.1270)$ of more than the p-value 0.05 between the pre-test and post-test. Though the two groups presented improvement in the post-test, the control group showed more improvement than the experimental group. However, improvement of the experimental group in the post-test suggest that the intervention strategy had a positive effect on learners in being able to arrange numbers from the smallest to the biggest.

The data that were analysed for control and experimental groups in Q8 displayed a statistically significance difference between pre-test and post-test with the $(p-value = 0.0000)$ and $(p-value = 0.0025)$ below a p-value of 0.05, respectively. The results indicated a significant improvement for both groups in the post-test, which propose that learners comprehended how to build a three-digit number using different number values. This implies that the intervention strategy had an influence in improving learners' performance in Q8 in building numbers.

The analysis of the results from the table above for the control group between the pre-test and the post-test in Q9 indicated a significant difference $(p-value = 0.0000)$, less than p-value 0.05 at a 95% confidence limit. On the other hand, the analysis of the experimental group's outcomes also showed a statistically significant difference between the pre-test and the post-test $(p - value = 0.0383)$, lower than the p-value 0.05. Even though the control group showed more improvement than the experimental group, the outcomes propose that the intervention strategy had a positive effect in the experimental group for learners to apply subtraction as a reverse operation for addition.

The results for Q10 in the table above revealed that control and experimental groups from the pre- and post-test results, no significant differences were produced. The control group showed no significant difference of the $(p - value = 0.8232,)$ while the experimental group recorded no significant difference of the $(p - value = 0.8955)$. Even though the control group showed no improvement from the post-test results, the experimental group showed a slight improvement. This proposes that the intervention strategy had some positive influence on the learners from the experimental group in finding the solution to the word problem.

Table 5. 23: Comparison of performance of control and experimental groups in pre- and post-tests

Percentage for control and experimental

Group	Obs	Setting	Mean	p-value
Control	74	Pre-Test	31.62162	
	68	Post-Test	46.29412	0.0001
Experimental	57	Pre-Test	40.70175	
	55	Post-Test	55.05455	0.0016

The results of the table above show the comparison of the analysis of the percentage performance of each of the groups in both pre- and post-tests. The results revealed that the control group's performance in the post-test scored a higher mean or average $(\bar{x} = 46.20412)$ as compared to $(\bar{x} = 31.62162)$ pre-test. The control group performed significantly different $(p - value = 0.0001)$ in pre-test and post-test, less than 0.05 at 95% confidence limit.

Furthermore, the table revealed that the experimental group's performance improved in the post-test with the higher mean score of $(\bar{x} = 55.05455)$ as compared to $(\bar{x} = 40.70175)$ in the pre-test. The experimental group improved significantly $(\bar{x} = 0.0016)$ in both the pre-test and the post-test, less than 0.05 at 95% confidence limit in the post-test, which suggest that the intervention strategy had a positive influence towards learning numbers, operations and relationships (NOR) concepts.

Table 5. 24: Summary of performance of control and experimental groups in pre- and post-tests

Percentage for pre and post-tests						
	Pre-Test			Post-Test		
Group	**Obs**	**Mean**	**p-value**	**Obs**	**Mean**	**p-value**
Control	74	31.62162		68	46.29412	
Experimental	57	40.70175	0.0254	55	55.05455	0.0269

The results of the analysis from the table above revealed that the control and experimental groups performed significantly differently (p-value = 0.0269), less than 0.05 from the post-test, as compared to the pre-test $(p - value = 0.0254)$. The results showed that the control group in the post-test scored higher mean or average $(\bar{x} = 46.294120)$ as compared to the pre-test $(\bar{x} = 31.62162)$. On the other hand, the experimental group exhibited improvement in the post-test with the mean or average (55.05455), as compared to the pre-test $(\bar{x} = 40{,}70175)$. In particular, the experimental groups scored a higher mean or average $(\bar{x} = 55.05455)$ than their control counter parts $(\bar{x} = 46.29412)$ in the post-test.

The results revealed that both groups enhanced significantly in the post-test, signifying that the learners improved generally in solving NOR in Grade 3 diverse classrooms. Even though both control and experimental groups improved significantly, the experimental group showed a better enhancement in the learners' performance in NOR, as compared to the control group. Although both groups showed improvement in the post-test as compared to the pre-test, the focus of the study was on the experimental group during the application of the intervention strategy. Hence, the outcomes propose that the intervention strategy had a positive influence on Grade 3 NOR concepts in the experimental group.

5.10 CHAPTER SUMMARY

This chapter has drawn on the information gathered from pre-test and post-test (quantitative), lesson observations and unstructured interviews (qualitative) to explore the performance of Foundation Phase learners in NOR in Grade 3 diverse classrooms. The pre-test and post-test, together with the lesson observations and unstructured interviews, were analysed in connection to the theoretical framework and the literature review. Data analysis and discussions for the pre-test and post-test were done according to the following categories adopted from Didis and Erbas (2015:1141) and Makgakga (2016:115): Correct Answers (CA), Partially Answered (PA), Wrong Answers (WA), Number Reversal (NR) or Wrong Spelling (WS), and Not Answered (NA), for each question from Q1 to Q10.

This chapter presented the outcomes of the study, which revealed that from the pre-test, the experimental group performed better than the control group with the $(p - value < 0.05)$, which indicated the significant different scores. The experimental group mean score $(\bar{x} = 55.05455)$, which indicated a significant improvement for the experimental and as compared to the control group $(\bar{x} = 46.29412)$ after the intervention strategy $(p = 0.0269)$. This proposes that the intervention strategy had a positive influence on the experimental group in enhancing the learning of Grade 3 learners NOR. The mean score percentage was used to compare the enhancement of the experimental and control groups in the post-test.

The analysis of the qualitative outcomes after the intervention strategy revealed that the application of dividing learners into small mixed groups, learners sharing ideas, teacher and peer scaffolding, and the application of concrete resources such as counters, improved P1's teaching and learners' learning of NOR concepts. Learners' positive participation and interaction between the teacher and other groups were found to have enhanced their learning and performance. The next chapter present the findings from both quantitative and qualitative data framed by literature and the adopted theory, recommendations and conclusion of the study.

CHAPTER SIX

DISCUSSION OF THE FINDINGS

6.1 INTRODUCTION

This chapter discusses the findings of the quantitative and qualitative data presented in Chapter 5. The analyses of the unstructured interviews conducted before and after the intervention strategy with both participating teachers and lesson observations conducted before, during and after the intervention strategy are presented. The findings discuss the quantitative data results, and then are followed by the qualitative data results. In the study, the quantitative results of both pre-test and post-test are discussed within the context of the analytical framework adopted, as noted earlier. Additionally, to respond to the research questions, the theoretical framework underpinning the study and literature review were used to interpret the data.

6.2 THE QUANTITATIVE RESULTS

Quantitative data results were generated from the pre-test and post-test conducted with both experimental and control groups. Excel was used for data management, and Stata Release 15 was used for statistical data analysis. T-test was used to compare the two study groups, the experimental and the control groups. The improvement of the mean scores was interpreted as before and after the implementation of the intervention strategy within and between the experimental and control groups.

6.2.1 The pre-test and post-test results

The aim of conducting the pre-test and post-test from the two groups was to gauge the improvement or deterioration of learners' performance in numbers, operations, and relationships before and after the implementation of the intervention strategy. Pre-test and post-test were aimed at gauging the net effect of group work strategy on learners' performance. A small group is putting learners into two to five numbers, working together to discuss particular activities and to share ideas to come up with the solution for a given problem, which comprises terms such as co-operative learning, shared learning, peer learning, or team learning. Group communications can aid persons to make sense of the material and steer the rearrangement of the information.

Stata Release 15 is a statistical software package used to analyse collected data. A t-test is a type of statistical test employed to determine whether there is a significant difference between the means of two groups, which may be connected in particular structures. It is frequently applied in hypothesis testing to determine whether a procedure or treatment has an impact on the population of interest, or whether two groups are different from one another. According to Bevans (2020:3), a t-test allows the researchers to do a comparison of the average values of the two information sets and determine whether they came from the same population, which means that if there were samples of learners from Group A and another sample of learners from Group B, the same mean and standard deviation would not be expected. Therefore, the mean score was used to evaluate the net effect of the intervention strategy and the interpretation of the results was performed at 95% confidence limit (2-sided). In other words, the results were declared significant if the p-value was less than 0.05. The findings of learners' performance per question before and after the intervention are given below.

6.2.1.1 Question1 results before and after intervention strategy

The outcomes of Q1 displayed that in the pre-test, the experimental group performed significantly differently from the control group $(t = -0.3688: p = 0.7129)$ ($t = -0.3688: p = 0.7129)$The experimental group recorded a higher mean score of $(\bar{x} = 0.9473684)$ than the control group $(\bar{x} = 0.8918919)$. The learners in the experimental group showed conceptual understanding in writing the numbers in words in Q1. NCTM (2020b:9) pointed out that conceptual knowledge constitutes a form of knowledge of concepts in which related concepts are understood in a relationship. Most learners in the experimental group were shown to have a basic conceptual understanding of numbers and what they represent. The recognition networks play a defining part in the development of conceptual knowledge, which entails connecting the representations in a meaningful way.

The post-test results after the implementation of the intervention strategy also revealed that the experimental group performed better than the control group $(t = -1.2966; p = 0.1972)$. The results revealed that the experimental group $(\bar{x} = 1.454545)$ scored a higher mean than the control group $(\bar{x} = 1.264706)$. However, both experimental and control groups showed improvement in the mean score $(\bar{x} = 0.5071766)$ and $(\bar{x} = 0.3728141)$ respectively, which showed that the intervention strategy in the experimental group worked in improving the results. Learners from the control group also showed that their conceptual understanding of NOR had improved. This indicates that learners, with conceptual understanding, can organise their knowledge logically so that they can connect new ideas with what they already know.

6.2.1.2 Question 2 results before and after intervention strategy

The pre-test results for Q2 indicated that the control group performed significantly differently from the experimental group $(t = 0.2586; p = 0.7963)$. The results showed that the control group scored a higher mean ($\bar{x} = 0.7567568$) than the experimental group $(\bar{x} = 0.7192982)$ before the intervention strategy. Learners from the experimental group appeared to lack number sense by means of which to focus on the mathematical information system that has been attained and the ability to differentiate between smaller and bigger numbers.

The post-test results for Q2 exhibited that the experimental group performed significantly differently from the control group $(t = -0.3256; p = 0.7453)$. The learners from the experimental group scored the mean ($\bar{x} = 0.9636364$), while the control group scored the mean $(\bar{x} = 0.9117647)$. After receiving the intervention strategy, the experimental group indicated an improvement of a mean score of (0.2443382), as compared to the pre-test mean score. This implies that learners from the experimental group were able to make sense of what numbers are, could compare numbers, and were able to connect what they learned to prior knowledge. The results from the control group also showed some improvement, which suggests that some learners have acquired knowledge to differentiate between smaller and bigger numbers.

6.2.1.3 Question 3 results before and after intervention strategy

The pre-test results for Q3 before the intervention strategy indicated that the experimental group performed significantly differently from the control group $(t = -2.5475; p = 0.0120)$The learners from the experimental group scored the mean $(\bar{x} = 0.9649123)$ whereas the control group scored $(\bar{x} = 0.5135135)$. The learners in the experimental group performed better than the control group, which indicated that learners from the experimental group had a conceptual understanding of counting numbers in order forward and backward or vice versa.

The post-test results for Q3 after the intervention strategy displayed that the experimental group performed significantly better $(t = -0.3204; p = 0.7492)$. The mean score from the post-test results for the experimental group was $(\bar{x} = 1.127273)$ as compared to the control group's mean score $(\bar{x} = 1.058824)$. The mean score for the experimental group increased by $(\bar{x} = 0.9649123)$, which proposes that the intervention strategy had a positive influence on the experimental group's performance. However, the mean score of the control group also showed that some learners' conceptual understanding of ordering numbers had improved. Learners showed their development of conceptual knowledge to be able to create the relationship between the ideas of the numbers.

6.2.1.4 Question 4 results before and after intervention strategy

The results for the pre-test in Q4 revealed that the experimental group performed significantly better than the control group $(t = 0.6690; p = 0.5047)$. The findings from the pre-test revealed that the experimental group scored the mean $(\bar{x} = 0.6140351)$ as compared to the control group $(\bar{x} = 0.7027027)$, which showed that the control group performed better than the experimental group. The learners from the experimental group were able to identify the tens and the units from the underlined digits of given numbers. The informal knowledge of ones, tens, and hundreds is foundational in mental strategies for multi-digit calculation and can be distinguished from predictable place value knowledge.

The results for Q4 from the post-test also revealed that the experimental group performed significantly better than the control group $(t = -1.2139, p = 0.2271)$. In other words, the experimental group $(\bar{x} = 0.9272727)$ consistently scored a higher mean than the control group $(\bar{x} = 0.75)$. Hence, the performance of the experimental group showed an improvement of from the mean score. Therefore, learners from the experimental group seemed to have attained knowledge of number values during the application of the intervention strategy. Learners from the control group also showed an improvement of $(\bar{x} = 0.0472973)$ from the mean score, which indicates that fewer learners gain knowledge of identifying the values of a digit from a given number. Once learners completely comprehend concepts and procedures such as place values and operations with one-digit numbers, they can expand these concepts and procedures to different areas. Play and games produce a solid foundation for 1st through 3rd grades when learners achieve operations with numbers and deliberate on place values and number values.

6.2.1.5 Question 5 results before and after intervention strategy

The pre-test results before the intervention strategy indicated that the control group performed significantly better than the experimental group $(t = 1.0433; p = 0.2988)$. The findings showed that the learners from the control group scored a higher mean $(\bar{x} = 1.135135)$ than the experiment group $(\bar{x} = 0.9649123)$. The results suggest that learners from the experimental group were unable to demonstrate and apply the understanding of major mathematical concepts, applications of numbers, and using real numbers in context.

Different results were obtained after the application of the intervention strategy, where the experimental group performed significantly better than the control group $(t = -2.7378; p = 0.0071)$. The learners from the experimental group improved by scoring the mean of $(\bar{x} = 1.327273)$ as compared to the control group, whose mean scores declined $(\bar{x} = 0.8823529)$. The experimental group's mean score increased by $(\bar{x} = 0.3623607)$ which suggests that some learners from the experimental group developed number sense and were able to recognise that numbers can be represented in different ways. The decline of the mean score from the control group indicates that learners appeared to lack number sense and the conceptual knowledge to link the number and its name.

6.2.1.6 Question 6 results before and after intervention strategy

The findings for the pre-test results for Q6 showed that learners from the experimental group performed better than the control group $(t = -0.2691; p = 0.7883)$ before the application of the intervention strategy. The findings showed that learners from the experimental group scored higher mean $(\bar{x} = 1.175439)$ when compared to the control group mean score $(\bar{x} = 1.121622)$. This indicates that learners from the experimental group showed their ability to make connections between the relationship of different digits from a number and their values.

The post-test results showed that learners from the experimental group performed significantly differently from the control group $(t = -1.4329; p = 0.1545)$. The findings showed that the experimental group scored a higher mean of $(\bar{x} = 1.745455)$, compared to the control group, which scored the mean $(\bar{x} = 1.470588)$. This indicates that the intervention strategy made an impact on the experimental group. Moreover, the experimental group's mean score increased by $(\bar{x} = 0.570016)$, which indicates that learners from the experimental group developed knowledge of interpreting base ten blocks in representing real numbers and making relationships thereof. Furthermore, the learners from the control group also exhibited an improvement of $(\bar{x} = 0.348966)$, which suggests that some learners have developed the understanding that numbers can be represented with objects, blocks, or pictures.

6.2.1.7 Question 7 results before and after intervention strategy

The results for the pre-test in Q7 before the intervention strategy revealed the control group performed significantly differently from the experimental group $(t = 0.1401; = 0.8888)$This showed that the control group scored a higher mean $(\bar{x} = 0.4864865)$ compared to the experimental group's mean score of $(\bar{x} = 0.4736842)$. This suggests that learners from the experimental group lack knowledge of counting numbers to at least two hundred, where most of the learners were unable to arrange the numbers 32; 54; 9; 28; 98; 61; 82 from the smallest to the largest. Most learners from the experimental group do not know or can hardly recall the meaning of terms such as smallest or biggest.

Similar results from the post-test revealed that the control group performed significantly differently from the experimental group $(t = 1.7699; p = 0.0793)$. The results revealed that the control group scored a higher mean $(\bar{x} = 0.7647059)$ as compared to the experimental group's mean score $(\bar{x} = 0.6181818)$. This revealed that the control group performed better than the experimental group and suggests that fewer learners have gained knowledge of counting forward and backward as compared to the experimental group. However, the experimental group from the post-test showed some improvement by the score of $(\bar{x} = 0.1444976)$, which suggests that some learners' actual level of development from the experimental group has developed so that learners can recognise numbers and arrange these from the smallest to the biggest.

6.2.1.8 Question 8 results before and after intervention strategy

The results for Q8 in the pre-test results revealed that the experimental group performed significantly differently from the control group $(t = -2.8916; p = 0.0045)$. The results revealed that the experimental group scored a higher mean $(\bar{x} = 1.245614)$ when compared to the control group's mean score $(\bar{x} = 0.8108108)$. This suggests that most learners from the experimental group demonstrated their conceptual knowledge by being able to make sense of numbers and being able to build and break numbers. Most learners were able to build numbers from values such as hundreds, tens and units; for example, 200 + 80 + 1 to be 281.

The post-test results after the implementation of the intervention strategy reached similar results. The experimental group also performed significantly differently from the control group $(t = -1.1935, p = 0.2350)$. The findings showed that the experimental group scored a higher mean $(\bar{x} = 1.672727)$ compared to the control group's mean score of $(\bar{x} = 1.529412)$. The experimental group showed an improvement of $(\bar{x} = 0.427113)$ mean score after the implementation of the intervention strategy, which indicates that some learners from the experimental group have developed the conceptual knowledge of building numbers from the values of the given numbers. Furthermore, learners from the control group also showed improvement of $(\bar{x} = 0.7186012)$, which suggests that learners from both the experimental group and the control group showed their procedural fluency in remembering basic facts of different values of digits from a number and using them to build three-digits numbers.

6.2.1.9 Question 9 results before and after intervention strategy

The Q9 results from the pre-test revealed that the experimental group performed significantly differently from the control group $(t = -3.6039; p = 0.0004)$. Therefore, learners from the experimental group scored a higher mean $(\bar{x} = 2.052632)$ than the control group $(\bar{x} = 0.972973)$. The learners from the experimental group showed their conceptual knowledge by linking addition to subtraction in a meaningful way. Most learners from the experimental group were able to, for example, add two numbers 2 +

12 = 14 and use subtraction, 14 – 12 = 2, which suggests that learners were able to conceptualise their knowledge that the numbers involve groupings and subtractions in the range 1 to 20.

The post-test results showed that the experimental group performed significantly differently from the control group ($t = -1.2223$; $p = 0.2240$). The experimental group consistently scored higher mean ($\bar{x} = 2.890909$) as compared to the control group ($\bar{x} = 2.441176$). In particular, the experimental group showed a score improvement of ($\bar{x} = 0.838277$), which proposes that the intervention strategy had a positive impact on learners from the experimental group. Learners from the control group also showed improvement of ($\bar{x} = 1.468203$), which suggests that more learners have gained basic numeracy skills in performing simple addition and subtraction problems as compared to the experimental group. Most learners showed their conceptual understanding that addition can be reversed through subtraction. Counting forward and backward might be the normal calculation of addition and subtraction of small numbers.

6.2.1.10 Question 10 results before and after intervention strategy

The pre-test results for Q10 before the intervention strategy showed that the experimental group performed significantly differently from the control group ($t = -4.1345$; $p = 0.0001$)This indicates that the learners from the experimental group scored a higher mean ($\bar{x} = 1.017544$) compared to the control group ($\bar{x} = 0.5205479$). Therefore, learners from the experimental group demonstrated their strategic competency of being able to articulate, signify, and resolve mathematical challenges, for example, in the morning Lebo has 19 apples, during lunch time she eats 6 apples, how many apples are left? The results showed that most learners from the experimental group were able to solve the given word problem by applying their strategic competency.

The post-test results for Q10 displayed that the experimental group performed significantly differently from the control group ($t = -4.8538$; $p = 0.0000$). The post-test outcomes exhibited that the learners from the experimental group scored a higher mean ($\bar{x} = 1.036364$) compared to the control group's mean score ($\bar{x} = 0.5$). The learners from the experimental group appeared to have acquired skills and demonstrated their strategic competency to solve the problem or were able to come up with ideas for finding the solution to a given problem (Garg, 2017:1). Hence, the experimental group's mean score improved by ($\bar{x}$ = 0.01882), which suggests that the intervention strategy influenced enhancing the results. The learners have shown their strategic competence by being able to choose between various strategies to match the demands of the problem and the condition in which it was posed. However, the learners from the control group showed a net decline of ($\bar{x}$ = 0.0205479), which suggests that some learners lack procedural knowledge of solving word problems.

6.3 SUMMARY OF PRE-TEST AND POST-TEST RESULTS

The summary of the pre-test and the post-test results were prepared using the total mean score percentage between the control and experimental groups. The summary of the results are shown in Table 6.1.

Table 6.1: Summary of pre-test results

Group	Obs	Mean	t - score	p - value
Control	74	31.62162	−2.2611	0.0254
Experimental	57	40.70175		
Combined	131	35.57252		

Table 6.1 above revealed that from the pre-test, the experimental group performed significantly differently than the control group (t = −2.2611; p = 0.0254) at 95% confidence limit. This suggests that the experimental group has consistently scored a higher mean () than the control group ($\bar{x}$ = 31.62162). The learners from the experimental group seemed to have developed conceptual knowledge that they could use to understand concepts from NOR and use the knowledge to solve the problems. The table below discusses the summary of the post-test outcomes for the experimental group and the control group.

Table 6.2: Summary of the post-test results

Group	Obs	Mean	t - score	p - value
Control	68	46.29412	−2.2408	0.0269
Experimental	55	55.05455		
Combined	123	50.21138		

The post-test results revealed the same conclusion (as in the pre-test) after the implementation of the intervention strategy. The learners from the experimental group performed significantly differently from the control group $(t = -2.2408; p = 0.0269)$ at 95% confidence limit. Hence, the experimental group's mean score improved by $(\bar{x} = 14.3528)$, which is the difference between the pre-test and the post-test results. The results suggest that the experimental group gained more profound knowledge and more procedures for solving NOR problems.

6.4 QUALITATIVE FINDINGS

This unit discusses the qualitative data obtained from lesson observations and unstructured interviews done with the participating teachers. The lesson observation was envisioned to establish whether the intervention strategy has had any impact on teaching mathematics in diverse classrooms. Furthermore, the interviews were used to understand the teacher's perspectives about the successes of the implementation of the intervention strategy and possible challenges thereof.

6.4.1 LESSON OBSERVATIONS

The results from the lesson observations that were generated before and after the intervention strategy displayed the following:

The question-and-answer method was used by P1 to involve learners during teaching and learning. However, proper support or scaffolding for learners who provided incorrect answers was not offered because the teacher did not guide learners towards giving the correct answers by asking probing questions. This suggests that scaffolding should be provided to learners who are unable to do the provided activities on their own. This revealed that the teacher could not support or accommodate the needs of all learners before the intervention strategy during teaching and learning. According to Meyer et al. (2014:101), the principle of UDL emphasises that supporting learners in a meaningful way assists them in developing their learning skills and eventually becoming experts. This showed that the teacher could not reorganise the knowledge or understanding of learners (Shimizu & Vital, 2018:14; Shulman, 1986:9), to be able to enhance the learning opportunities produced by learners (Excell & Linington, 2015:130).

The findings revealed that, even though learners were not supported during teaching and learning from the experimental group, they were given the chance to demonstrate their understanding by writing the answers on the chalkboard. This is consistent with what Pellegrin et al. (2018:11) found, namely that learners should be introduced to mathematical practices that provide them with numerous chances “to do, speak and write” their mathematical thinking in the early grades. Similarly, Steyn and Adendorff (2020:40) found that teachers were able to create the mathematics inquiry classroom, build trust, and encourage positive engagement during the teaching and learning of mathematics to actively involve learners. These indicate that for learners doing mathematics, it encourages positive participation during teaching and learning.

The results during the baseline observation revealed that learners in their groups did work collaboratively with each other. This is inconsistent with Donald et al., (2009:95) and PDST (2017:7) when saying that learners during group work should work together, discuss and communicate their ideas amongst themselves. Each learner worked out the answer on his or her own and answered the whole class. Multiple means of engagement, such as scaffolding or modelling (Hall et al., 2012:42) when the learners gave the wrong answer, were not applied. As noted earlier, learners who experience positive interactions in a diverse classroom result in more open minds, engagement in classroom conversations, and gain confidence in taking part in learning (Possi & Milinga, 2017:28).

The study found that teachers ensured that their classrooms were displayed with different learning resources to encourage positive learning for learners. Learners sometimes referred to the resources displayed on the wall while doing their activities, since the resources (like posters and word cards) were put up on the wall by the teacher at the end of each lesson. This is consistent with what Visser et al. (2015:6) and Ndlovu (2018:236) found in their studies, that the availability of resources in teaching mathematics makes learning enjoyable and has a positive influence on learners' performance.

During the intervention

Learners who were previously not supported during teaching and learning, were given support and different learning needs were accommodated (Cotton,2016:2). Providing learners with the opportunity to express their understanding (Kortjass, 2019:4), asking them to follow up questions, and giving the learners the chance to ask questions where they did not understand gave learners the opportunity to make sense of the concepts and support (Schwarzer & Grinberg, 2017:17). Learners seemed to have been motivated through evolving a flexible learning atmosphere in which material was accessible in multiple ways, where learners engage in learning in different ways, and give the learner the opportunity to provide options when demonstrating their learning (CAST, 2011:23; Harbour, 2012:1). The findings revealed that the intervention strategy seemed to have encouraged learner-centred teaching and learning during the application of the intervention strategy.

Post-intervention findings

The findings after the intervention strategy revealed that learners were capable of participating energetically during teaching and learning. Interaction among the learners, including listening to each other's ideas, seemed to have provided learners the opportunity to use different methods of solving NOR concepts and to support one another, this provided the teacher with the opportunity of accommodating learners who experienced challenges when learning NOR. Learner participation during teaching and learning seemed to have developed learners' knowledge and skills in answering mathematics challenges in NOR. The results suggest that learners' knowledge and understanding in NOR appeared to have improved, because all learners were participating actively, asking one another questions to understand their findings or to answer questions raised by the teacher or their peers (Retnowati, 2017:668). The results showed that P1 understood the learning needs of each learner, and how to accommodate them during teaching and learning mathematics because she was moving around to check how they were answering questions while doing activities. P1 followed CAST (2011:12), using multiple means of presentation by giving learners numerous opportunities of attaining information and knowledge; applying different ways to present the acquired knowledge; and multiple means of expression by offering learners different alternatives for representing what they know.

The collected data before, during, and after the intervention strategy was envisioned to respond to the following research objectives:

1. to explore how teachers are applying their teaching strategies to enhance the performance of the Foundation Phase learners in diverse mathematics classrooms;
2. to identify the challenges that are experienced by teachers in improving the performance of Foundation Phase learners in diverse mathematics classrooms; and
3. to determine teaching practices that can be employed to meet the performance needs of Foundation Phase learners in diverse mathematics classrooms.

The lesson observation data gathered before, during and after the intervention strategy are discussed below with reference to the themes that were developed.

6.4.2 TEACHING STRATEGY

The teaching style of the teacher from the experimental group before the intervention strategy was mostly not learner-centred and did not motivate learners during teaching and learning. When answering the questions, learners were not encouraged to explain how they worked the answers out, and some learners were passive in their groups because learners were not given roles, and the groups were large. The findings showed that P1 did not take into consideration the way of grouping learners, including size and their learning abilities to focus on their participation in the activities or solving problems. Additionally, the teacher's questioning style did not permit her to comprehend learners' reasoning and understanding of NOR concepts to determine how to support and develop their understanding.

The teaching strategy applied by the teacher from the experimental group during the intervention strategy demonstrated her knowledge of presenting information through multiple means. The ability of the teacher to accommodate and support learners who experienced learning difficulties as well as provide them with prompt feedback enabled learners to understand when to ask questions. This might have contributed to the improvement in the performance of learners in NOR. P1 got learners to be reflective about what they have learned by asking them questions to clarify the mistakes they have encountered while solving problems. Furthermore, the teacher guided learners in identifying the keywords or ideas and relationships between addition and subtraction to be able to find the solution to the given problems.

6.4.3 LEARNER INVOLVEMENT

The teacher from the experimental group prior to the implementation of the strategy did not encourage a positive and active learning environment. The teacher did not scaffold or support learners who gave incorrect answers to develop their thinking skills or encourage social interaction in the classroom by sharing ideas, developing their language, and increasing their confidence. The teacher was focusing on finding the correct answer, not on guiding or supporting the learners in understanding the concept to find the answers. When teachers do not engage in multi-level practices in accommodating and supporting learners, it is frequently not due to a lack of desire to do so, but it is frequently an absence of professional development in this area that leaves them under-skilled. Teachers should be equipped with skills that will enable them in supporting and accommodating the needs of all learners so that they become motivated during teaching and learning.

The findings during the intervention strategy pointed to the benefits of active involvement of all learners and ensured attainment for the individual learner from the experimental group. Learners were given the opportunity to expand their knowledge and understanding by asking each other questions to clarify their answers. Good teaching is the art of involvement in discovering what will inspire a learner to learn mathematics and to feel self-confident in his or her capabilities. Motivating learners during teaching and learning encourages them to discover their potential and to take charge of their own learning by participating actively and efficiently. Lack of awareness or knowledge to adapt teaching strategies often contributes to some teachers' hesitation about including all learners in the teaching and learning atmosphere. These suggest that teaching in an inclusive classroom should be adapted to accommodate the needs of all learners while alleviating learning barriers for others.

6.5 INTERVENTION STRATEGY: Group work

This study intervenes in the form of action research, which was implemented in three cycles. The first cycle focused on reducing the number of learners from the groups from eight to at least five to six learners grouping them randomly, focusing on their learning abilities and assigning roles, the second cycle focused on grouping learners into mixed learning abilities, assisting learners in reading (identifying keywords for working out the answers to the problem) and understanding the questions, and the last cycle focused on allowing learners to apply the skills they learned of identifying key words to solve the problems, which is discussed in 6.3.1. The teaching style can either impact learning positively or negatively, depending on how it is applied. The results before the implementation of the intervention strategy revealed that the teaching group work used could not accommodate the learning needs of all learners. Groups consisted of large numbers of learners and learners were not given roles so that they could all actively participate.

The findings during the intervention revealed that by changing the teaching style, the teacher from the experimental group was able to accommodate the learning needs of all the learners. Based on the theory of UDL, teaching and learning should be changed to accommodate or to provide all learners with equal opportunities to access information and demonstrate their knowledge and skills. Again, the teacher monitored the learners' behaviour and their responsibilities in their groups by moving around and monitoring the process and the outcomes from different groups. However, the issue of covering the curriculum prevents the teachers from accommodating learners who experience learning barriers because they must rush in finishing the provided curriculum and teaching the other three subjects daily.

6.5.1 Implementation of group work as an intervention strategy

The findings during the first cycle revealed that grouping learners randomly does not accommodate all learners because some of the learners were not actively participating in their groups. This implies that all learners should participate actively in the group to understand what they are learning. The teacher needs to know how each learner learns and to understand how to support or accommodate them during teaching and learning. The data revealed that even though learners were divided into smaller groups, failure to consider their different learning abilities prevented some learners from supporting one another. Knowing learners' abilities in a diverse classroom will enable the teachers to change their teaching strategies, curriculum content, teaching resources, and classroom groupings to deal with educationally significant differences.

Preparing worksheets and adjusting them to the learners' learning environment, assisted in helping the learners to understand the concepts being presented. Most of the learners participated actively in their groups and the teacher involved them by asking them questions, giving them the opportunity to make sense of the concepts and support. The learners were also guided by giving them clear instructions, accommodated, and supported where there was any need so that they could understand how to solve the problem.

The results obtained during the second cycle revealed that learners developed their understanding of the mathematical concepts being taught. Grouping learners according to mixed learning abilities and discussing in their groups, assisting them in working out the answer to the question. Using the worksheet prepared by the teacher seemed to have assisted learners in understanding the concepts because the activities were adjusted to the level and environment of the learners. In addition, reading questions together with learners appears to have helped those learners who experience difficulties in reading. Most learners explained how they worked out the answer to the problem to show their reading and problem-solving skills had improved. The teacher gave learners clues such as "how many are left", where they should subtract the numbers to get the answer, and "altogether", they should add the numbers to get the answer to guide them in answering the questions.

The findings from the third cycle suggest that most learners' reading and understanding of mathematical concepts have developed. The questions were no longer read together with the learners. However, they were reminded to identify the keywords while reading the question to be able to solve the problem. Most learners were able to identify or explain how they worked out their answers to the problem and presented their answers to the class. Learning mathematics means creating strategies for resolving problems, using those strategies, and ensuring if they lead to the answers and examining to realise whether the responses are logical. The assistance from a peer or the teacher was slowly removed to allow learners to demonstrate their understanding and learners were asked to identify keywords to help them answer the questions.

6.6 POST-INTERVENTION LESSON OBSERVATION

The teacher presented information orally, in written work, using pictures and the application of concrete materials. This encouraged active participation of learners because most of them were taking part in teaching and learning. Learners should be given the opportunity to present or demonstrate their understanding of the given problem using written words, pictures, spoken words, gestures, or using tangible material.

6.6.1 The teacher-learner interaction

Data from lesson observation suggest that a question-and-answer method used to link learners' prior knowledge to the new knowledge assisted learners in understanding NOR concepts and engaging them in active learning. After the intervention, most of the learners were answering the questions and the teacher gave them support. In addition, learners were given the opportunity to expand their knowledge and understanding by asking each other questions to clarify their answers. Allowing learners to ask questions during teaching and learning develops learners' learning interest and understanding of what they are learning.

The data displayed that the teacher from the experimental group guided, supported, and accommodated the different learning abilities of learners. This stands in contrast to the pre-intervention lesson observations, where the teacher did not consider learners' centredness in her teaching and learning. The teacher involved learners by guiding them on how to identify keywords from word problems which showed that the teacher was not passively passing information to the learner. This helped learners in working out the answers to the given problems without the assistance of the teacher. Moreover, most learners were able to ask questions or answer prompting questions from the teacher or their peers, which made them realise where they went wrong and helped them to rectify their mistakes.

6.6.2 Learner-learner interaction

Grouping learners into different learning abilities appeared to have motivated learners in working with their peers since they were able to interact co-operatively with one another in their different groups. Sharing and listening to each other's ideas appeared to have made a positive impact on their learning because their participation improved. Small groups were found to encourage learning by doing, learning by trial and error in a safe environment, and learning through interaction, such as communication and teamwork. Learners who experience positive interactions in a diverse classroom, results in more open minds and engagement in classroom conversations. Learners interacted with each other in their groups and demonstrated their understanding by doing it practically with their number cards in groups and on the chalkboard. Most learners were responsible for the specific parts of their work and the teacher allowed them to tackle problems and make mistakes so that they could learn from those mistakes.

6.6. 3 Teacher-group interactions

Creating the mathematical inquiry classroom by building trust and encouraging positive engagement during teaching and learning of mathematics encourages a positive learning environment. The teacher from the experimental group created a positive learning environment for all learners and encouraged them to share ideas and listen to each other without any interruption. For example, the teacher told the groups that one learner should speak at a time and that they should provide each other the opportunity to finish speaking and ask questions or make comments thereafter. Learners gave each other a chance to share their ideas and gave comments or asked questions where necessary. These appeared to have a positive impact as learners listened to one another, shared ideas, and asked each other questions where they did not understand what their group members were saying. It was revealed that learners have a chance to learn more when they feel protected and confident in sharing their different perceptions and understanding with one another.

6.6.4. Group-group interaction

Providing groups with the opportunity to present their work to the whole class seemed to have assisted the learners in discovering that one problem can be solved in different ways. The findings revealed that when learners present the solutions to the questions on the chalkboard, this allows other learners to express themselves and borrow ideas from one another. This indicates that encouraging positive participation during teaching and learning helps learners to learn from each other and to learn different methods of working out the answers to the problems. The results revealed that discussing different ideas, while questioning and simplifying each other's strategies, creates a common understanding, essential to learning objectives. On the other hand, learners who are engaged in mathematical argumentation write in a manner that reveals their thinking to one another and their teacher, because learners learned to ask each other questions.

6.7 CLASSROOM ASSESSMENT

Classwork and homework were continuously employed by the teacher from the experimental group as instruments for assessment. Classwork and homework appeared to have helped the teachers in understanding where they have been, where they are, where they might go next and support learners according to their needs. Again, monitoring of written classwork during the intervention strategy assisted the teacher from the experimental group in assisting learners who experienced learning difficulties, preventing them from developing a knowledge gap, and eventually, enhancing their performance. This is unlike before when the teacher was not guiding learners when writing. The activities ensured that the learners demonstrated their knowledge and understanding of solving NOR problems.

6.8 UNSTRUCTURED INTERVIEWS

Unstructured interviews were conducted with two teachers, as mentioned in Chapter Four. Unstructured interviews allowed the researcher to rearticulate the questions where necessary when asking the teachers, or to probe for clearness during the process. The aim of using unstructured interviews was to ascertain the challenges that cause Grade 3 learners from experimental and control groups not to perform well in mathematical concepts of NOR. The interviews were conducted one-on-one with both teachers before the intervention strategy and with the teacher from the experimental group after the application of the intervention strategy. The interviews were conducted for about thirty to forty-five minutes per session with the teachers.

6.8.1 Grade 3 learners' performance in Mathematics

The findings from the study revealed that poor performance of learners was categorised by numerous aspects as previously mentioned, viz. high-level teaching of mathematics that is lacking in primary school classrooms and overcrowding (Ngware, Ciera, Musyoka & Oketch, 2015:111; Naude & Meier, 2019:10); learning deficits exist during early learning (Spaull & Kotze,2015:13); the nature of socio-economic background (Australian Council for Educational Research & UNICEF, 2016:3; Wheater et al., 2016:2); a lack of learning resources (Khun-Inkeeree et al., 2016:47); the presence of mathematics anxiety (Ramirez et al., 2016:84); degree of parental involvement and teachers' qualifications (Maimela & Monyatsi, 2016:176); and lack of skills such as interaction, accepting learner differences, and supporting their learning needs (Arends, Winnaar & Mosimege, 2017:6). In addition, other factors rather than those identified by the literature cited above, contribute to poor performance of learners in mathematics, such as reading and writing, promotion policy, and language of learning and teaching. The experimental group seemed to have performed better than the control group, even though the performance was not satisfactory.

6.8.2 Reading and writing

The results also revealed that reading and writing are a challenge to most learners in Grade 3. The results showed that understanding what is written depends on the recognition of words and their meaning and comprehension requires connection to prior knowledge. This implies that if learners experience challenges in reading, it will be difficult for them to comprehend mathematical language or to make sense of what is being written about mathematics and will cause them not to perform well in mathematics. It was also found that the growth and understanding of mathematical language is important for learners to be dynamically involved in mathematical ordinary computational necessities to detailed understanding and constructing sense. Learners did not see the importance of "why" of reading or caring about the text and "why" they should continue engaging with it.

6.8.3 Learners' knowledge of mathematics

The learners' lack of mathematical knowledge in both experimental and control groups revealed that the learners lack conceptual knowledge of essential knowledge that inspires understanding of concepts, operations, and relations as essential in practicing mathematics. The results showed that learners with conceptual understanding can organise their knowledge logically so that they can connect new ideas with what they already know. Teaching learners how to develop conceptual knowledge encourages learners to reorganise connecting new knowledge with prior knowledge gathered in long-term memory.

Even though both groups lacked conceptual knowledge before the intervention strategy, active engagement of learners through questioning and guidance in reflecting on their learning seemed to have improved during the research. The teacher's teaching strategies during the intervention scaffolded learners by practically doing mathematics, not by passively listening to how others have previously made sense of mathematical concepts. The universal design of learning appeared to have assisted learners with different opportunities of attaining material and knowledge, multiple means of expressing and demonstrating what they know, and multiple means of engagement to tap into their interests, offering suitable challenges, and increased inspiration. Recognition networks are important in developing conceptual knowledge, which entails the connection of representations in a significant way. The teacher from the experimental group indicated that learners' participation during and after the intervention exhibited improvement, which entails that the intervention was effective in the learning of NOR. She also indicated that learners showed mutual support, where individual and group humanity was expressed through mutual interaction, and they also respected each other's ideas during the discussion.

6.8.4 Learner support in Mathematics

Teachers from experimental and control groups seemed to experience challenges in supporting or accommodating the different learning abilities of all the learners during teaching and learning. This showed that supporting learners from early learning helps the teacher to know them and how to use their findings to shape learning opportunities for the individual learner. The lesson observation findings support the unstructured interview findings, namely that the teacher from the experimental group did not follow

ZPD in guiding learners who were unable to answer the questions correctly. Similarly, the teacher from the control group involved learners by passively participating from their desks. However, teachers should be able to create the mathematics inquiry classroom and encourage positive engagement during the teaching and learning of mathematics.

Data revealed that the teacher from the experimental group applied group work successfully during the intervention to support and accommodate the needs of all learning. Learners were provided the means to demonstrate their learning abilities by presenting their work orally, in written form and in practice to express their knowledge or demonstrate their skills and were given the opportunity to make sense of the concepts and support by answering questions. The teacher applied multiple means of engagement by enabling learners to engage positively with their learning and multiple means of expression by ensuring that learners from groups demonstrated their understanding by presenting their work to the whole class. This supported learning by promoting different ways of participating with material, displaying information and subject matter in different ways to support understanding by the learner with different learning styles/abilities, and created a positive learning environment for learners. The teacher ensured that learners were grouped into mixed learning abilities, such that those who were more knowledgeable would be able to assist those less able.

6.8.5 Pedagogical content knowledge

The information before the intervention strategy revealed that teachers from the experimental group experienced challenges in choosing teaching approaches or teaching strategies that accommodated different learning needs of all learners and to be able to group learners according to their needs. Pedagogical content knowledge (PCK) incorporates the awareness of being able to teach specific topics and understanding of what makes the learning of the matters simple or tough. The teacher was unable to support learners and generate a learning atmosphere that provided learners with the opportunity to engage with each other and with her.

After the implementation of the intervention strategy, P1 revealed that she was able to support learners and gave them the opportunity to make sense of mathematics by applying prior knowledge to find the solution and create new ideas in the process. The teacher indicated that she gave learners the opportunity to participate effectively by asking them questions, which also required them to apply their prior knowledge and develop their thinking skills. The teacher from the experimental group needed to understand learners' thinking and reasoning by probing questions during the application of the intervention strategy. The results showed that teachers should be able to enhance learning opportunities produced by learners as well as offer opportunities by asking probing questions to guide them in finding the answers. The interview also revealed that the teacher learned how to engage learners in active participation in NOR.

6.9 OVERVIEW OF QUALITATIVE AND QUANTITATIVE RESULTS

As noted earlier, group work is understood as a learner-centred teaching approach that emphasises collaboration, co-operation and teamwork, where learners work together to develop knowledge and complete the task through collaborative communication and improve performance and constructive relationships between learners, compared to competitive or individualistic experiences. Furthermore, mathematical knowledge is transferred easily and effective interaction between the teacher and learners, between one another, promotes success and learners who are engaged in mathematical discussion, write in a manner that reveals their thinking to each other and to their teacher. It addresses common classroom problems and improves intergroup relations by increasing trust and friendliness and encourages learner engagement by accommodating various means of learner response. It encourages a supportive learning environment where learners perceive they belong, encourages positive learning towards the learners and develops conceptual understanding through doing mathematics, not by passively listening to how others have previously made sense of it.

6.9.1 TEACHER'S EXPERIENCE AND EXPERTISE

The results showed that small groups' teaching from the experimental group assisted the teacher in understanding how different learners learn and how to support them in learning NOR Grade 3. As noted earlier, group work was only administered in the experimental group to explore how learners are accommodated during teaching and learning in a diverse classroom. The purpose of underpinning the study with the theoretical framework of Universal Design of Learning (UDL), was to show that teachers should generate instructional approaches and resources that accommodate the learning needs of every learner. The teachers should create a single, one-size-fits -all teaching and learning approach, but they should support, reflect and embrace the learning diversity in the classroom. In addition, they should be patient with learners who are not grasping the content.

The UDL in this study took the form of the teacher adapting her ways of teaching and realising the differences every learner brings to the learning process and the need for flexibility in the "what," "how," and "why" of learning. The teacher from the experimental group, through the principle of using multiple means' representations, employed various ways of representations of information to permit learners to create relationships inside, as well as amongst the ideas. The results revealed that during group work, changeable rather than fixed grouping permitted improvement differentiation of activities and various roles for learners, as well as delivering prospects to acquire how to work most successfully with others. Furthermore, the teacher, by means of scaffolding, applied different instructional procedures to assist learners to comprehend what they were learning and learners raised questions, provided responses and assisted their friends in discovering innovative information which presented the opportunity for them to take effective responsibilities in their education.

6.9.2 MOTIVATION IN GROUP WORK

Group work interaction fosters deep learning, learning happens in an active mode and teachers and learners share knowledge. Learners borrow knowledge from the other groups and rearrange linking new knowledge with prior knowledge collected in long-term memory and making sense of information. The teacher from the experimental group developed her own worksheets and used more teaching and learning resources during her teaching. She also motivated learners by involving them through questioning and developed their thinking and reasoning by probing and using effective classroom discussion.

The findings displayed that the teacher from the experimental group was inspired by small groups as an intervention strategy to modify her teaching practices. The change in teaching practices correlates with the performance of learners. The teacher indicated that claims made by learners who experienced challenges had enhanced in terms of performance and involvement because they were offered support to deal with hindrances and to side-step nervousness. As a result, the teacher appeared to have had challenges involving and supporting learners in learning NOR and other mathematics concepts before the intervention. The intervention seemed to have motivated the teacher in teaching NOR effectively and efficiently.

6.9.3 IMPROVEMENT OF LEARNERS' PERFORMANCE

The study should explore the strategy that could be used to enhance the performance of Grade 3 learners in diverse classrooms in NOR. In this regard, it appeared that small groups' application in teaching Grade 3 NOR in the experimental group, had a positive influence on the learners' abilities in solving problems. As noted earlier, learners showed to have difficulties in solving NOR problems from the pre-test. Learners appeared to have lacked the conceptual understanding to comprehend mathematical concepts, operations, and relations. Most learners were unable to answer the questions involving arranging numbers from smallest to biggest, writing the values of the underlined digit, identifying the numbers represented by base ten blocks, and interpreting the word problem.

As mentioned earlier, the post-test results indicated the mean score difference between and within the experimental and control groups. The post-test revealed a significantly significant difference $(t = -2.2408: p = 0.0269)$ in the mean score total percentage between the two groups, with the experimental group still performing better. Hence, the experimental group enhanced significantly in the post-test after the implementation of the intervention strategy.

6.10 ANSWERING THE RESEARCH QUESTION

The study intended to answer the following primary research question, as indicated in Chapter 1:

What are the strategies that can be used to enhance the performance of Foundation Phase learners in diverse mathematics classrooms?

The secondary research questions are aimed at gaining a broader understanding of the research study. They are used to respond to the primary question originating from the objectives of the study. The secondary research questions are answered in the next section.

6.10.1 PEDAGOGICAL APPROACHES

The information collected from lesson observations displayed that both teachers from the experimental and control groups started their lessons by asking learners to count numbers forward and backward. The teacher followed a question-and-answer approach, however, the teacher from the experimental group did not support learners before the intervention strategy. Furthermore, the teacher did not scaffold learners towards emerging new skills to properly express knowledge, thoughts, and perceptions in the learning situation. Teaching and learning before the intervention strategy in the experimental group did not pay attention to supporting and developing them to become self-regulated, where they could take control of and evaluate their own learning.

The teacher from the control group did not actively involve the learners, because they gave the answers while sitting at their desks. The teacher did not allow learners to use different means of expression to express their understanding and clarify information. The teacher also did not support learners who experienced difficulties in dealing with learned concepts to encourage active learning.

Prior to the intervention strategy, co-operative learning was not practiced and encouraged by the learners. Learners discussed the activities in groups of eight to nine and then were given the chance to write their answers on the chalkboard. However, the learners were not given the opportunity to ask questions as to how that group worked out the answer or to explain and give clarity to their answer. Learners were, instead, passively absorbing information and not actively involved so that they could accomplish this independently. Learners were not supported and motivated to participate in learning NOR, as the teacher simply passed if the answer from the group was correct and gave them correct answers where it was incorrect.

The teacher from the experimental group before the intervention strategy was guided by the NECT lessons to prepare and present the lesson and only used the activities from NECT and DBE workbooks. The teacher never adapted the activities to suit the learners in her classroom. However, learners were provided with resources, such as counters and word cards, during teaching and learning. Hence, it is indicated that the application of different resources and real objects when teaching different numbers helps learners to improve their understanding and performance.

Teaching and learning during the intervention strategy from the experimental group took the form of action research, where learners worked in small groups to support and interact with each other. In the first cycle, the researcher and the teacher from the experimental group set out the objectives they wanted to achieve by reducing the number of learners from eight to five in the groups during teaching and learning. The researcher and teacher, together with the learners, developed classroom rules that should be followed by learners in their groups to promote effective interaction. Resources, such as counters, word cards and worksheets from the lesson plans, were used during teaching and learning. However, some of the learners were not yet free to participate and communicate with each other when doing the activities because the learners were still in large groups. Learners from the experimental group were provided with the opportunity to work with peers with different abilities, enabling more diverse learning experiences, while checking their commonalities and differences. Learners were supported by checking their understanding through questioning and offering appropriate feedback. Learning cannot occur without feedback, whereas as a result, learners required a clear picture of the development they make in the classroom. Furthermore, learners were given the opportunity to interact by themselves by asking each other questions to clarify how they arrived at the solution to the problem. However, most of the learners could not participate effectively because activities such as learning through games and pictures were not applied during the first cycle, and most of the learners were not free to communicate during the discussions. Hence, we moved to the second cycle to ensure that all learners are accommodated and supported during teaching and learning.

In the second cycle, the researcher and the teacher realised that without games and pictures, most learners seemed to be bored. We introduced games where learners used counters to determine how many sweets each of them sold, how they were sold in the morning, and during break time or how many were left. Pictures such as array diagrams, base ten blocks, and even pictures of sweets or apples, were used during the first cycle. The group members were also reduced from five to three and four (four learners in a group, two learners were not allowed to form a group) with mixed learning abilities. The teacher should be aware of how to structure the groups, including the size, expectations for the learners' behaviour, and individual and group roles while supervising both the process and the outcomes of the group experience. Learners were allowed to speak in the language that they all understand in their groups to allow everyone to take part during their discussions and to enhance learner communication.

During the second cycle, the values of *ubuntu* were also taken into consideration, such as kindness, friendliness, listening to one another, and care, so that they can realise that everyone has different learning skills, where through mutual support they can help each other to complete activities, as well as to learn from one another and develop their knowledge and understanding. Furthermore, games and pictures were introduced in those groups to teach NOR. The results revealed that during group work, changeable rather than fixed grouping permitted the active participation of learners and provided them with prospects as to how to work effectively and successfully with other learners. However, to accommodate all the learners, curriculum differentiation and instruction differentiation were not considered, being difficult to implement since the teacher was rushing to finish the syllabus. However, the researcher and the teacher tried to discuss this, during which the teacher pointed out that it would delay the syllabus, and in the Foundation Phase, they do continuous assessment, which is done approximately every two weeks. According to the researcher, curriculum differentiation would make group discussion effective, as those learners who were able, would be given more complex problems to develop their knowledge, and those that struggled would be given simpler problems so that they could be grounded. We tried to give them these problems to discuss in the classroom, but when giving them classwork and homework activities, it was difficult, especially when we were assessing because of time. On the contrary, curriculum differentiation and instructional differentiation strategies were found to be the keys to responding to the needs of learners with varied learning styles, particularly in teaching mathematics.

The researcher and the teacher realised that some of the learners were unable to read the questions on their own and decided to proceed to the third cycle. This made the researcher and the teacher follow curriculum differentiation so that learners who were unable to read might be encouraged and be given a chance to read. Those who were unable to read were given a chance to read in groups and supported during reading. Furthermore, symbols, vocabulary, and structures to help in the reading and conveying of information to learners helped to clarify for learners who were unable to read. Learners participated in games with learning resources, displayed information, communicated their ideas and supported each other, which created a positive learning environment for all the learners. The spirit of kind-heartedness, politeness, consideration and openness, friendliness, togetherness and respect emerged, because learners were able to listen to and support one another. After realising that most learners were able to read, support was gradually removed so that they could be independent. The researcher and teacher then realised that the strategy used appeared to be effective in the third cycle of action research, as learners were accommodated in the diverse classroom.

The lessons taught during the intervention strategy were mostly characterised by questioning and discussion techniques, where the teacher interacted with learners and learners interacted with one another to understand their reasoning and intellectual thinking about the concepts being taught. The teacher from the experimental group enhanced learners' engagement and concentration, offered them a sense of determination, and made it simpler for learners to link the information to the new knowledge of NOR by asking questions. Learners were introduced to social interaction skills required for effective interaction and listening skills to listen to other ideas for active learning to take place effectively. The teacher provided learners the chance to present their work on the chalkboard and used questioning techniques that lead to understanding, diagnosed their errors and misconceptions, and enabled learners to work on the solution of the problems on their own in the future. The teacher offered support to learners by asking questions to clarify the errors and misunderstandings that the learners experienced during teaching and learning.

After the intervention strategy, the teacher prepared worksheets with counters and used the DBE workbook together with the activities from the NECT lesson plans to give to learners to write out. It was revealed that providing tangible resources to learners and guiding them to use their creativeness to do additional work on mathematics concepts instead of merely relying on worksheets, develops learners' understanding. Teaching and learning resources gave every learner reasonable access to learning chances through material and activities in multiple arrangements and multiple means for engagement, expression, and learning. The learners appeared to have gained knowledge and developed understanding in NOR since they shared resources, used games and used worksheets, which is consistent with the performance of learners. Real life examples were used to enhance understanding of the concept being taught, where learners were able to make a relationship between the content and instruction since examples are relevant to learners' lives both inside and outside of school. The teacher motivated learners by using multiple means of engagement and presentation to encourage them, to appreciate learning and doing mathematics, and recognising that learning and doing mathematics is both imperative and beneficial.

6.10.2 REQUIREMENTS FOR SUCCESSFUL GROUP WORK AS A TEACHING STRATEGY

Group work is defined as a technique for conceptual learning, developing academic language proficiency, and for improving intergroup relations by increasing trust and friendliness among the learners (Baines, Blatchford & Webster, 2015). Group work was seen as a teaching strategy that should develop skills for listening to one another’s ideas, respecting each other’s opinions, working with each other in groups, and a strategy for addressing mutual classroom challenges, such as keeping learners engaged with their work.

First and foremost, for effective group work as a teaching strategy, teachers and learners ought at first to set the rules about the group work for learners to abide by them. The learners needed to ensure that they abide by those rules during group work. The following should be given attention: learners should respect one another and their ideas, there should be mutual communication during group work, kindness, compassion, support, sharing of resources and harmonious co-operation to promote positive learning. In grouping learners to have discussions, the teacher should set the objectives that he or she wants to achieve during the discussion. In that space, the teacher ought likewise to have compassion for the learners, care for them, and listen to the learners' ideas to provide support where needed.

Learners can be grouped into small mixed abilities so that learners who are able can assist learners who experience learning difficulties. This is where peer support comes in, and friendship and kindness is encouraged. The teacher should ensure that each learner in a group has been assigned a role so that some learners do not sit idle during group discussions. As mentioned earlier, to promote effective group discussion, the values of *ubuntu* should be taken into consideration to encourage mutual communication so that they complete the activity given to them in time.

During group work discussions, curriculum differentiation should be given attention, where learners can also be separated according to their cognitive learning abilities so that those who are able to are not delayed in solving the problems that they already understand. Hence, it is better to separate them for the teacher to be able to support those who are struggling or experiencing learning difficulties. Games, such as learners using counters to find how many candies they sold, how many are left, number builders and pictures such as array diagrams, base ten blocks to identify numbers, and number cards to build numbers, should also be used to reinforce group work in the Foundation Phase. Also, those able learners can be given more complex problems to solve so that they can learn and develop their knowledge, rather than giving them simpler problems that will bore them and not sufficiently develop their reasoning skills. However, learners can be given the same classwork and homework so that teacher might be able to give feedback to all the learners at the same time in form of correction.

In the group discussion, because they are Foundation Phase learners, learners can be given the opportunity to learn through playing games, using pictures, diagrams, and counters in the form of storytelling, oral communication, and mathematical symbols. Learning through play can influence reasoning skills, attitude, and abstract conduct (Kenta, 2017:48). Learners should be taught communication skills to be able to communicate effectively during group discussions and to make learning interesting.

6.10.2 POTENTIAL BARRIERS

Intervention in the form of small group work during teaching and learning revealed its own barriers in the framework of the study. During the first cycle, some of the learners were not able to participate effectively, use games, and communicate freely, because they were still in large groups. Play and games can provide learners the opportunities to acquire and develop foundational mathematics skills that are associated with common core standards. Furthermore, games can influence reasoning skills, attitude, and abstract conduct, which are significant mechanisms to improve academic achievements. The researcher and the teacher from the experimental group moved to the second cycle to modify the groups so that the diverse learning needs of all the learners could be accommodated.

In the second cycle, the researcher and the experimental teacher ensured that the different learning needs of learners were accommodated by supporting them when doing their activities. However, the assessments given to learners were not differentiated according to their learning abilities, because the teacher had to follow the guidelines stipulated by the department on how assessments should be set. Activities within units and across the programme should reflect the diversity and range of assessments to be applied to a diverse range of learners. Teaching other subjects and completing the syllabus was a problem for a teacher to be able to differentiate the curriculum, as well as to support and accommodate the needs of all learners. These hindered teachers in developing activities that were fair, clear, open and sensitive to different learning abilities of learners that would accommodate all the learners. It has been revealed that curriculum differentiation and instructional differentiation strategies are keys to responding to the needs of learners with varied learning styles, particularly in teaching mathematics, however, all learners were assessed with the same activities even though they had different learning abilities.

In the third cycle, the researcher and the teacher tried to implement curriculum differentiation to accommodate the different learning abilities of learners, especially those who were unable to read. However, learners were grouped according to their learning abilities so that those who could not read would be supported and those who could read can be given more complex problems to do to avoid learning delays. When giving learners activities such as classwork and homework, it was difficult to give them differentiated work, especially when conducting the assessment, because the teacher noted that this would delay her progress. For this reason, they were given the same activities, but those who were able to complete classwork and homework were given extra activities so that they do not finish and become bored while waiting for other learners to finish doing their activities and to expand their knowledge and understanding of the concepts.

6.10.3 BENEFITS OF SMALL GROUPS IN TEACHING NUMBERS, OPERATIONS AND RELATIONSHIPS IN GRADE 3 DIVERSE CLASSROOMS

The application of small group interactions helped individual learners to comprehend information when learning NOR and motivated learners in rearranging information to solve mathematical problems. Grouping learners into heterogeneous groups provided the learners the opportunity to work with peers with different abilities and enabled more diverse learning experiences. Group work helped learners to learn effectively and gave them the experience to approach problems in their own ways. During group interactions, learners' intergroup relations improved, trust and friendliness increased, and they learned skills for working together in groups that could be transferred to various learners and adults in work environments. Listening to each other's ideas, supporting each other and working together to solve the mathematical problems, provided learners with the ability to construct knowledge and accomplish the task by interacting with each other.

The use of small groups as an intervention strategy allowed the teacher to know her learners, their capabilities, their learning challenges, and how to accommodate them in a teaching and learning situation. Changing grouping after each topic permitted the teacher to improve the activities and numerous roles, as well as deliver prospects to determine how to work most successfully with others. Learners allowed each other to speak and tell their stories about how they worked their answers out from their groups. Small groups permitted learners to share ideas, and support each other during teaching and learning, equipped learners with communication skills that brought a change in their learning, and enabled them to construct knowledge in NOR concepts.

6.10.4.1 Change in learner performance

The data analysis obtained from the pre-test, the post-test, lesson observations and unstructured interviews exhibited that learners’ performance from the post-test was enhanced after the implementation of the intervention strategy. The findings suggest that the intervention helped in enhancing learners’ performance in Grade 3 NOR, which supports that group interactions helped individuals to make sense of the information while improving their understanding. The pre-test and post-test outcomes displayed learners’ improvement in their conceptual understanding and comprehension of mathematical concepts in NOR during the intervention strategy and after the implementation of the intervention strategy. Learners could apply games, communicate effectively in their groups and tell how they found the solutions to the activities.

Furthermore, lesson observations during and after the intervention strategy presented an improvement in learners' participation in NOR. Learners were able to solve simpler problems and move to complex problems to see how they performed. Learners participated actively, respected each other's ideas, gave each other turns to speak, supported each other, shared the resources and worked together to complete the activities they were given. What we did in the third cycle, gave us the impression that when struggling learners are given simpler problems they were able to solve them, hence they were given more complex ones whilst they were being assisted. This is where the scaffolding came in and learners were engaging because they realised that they were learning, and they were not solving simpler problems that they already know. Curriculum differentiation works for all learners because those who can are also given challenging problems that they can do and learn and even those who are struggling are given problems at their level that they can do and learn. Learners who could not read were grouped so that every learner could be given a chance to read whenever they were given problems to develop their reading abilities until we realised that all the learners were independent. However, curriculum differentiation could not be done at the end of the formal assessment, because the teacher said that it was going to delay her syllabus and according to ethical considerations, the researcher had to respect the participant's views and requests and protect the participant.

The statistical results in the pre-test showed the performance mean score $(\bar{x} = 40.70175)$ for the experimental group, as compared to the mean score $(\bar{x} = 31.62162)$ for the control group. Neither of the groups performed well with the statistically significant difference of $(t = -2.2611;\ p = 0.0254)$ at 95% level of confidence. Learners from the experimental group did not perform well even though they performed better than the control group from the pre-test. The experimental group performed lower in the pre-test as compared to the post-test. In the pre-test, the mean score for the experimental group was $(\bar{x} = 40.70175)$ while in the post-test, it was $(\bar{x} = 55.05455)$, and this exhibited that the learners from the experimental group showed some improvement in their performance. This showed an improvement in the mean score of $(\bar{x} = 14.3528)$ and it also showed a significant difference of $(t = -2.2408{:}\ p = 0.0269)$ at 95% confidence limit between the two groups. The learners from the experimental group seemed to have attained deeper conceptual and procedural knowledge in solving NOR problems.

6.10.4.2 Change in teaching practice

The qualitative data analysis gathered from the unstructured interviews and lesson observations showed that the teacher from the experimental group through the exposure gained during small group teaching had changed her teaching strategy by involving learners during teaching and learning. It is found that through small groups, the atmosphere of the interaction inspired learners to learn, to develop their reasoning skills, to discover some different thinking, and to learn for appreciating input from other learners or the environment. Other researchers support that teaching through small groups allows teachers to support all the learners, respect, care for others, and care for all the learners, irrespective of their background, learning variances, or the language they speak.

Teaching through small groups benefited the teacher from the experimental group and the learners. Learners gave each other mutual respect, along with the chance to speak and supported their peers. Learners were taught to understand that their different learning abilities are not merely respected but also integrated in such a way that effective teaching and learning are brought out and a sense of belonging and acceptance is engendered. Learners learned to support each other during teaching and learning, to listen to each other's ideas and shared which made every learner feel a part of the teaching and learning.

Furthermore, the teacher from the experimental group gained knowledge in supporting the learner’s abilities by asking open-ended questions, contributing with suggestions, demonstrating, and strengthening the learner’s understanding. The teacher interacted with a few learners directly, motivated them, positively engaged them and made the learners communicate freely. The teacher also improved her questioning style by showing learners that finding the correct answer to the problem is not the only purpose of shared learning experiences, however, discussing different ideas, questioning and refining each other’s tactics, and generating a mutual understanding are the essential learning objectives.

The teacher from the experimental group started to adapt some of the activities from the lesson plans to suit the learning environment of the learners. As indicated, learners were given the same classwork and homework because the teacher did not want to delay her programme because she was focusing on finishing the curriculum. Games, pictures, symbols, and learner-communication for teaching NOR concepts showed that the teacher started to apply different teaching strategies to accommodate all the learners. Learners used games like one learner being a shopkeeper who sells sweets while others were customers, and he/she had to find out the number of sweets sold in the morning and during the break, and how many sweets are left. Learners used counters to work out the answers. Pictures such as base ten blocks, pictures of sweets, apples, and array diagrams and number cards were used by learners during teaching and learning. Using games in mathematics teaching and learning makes the process more meaningful and interesting and facilitates the growth of mathematical knowledge. For this reason, discussions between the researcher and the experimental teacher during the three cycles seemed to have exposed the teacher to applying different teaching and learning strategies.

6.10.4.3 Challenges of using small groups in teaching and learning

Intervention in the form of small group teaching presented its own challenges in the context of the study. The findings revealed that the teacher had to prepare activities based on learners' abilities in the groups and to ensure that every learner participated actively. Again, group work is challenging, because it involves organising the classroom to increase the ability for group work by thinking about classroom arrangement, the structure, size, and consistency of groups. Teachers had to support the groups' capability to do the activities rather than guiding them in how to do these using observing and directing, for example, and by asking open-ended questions, presenting suggestions, demonstrating, emphasising and thorough monitoring. All these sometimes required a great deal of time, which is not possible since the teacher was required to also teach other subjects.

6.10.5 DEVELOPING AN EFFECTIVE SMALL GROUP WORK MODEL

The results for grouping learners into small groups according to different learning abilities indicated that learners should be given a role to participate effectively during the interaction. All learners had to take part in the discussion and not become passive observers who absorbed information without understanding. Small group interaction in the study focused on the experimental group that was also not performing well in Grade 3 NOR, where the researcher was supposed to identify the strategy that could be used to enhance the performance of learners in the diverse classroom.

The teacher needs to know the learners, their learning level, and how they learn, including their strong and weak points before putting learners into different groups. Also, *ubuntu* values need to be taken into consideration so that learners can respect each other's ideas, can share resources, and give each other a chance to speak. Learners who are engaged in mathematical argumentation write in ways that expose their reasoning to one another and their teacher during group interaction, help learners to deal with different mathematical problems and eventually improve in performance. Group work should develop group-working skills and support a rational method, where learners feel safe to take part, ask questions, deliberate on challenges and be accountable for their learning. Group work benefits teachers and learners because the teacher changes her approaches to teaching while learners through co-operative and collaborative learning, produce higher achievement and create positive relationships amongst themselves, rather than competitive or individualistic experiences.

6.11 DEFICIENCY IN UNIVERSAL DESIGN FOR LEARNING

The theoretical framework that has underpinned this study took the form of the Universal Design for Learning, incorporating the Zone of Proximal Development and *ubuntu* African philosophy. UDL focuses on accommodating the learning needs of all the learners by giving learners differentiated activities, and not a one-size-fit-all technique where learners are treated the same. UDL suggests flexible teaching and learning styles that accommodate the needs and capabilities of all learners and eradicates pointless hindrances in the learning procedure by developing a compliant learning situation in which information is offered in multiple ways, learners engage in learning in different ways, curriculum differentiation, and options provided when demonstrating their learning. However, the theory does not bring up the values of *ubuntu* for differentiated activities. This might lead those learners who can undermine those who experience learning difficulties in the classroom. Learners should learn to respect each other's different learning styles, and there should be mutual communication among them. UDL can be complete if the values of *ubuntu* are infused into the theory to make it more effective.

Furthermore, during teaching and learning, those learners who are able might undermine the learners who are struggling, by saying they are given simpler problems. This may discourage struggling learners during teaching and learning from participating effectively. All learners should be made aware that learners are unique and learn differently and should be accepted the way they are. Hence, they should not undermine others, but respect one another, irrespective of their cognitive abilities. They should be made aware that they can show compassion to other learners by assisting them. Again, learners should understand that experiencing learning difficulties during teaching and learning does not make one less human, where the difference is that they learn and understand the concepts differently. If learners are not made aware that all learners are equally important in teaching and learning, those learners who are able might either undermine or end up labelling other learners, who experience learning difficulties.

The data collected in the study shows that UDL can be effective if respect, kindness, compassion, friendliness, care for each, politeness, consideration and openness can be added. Curriculum differentiation does not cater to the learners' wellbeing, whereby learners should be respected, cared for, or considered. We can differentiate the curriculum, but if the learners' wellbeing is not given due attention, then all the activities that are being done may not work for others, because some learners may feel threatened. Additionally, since they are Foundation Phase learners, some may not have the confidence to indicate where they do not understand or ask questions. If a learner does not have the confidence to do something, that learner should be respected and empowered, so that he or she can enjoy a sense of belonging, as per *ubuntu* values. If learners feel that they are part of the group and the lessons, even if they are struggling, they can still pay attention because they do not feel threatened, they do not feel that they are not part of the group or part of the lessons, they do not feel that there are learners who can solve the given problems, and they cannot, but they are all part of the learning because there is mutual respect.

6.12 CHAPTER SUMMARY

This chapter discussed the qualitative and quantitative data generated from the study. The analyses of the pre-test and post-test, together with unstructured interview responses and lesson observations were integrated with theoretical perceptions and the literature review. The quantitative data from the pre-test revealed that learners from the experimental group performed better as compared to the control group, even though their performance was not satisfactory. Unsatisfactory performance from the experimental group was also supported by challenges identified during open-ended interview questions with the teacher.

The lesson observations results revealed that most learners appeared to experience learning difficulties in numbers, operations and relationships before the intervention, as they were not guided by the teacher when providing incorrect answers to the questions posed to them. The results also revealed that the teacher from the experimental group was unable to support the learners during teaching and learning, as scaffolding was not provided to accommodate the learning abilities of different learners. However, P1 tried to provide multiple means to involve all learners in participating during teaching and learning by involving even learners who did not raise their hands. On the other hand, the teacher from the control group did not actively involve the learners, because they gave answers by sitting at their desks.

The data collected from the experimental group during the intervention strategy showed improvement in learners' participation and the teacher's support. Learners participated actively during the group work activities by discussing in their respective groups, presenting their solutions to the given problems to the whole class, and becoming involved by asking questions and discussing different answers from other groups to understand how they arrived at those answers. The teacher from the experimental group was interested in learners' reasoning and thinking when asking them questions based on their answers. Furthermore, learners who were not participating actively in group discussions before, started to participate as they were given roles and more knowledgeable learners supported their peers which indicated that they understood how to apply strategic knowledge to answer NOR related problems.

The resources, such as counters, word cards, and number charts, were used to reinforce the concepts and used to work out the answers. The teacher would always start the lesson by doing mental maths with learners, either asking them to count in 5s, starting from one hundred to two forward and backward, or asking them simple addition or subtraction numbers orally. Working out the solution to the problems seemed to be easier for learners because they had counters to help them do the addition or subtraction of numbers from the given problems.

The statistical analysis before the intervention strategy revealed a significant difference between the experimental and control groups, with the learners from the experimental group performing better when compared to the control group. The results after the implementation of the intervention strategy showed improvement between the pre-test and the post-test for both the experimental group and the control group. The findings revealed that there was a significant difference in learners' performance between both the experimental and control groups, hence the experimental group continued to perform better than the control group.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATIONS

7.1 INTRODUCTION

The purpose of the study was to explore the strategies that could be used to enhance the performance of Foundation Phase learners in diverse mathematics classrooms in NOR. Learning in a diverse classroom entails receiving equal and the same education irrespective of language, learning difficulties, social background and being able to develop capabilities to comprehend information, have compassion and solve problems (Sagor & Williams, 2017:1). However, teachers experience challenges in accommodating and supporting the needs of all learners in the classroom. The study was conducted in two schools that were not performing well with mathematics learners in Grade 3.

For this study, small group work was identified as the intervention strategy for the experimental teacher to change her teaching practices to improve learners' performance in Grade 3 NOR. Groupwork is a learner-centred method of teaching that emphasises teamwork, collaboration, and co-operation, where learners work collectively to construct knowledge and achieve the objective through interacting with each other (Morris, 2016:4; Retnowati et al., 2017:667). The identification of the intervention strategy followed reconnaissance action research which took the form of a three-cycle implementation. Setting rules together with the learners for everyone to abide by them in the first cycle made learners able to work with each other during group work discussion, because learners respect each other, listen to each other's ideas, and share friendship. However, most of the learners could not participate effectively, because learning through play by using a variety of games, or using pictures, was not introduced. Learners in the Foundation Phase learn effectively when they can touch, see or practically do what they are learning so that they can understand the concept. The teacher becomes efficient in checking learners' understanding and offering appropriate feedback (Molina, 2018:16), accommodating and supporting the diverse needs of the individual learner, express respect, and kindness toward the learners (Meyer & Rose, 2012; Maghfirah & Mahmudi, 2018:2). For learners to engage in mathematical discussion, write in ways that exposed their reasoning to each other and their teacher (Gamlem, 2019:2), they need to feel as part of the group during teaching and learning. Groupwork allows learners to struggle on their own, to make mistakes, and makes learners responsible for specific parts of their work (Bussi & Sun, 2018:15; Cohen & Lotan, 2014:6; Gamlem, 2019:2). It teaches skills for working in groups that can be transferred to many learners and adult work circumstances (Cohen & Lotan, 2014:6; Sun et al., 2018:99).

During the second cycle games, where all the learners in a group took part, using pictures and concrete resources seemed to have motivated learners to be positively and effectively involved in teaching and learning. Learners displayed a different status of learning by supporting each other and treating each other as human beings, which made all the learners have a sense of belonging and ensured that they felt part of teaching and learning. The application of curriculum differentiation in the third cycle also seemed to have allowed the teacher to give learners problems to solve based on their learning abilities to accommodate and support their learning differences. The teacher, through discussion and planning with the researcher, became more efficient in using games, pictures, word cards, counters, and worksheets in developing learners' understanding and including the different learning needs of all the learners during teaching and learning.

This chapter finally, reflects on the rationale for and the research design of the study in order to draw conclusions on the benefits of small groups as a teaching and learning strategy. The chapter also discusses the limitations of the study, and the implications of the framework applied in the study to adjust it. Finally, recommendations for future study are suggested.

7.2 IMPORTANCE AND DESIGN OF THE STUDY

As mentioned that small group work was identified as an intervention strategy, it was identified in teaching and learning Grade 3 NOR in the experimental group. Groupwork is a learner-centred approach to teaching that emphasises collaboration, co-operation, and teamwork, where learners work together to construct knowledge and accomplish the task through interacting with each other (Morris, 2016:4; Retnowati et al., 2017:667). In this study, small groups were used to support a learning environment, where learners perceive that they belong, encourages positive learning towards the learners' needs and teachers' capability to develop passionate helpful classroom settings with sincere and considerate relationships to improve the performance of learners (Gamlem, 2019:2; Molina, 2018:11). Classes from the schools and the other schools from the circuit not incorporated in the research study seemed to have been deprived of the opportunity to share their proficiency, skills, and knowledge. For this reason, the study was designed to explore the teachers in relation to their teaching practices, as well as the impact of the small group teaching, and the intervention strategy in the experimental group. Furthermore, the study employed pre-test and post-test at the learner level to measure the impact of small group teaching as the intervention strategy.

The study employed an explanatory research design using pre-test and post-test to measure the impact of the intervention strategy at the level of learners in the experimental group. The pre-test and post-test were also used to compare the results of the experimental group and control group. A pre-test before the intervention strategy was used to examine a Grade 3 level of performance in NOR from the experimental group and the control group. The pre-test results revealed that both the experimental group and control groups performed poorly, however, the experimental group was slightly better than the control group. The open-ended interviews conducted with the two participating teachers helped in understanding the challenges experienced in Grade 3 NOR. Lesson observations were conducted in the experimental group before, during, and after the intervention strategy (group work). As mentioned earlier, the post-test was administered after the implementation of the intervention strategy. Reconnaissance action research was applied to conduct the intervention strategy in three cycles in the experimental group.

7.3 MAIN FINDINGS OF THE STUDY

The pre-test results revealed that the experimental group performed better than the control group, which showed a statistically significant difference between them. However, the performance of the experimental group was not satisfactory, because learners demonstrated a low proficiency in numbers, operations, and relationship concepts, which required the attention of the intervention strategy. The pre-test data collected from the quantitative study indicated the statistically significant difference between the experimental and control groups (the mean score). The post-test results after the intervention strategy showed improvement for both experimental and control groups. In particular, the experimental group showed an improvement in the mean score ($\bar{x} = 55.05455$). The improvement suggests that the group work had a positive impact on the changing of P1's teaching practice, where the learners' performance improved.

Quantitative and qualitative data collected before the intervention strategy proposed that learners lacked the mathematical conceptual knowledge to be able to create the relationship amongst the ideas of the numbers (CAST, 2011:5; Kilpatrick et al., 2001:5). The results also revealed that the teacher from the experimental group was unable to support the learners during teaching and learning, as scaffolding was not provided to accommodating the learning abilities of different learners. Teachers' should be able to examine their teaching strategies, explore possible ways of recognising different learning styles, adapt to each learner's needs, and carefully select the appropriate teaching styles to ensure that each learner is involved in learning (Landsberg et al., 2011:76; Philpott, 2009:20). Learners were not guided when answering the questions and even those who gave the incorrect answers were not motivated. According to Schwarzer and Grinberg (2017:17), teachers need to support learners, and the opportunity to make sense of mathematics in connection with their prior knowledge. P1 did not apply different mathematical techniques to support the learners in solving problems, or guide or motivate learners to be creative (Junqueira & Nolan, 2016:979). Most of the questions were partially answered and some of them were left unanswered.

During the intervention strategy, the application of resources, such as worksheets, word cards and counters to complement the activities provided with lesson plans (NECT) and the DBE workbook in the experimental group, produced an improvement in the learners' performance. Learning by doing in mathematics is imperative and teaching aids facilitate the understating of learners in learning mathematics and improving their performance (Alshatri et al., 2019:448; Willacy & Calder, 2017:6). This suggests that the availability of resources and the correct application thereof, can promote positive learning while improving the performance of learners.

Small groups teaching during the intervention strategy proposed that there was a change of interaction between the teacher and learners, which brought about improvement in teaching and learning in the classroom (Gamlem, 2019:2). In the first cycle, the results showed that applying group work without using games, pictures and concrete resources that would make learners enjoy their learning, was not effective. In other words, learners in the Foundation Phase enjoyed learning by doing, touching, and playing games that would motivate them to learn, while enhancing their understanding. It was also found that respecting each other's ideas, caring for one an other, having mutual communication during group discussions, and listening to each other, encouraged effective teaching and learning, and made all the learners feel part of teaching and learning.

Small groups, which were made up of learners with different learning abilities from the experimental group, seemed to have encouraged the learners in sharing ideas amongst themselves, with the class, and noted that there are different ways of solving a problem. Asking learners or groups of learners probing questions and encouraging them to ask each other questions for clarity and understanding, encouraged learner thinking and reasoning regarding the concepts being taught. According to Molina et al. (2018:11), conveying respect and compassion for the learners, as well as assessing learners' understanding and offering suitable feedback, has a positive influence on learners' learning and performance.

The data during the second cycle proposed that there was an improvement and shift towards learner involvement during teaching and learning through small group discussions. The use of games, concrete resources and pictures in the small groups from the experimental group seemed to have motivated learners to participate actively and work together while showing humanity towards one another. In addition, working with small groups allowed the teacher to know her learners learning abilities and how to accommodate and support them.

The findings from the third cycle suggest that the introduction of the curriculum differentiation during small group discussions appeared to be successful during the intervention. Giving learners problems according to their learning abilities gives every learner the opportunity to participate in teaching and learning. In addition, if learners who are able are given more complex problems than simple ones, they become motivated and learn while solving them, and when the struggling learners are given simpler problems, they will also try to solve them and be given complex ones to develop their understanding. Curriculum differentiation showed that the teacher can support the struggling learners, while the able learners are doing something that will motivate them in learning rather than giving them simpler problems that will bore them.

The findings propose that the research study has accomplished its objectives, that is, to explore the strategy that can be used to enhance the performance of Foundation Phase learners in diverse mathematics classrooms. Teaching through small groups was discussed by the researcher and the teacher from the experimental group after observing that she was applying larger groups before the intervention. This permitted the researcher to measure its influence statistically in connection with changes in learners' performance in Grade 3 NOR. Learners appeared to have learned to make sense of the information, think critically and link the existing knowledge with prior knowledge.

7.4 THE RESEARCHER’S VOICE AND THEORETICAL FRAMEWORK

The results of the study provided perception and understanding of teaching and learning of NOR in Grade 3 diverse classrooms. The quantitative data analysis proposes that number sense should be emphasised during teaching and learning so that learners develop a holistic concept of the capability to comprehend amounts, numbers, operations, and relationships among them, which are employed competently and flexibly in making a mathematical decision, and the capability to complete basic arithmetic computations (Maghfirah & Mahmudi, 2018:2). The results revealed that prior knowledge is the key for learners to understand the new concepts. More importantly, the application of teaching and learning resources plays a significant role in helping learners understand the concept being taught. As noted earlier, the active involvement of learners in teaching and learning helps learners to acquire knowledge, rather than passively receiving information without understanding.

The experimental group exhibited greater improvement in the post-test as compared to the pre-test, which revealed a positive influence of the intervention on the learners' learning. However, for the teacher to implement small group teaching successfully, the teacher needs to consider the learning abilities of each learner in the classroom, their prior knowledge, application of teaching and learning resources, and being able to adapt to any situation during teaching and learning to accommodate every learner. It is important for the teacher to facilitate teaching and learning when using small groups and give each learner from the group roles so that they all participate effectively and positively. Learners should be provided with the opportunity to comprehend, and express their learning, be involved with the resources in a manner that most benefits them and be encouraged to be involved with resources in a manner that would aid them to increase their proficiencies and advance in areas in which their skills are not as strong (CAST, 2011:32; Harbour, 2012:1; Hall et al., 2012:18). Small groups can be effective if they do not stay fixed but alternate for different topics to give learners the opportunity to work with peers of different abilities, enabling more diverse learning experiences, sharing ideas and acquiring different strategies of solving problems.

Teaching and learning in small groups were characterised by collaboration in which learners respected each other's opinions, increasing trust and friendliness. The outcomes suggest that working in small groups taught learners skills that allowed them to struggle on their own and make mistakes and be responsible for specific parts of their work, which are skills that can be transferred to many learners and adult work conditions (Cohen & Lotan, 2014:2; Bussi & Sun, 2018:15). The results revealed that if a small group can be effectively applied during teaching and learning, learners' performance can improve, and the teacher's teaching practices can change.

Universal design for learning is guided by three key principles, namely: to provide multiple means of engagement (why of learning); to provide multiple means of representation (what of learning); and to provide multiple means of action and expression (how of learning) (CAST, 2011:29). However, if learners' minds are not prepared, these three key principles may not apply during teaching and learning. Learners should be prepared to know to respect each other, listen to each other's ideas, be friendly to each other and care for each other so that they can feel that they are part of the group. Once learners are at that level, they can know what they should learn, why they learn it, and how they should learn those topics. If learners do not respect one another, some may feel threatened, some may feel inferior, or the teachers may assume that the learners are learning while they are not learning due to being threatened, feeling inferior, or being intimidated by other learners. Hence, learners ought first to be taught to respect one another before they can enter the space.

This study finds that learners can learn what they are supposed to learn only if they are well prepared in terms of the philosophy of *ubuntu,* where they should respect one another so that every learner should feel a sense of belonging, feel to be part of the group, be mentally ready to learn because some learners might be threatened or intimidated by some of their peers, who think that they are much better than them. Sometimes, they can become absent-minded, not enjoy the lessons because they are not ready, or feel that they are not part of the group. Also, teachers should refrain from treating learners differently in the classroom, especially discriminating against those who are not doing well in the classroom, by focusing more on those who are doing well, which is discrimination of some sort and may affect learners mentally in one way or another. However, if the philosophy of *ubuntu* is brought on board, learners feel that they are treated equally, where the universal design of learning can be more effective.

This implies that the teacher should be able to motivate learners so that they understand why they are learning by engaging them in different ways. Again, learners should be provided with the opportunity to present what they have acquired during teaching and learning. Finally, the teacher should differentiate the ways that learners can express what they know and be supported in doing that, thereby creating a positive inclusive learning environment by accommodating a broad variety of needs that may reduce possible learning barriers or unnecessary learning difficulties from learners. These guidelines can be achieved if the teacher can accommodate the learning needs of all learners in the diverse classroom. Also, the correct application of ZPD and scaffolding can enhance learners' understanding and develop their thinking and reasoning skills.

7.5 KNOWLEDGE CONSTRUCTION

Knowledge construction can be based on how teaching and learning takes place in diverse classrooms. Extant literature indicates that knowledge does not only emphasise what is known but the way individuals come to know the concepts and their connections, which they may use to understand ideologies in a sphere of influence, to remember and make judgements and projections (Garg, 2017:1; Machery, 2010:200). If learners start to develop an understanding of the concepts being taught, they can create the relationship of mathematical themes and can organise their knowledge logically so that they can connect new ideas with what they already know (Math Assessment Resource Service, 2017:5; NCTM, 2020a:7).

Based on the findings from the study, infusing the values of *ubuntu* during group discussions can motivate the learners in learning, especially learners who experience learning difficulties. During group discussions, mutual respect to encourage effective interaction and participation should be considered so that learners' thinking skills can be developed. Through creative thinking, learners will learn to construct their own knowledge of the concept being learned. Also, through peer support, the teacher's support, and accommodation and by making them feel that they belong to a group and are part of teaching and learning, they can develop their understanding and learn to construct knowledge. Confidence also encourages learners to be eager to learn and take risks in their own learning, which will develop their skills in constructing knowledge.

Learning new concepts depends on the mastery of earlier ones so that the learners can make a connection between what they are presently learning and what they have already learned (Hall et al., 2013:74; Junqueira & Nolan, 2016:983). This implies that if learners have not mastered the concepts that they previously learned, it will be difficult for them to construct knowledge from what they have learned to link the new knowledge. According to Schwarzer and Grinberg (2017:11), connections are formed when the content and instruction are relevant to learners' lives inside and outside of school. Effective teaching requires meaningful connections between learners and the curriculum (Schwarzer & Grinberg, 2017:11).

The teachers should use questioning techniques that lead to understanding, diagnose their errors and misconceptions and enable learners to work on the solution of the problems on their own in the future (Barbour, 2016:7; Shulman, 1986:8; Steyn & Adendorff, 2020:5), to allow learners to construct knowledge. Askew, Venkat, Mathews, Ramsingh, Takane and Roberts (2019:5) point out that by focusing only on what learners are learning in acquiring knowledge, learners may divert from attending to who they are becoming through the processes of this learning because of what they are learning, and is not just about mathematics, but also about themselves and others. In addition, learners should also be made aware that the wrong answer can be used to direct or guide them into creative thinking while leading them to finding the correct answer, thereby constructing new knowledge. Moreover, the questioning style should be used to highlight to the learners that finding the correct answer to the problem is not the only way of constructing knowledge, however, discussing different ideas, questioning and refining each other's tactics, and generating a mutual understanding of how the answer was established, is the essence of constructing knowledge (Mutara, 2016:241). Learning through playing games with peers might direct them to acquire new skills, practice their existing abilities, and build their interests while constructing new knowledge and recollecting mathematical concepts. Furthermore, games can influence reasoning skills, attitude and abstract conduct, which are significant mechanisms for improving academic achievements. The use of different pictures during teaching and learning helps learners to associate numbers with pictures, and to develop a number sense, as well as their reasoning skills. Pictures also help learners to develop their understanding by creating their knowledge through them. In addition, learners should also be made aware that the wrong answer can be used to direct or guide the learners into creative thinking while leading them into finding the correct answer.

7.6 PROPOSED EFFECTIVE TEACHING STRATEGY

The projected effective teaching strategy can be based on the outcomes of this study, the literature, and the theoretical framework underpinning the study. The literature presented that small groups can be implemented for different reasons, such as enabling the teacher to interact with a few learners directly, to motivate them, positively engage them, and make learners communicate freely with each other or with the teacher to accommodate the diverse needs of all the learners in the classroom (Lin et al., 2020:3). The literature showed that group works can help learners learn in effective ways and give them the experience to study in their own ways (Mallipa, 2018:192) when the values of *ubuntu* are infused during group discussions. Learners can borrow knowledge from the other groups and reorganise, linking new knowledge with prior knowledge gathered (Retnowati et al., 2017:668), and the teacher takes the role of facilitator, teachers and learners share knowledge and ideas (University of Suffolk 2019:533). Small group work improves academic language proficiency and intergroup relations by increasing trust and friendliness among the learners (Baines, Blatchford & Webster, 2015:19).

In this study, group work focused on the experimental group, with the researcher sharing ideas with the teacher on how to make group work effective in the diverse classroom in teaching NOR. Application of small groups during teaching and learning should focus on the learning needs of different learners as well as diversity in the classroom and take into consideration the challenging concepts or topics to learners. The teacher should identify the learning challenges of learners in the classroom, identify their learning abilities and use the resources to enhance learners' understanding. Furthermore, the teacher should identify the topics that are challenging to learners to improve their performance. The teacher should provide different means of engagement, different means of representing information, and different means of expression during teaching and learning (CAST, 2011:25).

During small group teaching and learning, the learners need to be shown the necessity of mutual respect, friendliness, compassion and support for each other and not undermine each other in a group (Letseka, 2016:6; Müller et al., 2019:26), to promote active and positive learning. Grouping learners into varied learning abilities can provide the learners the opportunity to work with their peers, to acquire more diverse learning experiences (University of Suffolk, 2019:4). Teachers should use different options to present information to the learners and use questioning techniques that can lead learners to understand, diagnosing their errors and misconceptions and enable learners to work on the solution of the problems on their own in the future (Barbour, 2016:7; Shulman, 1986:8; Steyn & Adendorff, 2020:5). The teachers should employ various means to present information to learners, employ different means for engaging learners, as well as guiding and allowing learners to express their knowledge and understanding (CAST, 2011:5; NCSC, 2012:6; Hall et al., 2012:10) during teaching and learning. The activities for classwork and homework should be modified to suit the different learning abilities of all the learners, including the environment where they live to help learners connect new knowledge to existing knowledge (Letseka, 2016:6; Müller et al., 2019:26) while providing them with continuous feedback after the completion of each activity. Furthermore, extra activities for learners who are able should be prepared to keep them busy and develop their knowledge. Learners who are struggling should be supported and motivated toward effective learning by ensuring that they feel like part of the group and part of teaching and learning.

Learners needed to be encouraged to respect each other, interact effectively in their groups, communicate their ideas to the whole class, accept input from other groups and ask clarity seeking questions when needed (Apriliyanto, Saputro & Riyadi, 2017:2) so that small group work as a strategy works effectively. During teaching and learning, learners must share resources, use different pictures to develop number sense, and use different games to learn mathematical concepts, such as selling, where learners play different roles such as being a shopkeeper or selling goods, to develop a conceptual understanding of mathematical operations, to acquire new skills, practice their existing abilities, and build their interests, particularly in recollecting mathematical concepts, such as addition and subtraction (Ramani & Eason, 2015:28; Google Image, 2018:5; Rondina & Roble, 2019:5).

Based on the outcomes of the study, teaching using small groups should involve teachers at the school who teach the same grade or phase. Teachers should plan together to support each other with ideas on how to structure small groups so that the learning abilities of all the learners are catered for during teaching and learning.

Monitoring and support by the SMT should be strengthened and professional development workshops organised and ensuring that enough teaching and learning resources such as counters, word cards, number cards, and mathematical set boxes for Foundation Phase are available for teachers and learners. Group work should involve teachers teaching in the same grade or phase to plan together as teachers, share information, solve problems and build essential teamwork and skills that will improve effective teaching (Kenta, 2017:44). Working together as teachers can assist in discovering how other teachers accommodate different learners in diverse classrooms, accept each other's ideas and share resources (Campbell-Whatley & Lyons, 2013:129; Sciullo, 2016:32). Furthermore, planning together can help in closing the teacher's mathematics content knowledge gap and offering insight into the school's effects, can increase interest in examining the different activities, processes, contexts, and increase teachers' expertise and teaching practices (Crowley, 2017:2; The International Program Committee, 2019:2). Group work should focus on the different learning abilities of all the learners, resources to be used and humanity for support and effective interaction (Letseka, 2016:6).

For effective small group work application in teaching and learning, teachers should apply the UDL's principles of providing multiple means of representation (the "what" of learning) of information, providing multiple means of action and expression (the "how" of learning) and provide multiple means of engagement (the "why" of learning) in their classrooms (CAST, 2011:5; NCSC, 2012:6; Hall et al., 2012:10; Israel et al., 2014:7; Kortjass, 2019:4; Meyer, et al., 2014:54). Furthermore, the primary values of humanity, consideration, sharing of resources, treating each other with respect, compassion and sense of belonging (Letseka, 2016:6) and the teacher showing respect, care for others and care for all the learners regardless of their background, culture or language they speak (Mahaye, 2018:12), should be encouraged. The rationale of employing the UDL and *ubuntu* is to effectively include and support the various learning needs of all the learners during teaching and learning and to ensure that no learner experiences learning barriers by not being accommodated in the teaching and learning situation.

7.7 THE LIMITATIONS OF THE STUDY

As stated earlier, participants were selected only from the previously disadvantaged schools of Nylstroom Circuit, in the Waterberg district of Limpopo Province. The study was conducted using only two teachers with their learners from two schools out of eight teachers from the two primary schools. Other teachers from the two schools or the Circuit might have provided different responses since the social background of the environment influences teaching and learning.

The study concentrated on strategies that can be used to enhance the performance of Foundation Phase learners in diverse mathematics classrooms. The researcher depended on the learners' responses from the pre-test and post-test, and the lesson observations and teachers' responses from the interviews, which might have limited the researcher from collecting more data since other research instruments may have contributed positively to this research study.

7.8 SUGGESTIONS FOR FUTURE RESEARCH

The main findings of the study appeared to suggest that group work in diverse classrooms is effective when support, accommodation of different learning abilities of learners, resources, and effective interaction during teaching and learning is encouraged. In addition, taking into consideration the values of *ubuntu* makes learners feel part of teaching and learning because they are respected, they respond to each other's ideas, they are friendly towards one another and give one another the chance to speak during teaching and learning. Through the reflection of the intervention in the study, the benefits of small groups in the process of teaching and learning, and mathematics in general, should be explored by involving all Foundation Phase teachers, since they all teach mathematics. The nature and effectiveness of group work in large classes needs to be investigated to understand how teachers can be supported. Other effective strategies, such as using technology, learning through watching, response to intervention, and project-based learning can be used in diverse classrooms, and need to be investigated regarding how they can be effectively employed in teaching either small classes or big classes.

Group work teaching can be practiced for the whole school to ensure effective teaching and learning for the diverse needs of all learners. Therefore, studies that would further probe the perceptions and benefits of small group work of the phases at the school are needed, to function within the framework of all the key elements of successful group work that were identified in the study reported here. Other questions that may enhance understanding of the influence of small group work on learners' academic performance are: what is the influence and impact of group work on the learners' academic performance? Or the different phases such as Foundation Phase, Intermediate Phase and Senior Phase, collaborate to plan together, and share resources and teaching strategies.

7.9 CONCLUSION

The study explored the strategies that can be used to enhance the performance of Foundation Phase learners in diverse mathematics classrooms. The researcher with the experimental group teacher identified small group work, which appeared to have a positive impact on teaching NOR in a Grade 3 class, and learners' academic performance. Moreover, the study is important because it enabled teachers to accommodate and support the different learning needs of all learners in diverse classrooms during teaching and learning.

The data collected from the study can contribute to the body of knowledge for the development of the South African Department of Basic Education, regarding how Foundation Phase teachers should accommodate and support learners with learning challenges. The benefits of small group teaching in Grade 3 NOR, as specified in the study, should encourage other schools to implement this strategy early, effectively and efficiently in the Foundation Phase classes.

The results of the study should additionally offer awareness of the effect of a small group on the school management teams and all the teachers in the intermediate and senior phases on how small group work can be effectively implemented to enhance the quality of teaching and learning in their subjects. The results should also offer the participating teachers the benefits of the intervention strategy, to impact change in the academic performance of learners in general.

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APPENDIX A: ETHICS CLEARANCE CERTIFICATE

UNISA university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2020/11/11

Ref: **2020/11/11/31640036/07/AM**
Name: Ms TF Sambo
Student No.: 31640036

Dear Ms TF Sambo

Decision: Ethics Approval from 2020/11/11 to 2025/11/11

Researcher(s): Name: Ms TF Sambo
E-mail address: rishongile@hotmail.com
Telephone: 073 793 8869

Supervisor(s): Name: Dr T Makgakga
E-mail address: makgasw@unisa.ac.za
Telephone: 012 429 4293

Title of research:

The strategies used to enhance performance of Foundation Phase learners in diverse mathematics classrooms

Qualification: PhD Education

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2020/11/11 to 2025/11/11.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2020/11/11 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
8. No field work activities may continue after the expiry date **2025/11/11**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2020/11/11/31640036/07/AM** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

Prof AT Motlhabane
CHAIRPERSON: CEDU RERC
motlhat@unisa.ac.za

Prof PM Sebate
EXECUTIVE DEAN
Sebatpm@unisa.ac.za

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APPENDIX B: DEPATMENT OF EDUCATION FROM DISTRICT DIRECTOR

COLLEGE OF EDUCATION

REQUESTING PERMISSION TO CONDUCT RESEARCH

Request for permission to conduct research at Nylstroom Circuit in the Waterberg District

Title of the title of your research: **Strategies to enhance performance of Foundation Phase learners in diverse mathematics classrooms**

Date ________________________________

District Director
Ms Madela SJ
Department of Education
Waterberg District
Modimolle
0510
Tel: 014 718 1500

Dear Ms. Madela, SJ

I, Tinyiko Florence Sambo am doing research under supervision of Dr T Makgakga, in the Department of Mathematics Education towards a PhD at the University of South Africa. We are requesting the District Director to allow us to approach Grade 3 teachers from schools in the Waterberg district to participate in a study entitled: Strategies used to enhance performance of Foundation Phase learners in diverse mathematics classrooms.

The aim of the study is to:
The main aim of the study is to explore the strategies that can be used to enhance the performance of Foundation Phase learners in mathematics

- To explore how teachers are applying their teaching strategies in order to enhance the performance of the Foundation Phase learners in diverse mathematics classrooms.

- To identify the challenges that are experienced by teachers in improving the performance of Foundation Phase learners in diverse mathematics classrooms.
- To determine teaching practices that can be employed in order to meet the performance needs of Foundation Phase learners in diverse mathematics classrooms.

Your department has been selected because Grade 3 learners have not been performing in mathematics which eventually affect Grade 12 results in mathematics.

The study will entail learners writing a pre-test and post- test and conducting individual face-to-face interviews with teachers and observing how they apply their strategies in teaching Grade 3 learners in a diverse mathematics classroom.

The benefits of this study are:

The study could identify effective teaching strategies for enhancing learners' performance in the diverse mathematics classrooms. Teachers will change the way they used to teach their learners and start involving learners to actively engage in positive learning to improve their understanding and performance. The aim of the research is to recommend valuable guidelines to the schools to their vision, mission, policies, and their practices that reflect the commitment to effective teaching and learning that bring good results. The study will also contribute to the schools' setting goals for their curriculum development and strategies that reflect the vision and values of accommodating the diverse needs of all learners. Therefore, it is believed that the findings will contribute meaningfully to the study and the recommendations will help improve the situation.

There are no potential risks for taking part in the research study. There will be no reimbursement or any incentives for participation in the research. Feedback procedure will entail writing of a detailed report or email the report to you when requested.

Yours sincerely

____

TF Sambo (Ms)

Student at the University of South Africa

Contact number: 073 793 8869

Email: rishongile@hotmail.com

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PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF
EDUCATION

WORKING TOGETHER WE CAN DO MORE IN PROVIDING QUALITY EDUCATION

APPENDIX C: RESPONSE FROM DISTRICT DIRECTOR

WATERBERG DISTRICT

Ref : 3/5/7/2

Private Bag X 1040
Modimolle
0510

Your Ref: 80146864
Enq : Ramodipa MA
Tel : 014 718 1500

TO : Ms Sambo TF
Nystroom **Circuit Office: Modimolle Primary School**
Po Box 2714
Modimolle
0510

FROM: HR CONDITIONS OF SERVICE

RE: REQUEST TO CONDUCT RESEARCH: 80146864

1. Receipt of your letter on the above subject is hereby acknowledged.

2. In response thereto, please be advised that permission to conduct a research study for proposed research in Waterberg District: Nystroom Circuit: All Primary School around Nylstroom Circuit.
3. Approval is hereby granted subject to the following conditions:
   - That the interviews will be conducted outside school working hours and will also not interfere with teaching and learning in schools.
   - The research will not have any financial implications for the Limpopo Department of Education.
   - Upon completion of research study, the researcher shall share the final product of the research with the Department.

4. The District appreciates the contribution that you wish to make and wishes you success on your research.

5. Regards.

....
DISTRICT DIRECTOR

2020/11/01
DATE

Tel: +27(14) 718-1500
E-mail:ramodipama@edu.limpopo.gov.za
Room BWT 18, NTK Building, MODIMOLLE 0510,

Fax: +27 (086) 296 8318
Web: www.limpopo.gov.za

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APPENDIX D: REQUESTING PERMISSION FROM CIRCUIT MANAGER

COLLEGE OF EDUCATION

REQUESTING PERMISSION TO CONDUCT RESEARCH

Request for permission to conduct research at Nylstroom Circuit in the Waterberg District

Title of the title of your research: **Strategies to enhance performance of Foundation Phase learners in diverse mathematics classrooms**

Date __________________________________

Circuit Manager
Mr Mabusela SN
Department of Education
Nylstroom Circuit
Modimolle
0510
Tel: 071 674 6814

Dear Mr. Mabusela SN

I, Tinyiko Florence Sambo am doing research under supervision of Dr T Makgakga, a in the Department of Mathematics Education towards a PhD at the University of South Africa. We are requesting the circuit manager to allow us to approach Grade 3 teachers in Nylstroom circuit to participate in a study entitled: The strategies used to enhance performance of Foundation Phase learners in diverse mathematics classrooms.

The aim of the study is to:
The main aim of the study is to explore the strategies that can be used to enhance the performance of Foundation Phase learners in mathematics

- To explore how teachers are applying their teaching strategies in order to enhance the performance of the Foundation Phase learners in diverse mathematics classrooms.
- To identify the challenges that are experienced by teachers in improving the performance of Foundation Phase learners in diverse mathematics classrooms.
- To determine teaching practices that can be employed in order to meet the performance needs of Foundation Phase learners in diverse mathematics classrooms.

Your department has been selected because Grade 3 learners have not been performing well in mathematics which eventually affect Grade 12 results in mathematics.

The study will entail learners writing a pre-test and post- test and conducting individual face-to-face interviews with teachers and observing how they apply their strategies in teaching Grade 3 learners in a diverse mathematics classroom.

The benefits of this study are:
The study could identify effective teaching strategies for enhancing learners' performance in the diverse mathematics classrooms. Teachers will change the way they used to teach their learners and start involving learners to actively engage in positive learning to improve their understanding and performance. The aim of the research is to recommend valuable guidelines to the schools to their vision, mission, policies and their practices that reflect the commitment to effective teaching and learning that bring good results. The study will also contribute to the schools setting goals for their curriculum development and strategies that reflect the vision and values of accommodating the diverse needs of all learners. Therefore, it is believed that the findings will contribute meaningfully to the study and the recommendations will help improve the situation.

There are no potential risks for taking part in the research study. There will be no reimbursement or any incentives for participation in the research. Feedback procedure will entail writing of a detailed report or email the report to you when requested.

Yours sincerely

____

TF Sambo (Ms)
Student at the University of South Africa
Contact number: 073 793 8869
Email: rishongile@hotmail.com

LIMPOPO

PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA
WATERBERG DISTRICT

APPENDIX E: RESPONSE FROM CIRCUIT MANAGER

DEPARTMENT OF EDUCATION
NYLSTROOM CIRCUIT

CONFIDENTIAL

Enq : Molekwa NF
Tel: 0794754058/0716746814
Email: nylstroomcircuit@gmail.com

To: **Ms Sambo TF**
Student at University of South Africa

RE: PERMISSION TO CONDUCT RESEARCH: SAMBO TINYIKO FLORENCE

1. Receipt of your letter on the above subject is hereby acknowledged.

2. Please be advised that permission for your application to conduct research at Nylstroom Circuit Primary Schools is granted subject to the following conditions:-

2.1 The research is self-initiated and approved with own cost.
2.2 The research must not interfere with the normal running of the school.

3. The Circuit appreciates the contribution that you wish to make and wishes you good luck.

4. Thank you.

Circuit Manager
Mabusela SN

28/09/20
Date

APPENDIX F: REQUESTING PERMISSION FROM SCHOOL PRINCIPAL AND SGB

COLLEGE OF EDUCATION

REQUESTING PERMISSION TO CONDUCT RESEARCH

Request for permission to conduct research at Nylstroom Circuit in the Waterberg District

Title of the title of the research: **Strategies to enhance performance of Foundation Phase learners in diverse mathematics classrooms**

The Principal and School Governing Body
Name of school: ________________________________
Tel: ______________________________________

Dear Sir/Madam

I, Tinyiko Florence Sambo am doing research under supervision of Dr T Makgakga, in the Department of Mathematics Education towards a PhD at the University of South Africa. We are inviting you to participate in a study entitled: The strategies to enhance performance of Foundation Phase learners in diverse mathematics classrooms

The aim of the study is to:
The main aim of the study is to explore the strategies that can be used to enhance the performance of Foundation Phase learners in mathematics

- To explore how teachers are applying their teaching strategies in order to enhance the performance of the Foundation Phase learners in diverse mathematics classrooms.

- To identify the challenges that are experienced by teachers in improving the performance of Foundation Phase learners in diverse mathematics classrooms.
- To determine teaching practices that can be employed in order to meet the performance needs of Foundation Phase learners in diverse mathematics classrooms.

Your department has been selected because Grade 3 learners have not been performing in mathematics which eventually affect Grade 12 results in mathematics.

The study will entail learners writing a pre-test and post- test and conducting individual face-to-face interviews with teachers and observing how they apply their strategies in teaching Grade 3 learners in a diverse mathematics classroom.

The benefits of this study are:

The study could identify effective teaching strategies for enhancing learners' performance in the diverse mathematics classrooms. Teachers will change the way they used to teach their learners and start involving learners to actively engage in positive learning to improve their understanding and performance. The aim of the research is to recommend valuable guidelines to the schools to their vision, mission, policies, and their practices that reflect the commitment to effective teaching and learning that bring good results. The study will also contribute to the schools setting goals for their curriculum development and strategies that reflect the vision and values of accommodating the diverse needs of all learners. Therefore, it is believed that the findings will contribute meaningfully to the study and the recommendations will help improve the situation.

There are no potential risks for taking part in the research study. There will be no reimbursement or any incentives for participation in the research. Feedback procedure will entail writing of a detailed report or email the report to you when requested.

Yours sincerely

____

TF Sambo (Ms)

Student at the University of South Africa

Contact number: 073 793 8869

Email: rishongile@hotmail.com

APPENDIX G: CONSENT LETTER TO PARTICIPANTS

4.2 PARTICIPANT INFORMATION SHEET (Use this example as the letter for consent and assent)

Date: ___________________________________

Title: **Strategies to enhance performance of Foundation Phase learners in diverse mathematics classrooms**

DEAR PROSPECTIVE PARTICIPANT

My name is Tinyiko Florence Sambo and I am doing research under the supervision of Dr. T Makgakga, in the Department of Mathematics Education towards a PhD at the University of South Africa. We are inviting you to participate in a study entitled: The strategies to enhance performance of Foundation Phase learners in diverse mathematics classrooms.

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could identify effective teaching strategies for enhancing learners' performance in the diverse mathematics classrooms. Teachers will change the way they used to teach their learners and start involving learners to actively engage in positive learning to improve their understanding and performance. The aim of the research is to recommend valuable guidelines to the schools to their vision, mission, policies, and their practices that reflect the commitment to effective teaching and learning that bring good results. The study will also contribute to the schools setting goals for their curriculum development and strategies that reflect the vision and values of accommodating the diverse needs of all learners. Therefore, it is believed that the findings will contribute meaningfully to the study and the recommendations will help improve the situation.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited because the grade that you are teaching is where relevant information for the study about learners' performance can be collected. I obtained your contact details from names of schools listed in the circuit. The researcher has chosen to collect data from one participant from the school. The researcher has chosen to gather information from two participants, that is, one participant from each of the two schools. You have been chosen because you meet the requirements of the study which includes your professional qualifications, the teaching experience in the grade.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

Describe the participant's actual role in the study.

The study involves face-to-face open-ended interview in the classroom setting which will include audio or video taping with the consent of the teacher. The interview and the observation will take forty-five minutes to one hour and not more than one hour. The following questions will be asked during the interview:

- What are your opinions about teaching mathematics in the diverse classrooms?
- Which factors affect performance of Grade 3 learners in diverse mathematics classrooms?
- How can the learning needs of all learners in diverse mathematics classrooms be accommodated?
- What kind of strategies are followed to ensure that effective teaching and learning in diverse classrooms takes place?
- How can you be supported in teaching mathematics in Grade 3 diverse classrooms effectively and efficiently?
- Is there anything that was not asked but you will like the researcher to know?

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are assured of complete anonymity, privacy and confidentiality of the information that you are going to give towards the study. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

There are no potential benefits for the participants, participants as a group, the scientific community and/or society for taking part in the study. The purpose of the study is to help the participants identify the effective strategies that can be used in the diverse mathematics to improve Grade 3 learners' performance and to help the participants in accommodating all learners in teaching and learning process so that no one is left behind.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There are no negative consequences for you if you take part in the research project. There are no potential levels of inconvenience and/or discomfort to the participant or foreseeable risks of harm or side-effects to the potential participants.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research. Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a code number, or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

The records that identify you will be available only to people working on the study unless you give permission for other people to see the records. The report of the study may be submitted for publication, but participants' names will not be identified from the report because the names used will be anonymous. Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet in the researcher's place for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Hard copies will be shredded and/or electronic copies will be permanently deleted from the hard drive of the computer using a relevant software programme.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

There is no payment or reward offered, financial or otherwise for participating in the study. Participants will not incur any costs in the study.

HAS THE STUDY RECEIVED ETHICS APPROVAL

This study has applied for a written approval from the Research Ethics Review Committee of the University of South Africa, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Tinyiko Florence Sambo on 073 793 8869 or email rishongile@hotmail.com. The findings are accessible for a period of five years and thereafter it will be destroyed.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact TF Sambo at 073 793 8869 or email rishongile@hotmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Dr T Makgakga at email makgasw@unisa.ac.za or 012 429 4293.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

____

TF Sambo (Ms)

Student at the University of South Africa

Contact number: 073 793 8869

Email: rishongile@hotmail.com

CONSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, ___________________ confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the open-ended interview that will not take more than an hour to collect information.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print) ______________________________________

______________________________ ____________________________________

Participant Signature Date

Researcher’s Name & Surname: Tinyiko Florence Sambo

Researcher’s signature Date

APPENDIX H: LETTER REQUESTING PARENTAL CONSENT FOR MINORS

4.3 EXAMPLE OF A LETTER REQUESTING PARENTAL CONSENT FOR MINORS TO PARTICIPATE IN A RESEARCH PROJECT

Dear Parent

Your child ______________________ is invited to participate in a study entitled: **Strategies to enhance performance of Foundation Phase learners in diverse mathematics classrooms.**

I am undertaking this study as part of my doctoral research at the University of South Africa. The purpose of the study is to identify the strategies that can be used to enhance Foundation Phase learners performance in Grade 3 diverse mathematics classrooms. The possible benefits of the study are the improvement of teaching and learning in mathematics. Also, the study might improve positive and active learning by accommodating and supporting all learners so that they acquire knowledge. I am asking permission to include your child in this study because his or her participation in writing the tests will help the researcher to identify the challenges learners might be experiencing in learning the topics of numbers, operations and relationships in mathematics. I expect to have forty learners to participate in the study.

If you allow your child to participate, I shall request him/her to:

1. Complete pre-test and post-test in mathematics which covers topics in numbers, operations and relationships. The test will be written in their classrooms in the presence of their teachers during their normal teaching hours at school.
2. Video recording will be used from the group where the researcher will not be present or not allowed to enter the school premises due to COVID-19 protective measures. Video recording will be used to observe how learners write their test in their classes and prior permission will be requested from the school principal and their class teachers.

Any information that is obtained in connection with this study and can be identified with your child will remain confidential and will only be disclosed with your permission. His/her responses will not be linked to his/her name or your name or the school’s name in any written or verbal report based on this study. Such a report will be used for research purposes only.

There are no foreseeable risks to your child by participating in the study since he or she will be only writing both pre-test and post-test. Your child will receive no direct benefit from participating in the study; however, the possible benefits to education are that effective teaching strategies that accommodate all learners in teaching and learning in diverse classroom can be identified. Learners who experience learning difficulties can be supported in their learning process so that they do not experience any barriers. Also, different skills from learners can be identified, knowledge be improved in learning mathematics and eventually their performance in mathematics can be improved. Neither your child nor you will receive any type of payment for participating in this study.

Your child's participation in this study is voluntary. Your child may decline to participate or to withdraw from participation at any time. Withdrawal or refusal to participate will not affect him/her in any way. Similarly, you can agree to allow your child to be in the study now and change your mind later without any penalty.

The study will take place during regular classroom activities with the prior approval of the school and your child's teacher. However, if you do not want your child to participate, an alternative activity will be available of giving the tests to your child to write at home so that you can see how he or she is performing well in mathematics.

In addition to your permission, your child must agree to participate in the study and you, and your child will also be asked to sign the assent form which accompanies this letter. If your child does not wish to participate in the study, he or she will not be included and there will be no penalty. The information gathered from the study and your child's participation in the study will be stored securely on a password locked computer in my locked office for five years after the study. Thereafter, records will be erased.

The benefits of this study are: The study could identify effective teaching strategies for enhancing learners' performance in the diverse mathematics can be identified. Teachers will change the way they used to teach their learners and start involving learners to actively engage in positive learning to improve their understanding and performance. The aim of the research is to recommend valuable guidelines to the schools to their vision, mission, policies and their practices that reflect the commitment to effective teaching and learning that bring good results. The study will also contribute to the schools setting goals for their curriculum development and strategies that reflect the vision and values of accommodating the diverse needs of all learners. Therefore, it is believed that the findings will contribute meaningfully to the study and the recommendations will help improve the situation.

There are no potential risks of participating in the research study.
There will be no reimbursement or any incentives for participation in the research.

If you have questions about this study, please ask me or my study supervisor, Dr T Makgakga, Department of Mathematics Education, College of Education, University of South Africa. My contact number is 073 793 8869 and my e-mail is rishongile@hotmail.com . The e-mail of my supervisor is________________________. Permission for the study has been requested from the principal and SGB of the school and the Ethics Committee of the College of Education, UNISA.

You are making a decision about allowing your child to participate in this study. Your signature below indicates that you have read the information provided above and have decided to allow him or her to participate in the study. You may keep a copy of this letter.

Name of child:

Sincerely

_____________________________________ __________________________________ ___________________

Parent/guardian's name (print) Parent/guardian's signature: Date:

____________________________ ________________________________ ___________________

Researcher's name (print) Researcher's signature Date:

APPENDIX I: LETTER REQUESTING ASSENT FROM A LEARNER IN A PRIMARY SCHOOL

4.5 EXAMPLE OF A LETTER REQUESTING ASSENT FROM LEARNERS IN A PRIMARY SCHOOL TO PARTICIPATE IN A RESEARCH PROJECT

Dear learner, Date_______________

My name is Teacher TF Sambo and would like to ask you if I can come and watch you do mathematics activities with your teacher in your classroom. I am trying to learn more about how children do mathematics activities with their teachers as well as when they do them with friends.

If you say YES to do this, I will come and watch you when you are with your teacher doing mathematics activities. We will do a fun game where you have to answer some questions for me. I will also ask you to do some activities with me. I will not ask you to do anything that may hurt you or that you don't want to do.

I will also ask your parents if you can take part. If you do not want to take part, it will also be fine with me. Remember, you can say yes or you can say no and no one will be upset if you don't want to take part or even if you change your mind later and want to stop. You can ask any questions that you have now. If you have a question later that you didn't think of now, ask me next time I visit your school.

Please speak to mommy or daddy about taking part before you sign this letter. Signing your name at the bottom means that you agree to be in this study. A copy of this letter will be given to your parents.

Regards

Teacher ______________________________

Your Name	**Yes, I will take part** 	**No, I don't want to take part** 
Name of the researcher		
Date		
Witness		

APPENDIX J: PRE-TEST AND POST-TEST IN SEPEDI

Leina la Sekolo : ________________ Leina la morutwana: ________________

Mathematics Date: _______________________

Grade 3: ___________ Total: 25

1. Ngwala dinomoro tše di latelago ka mantšu: (2)
   a. 68 ___________________________________
   b. 132 __________________________________
2. Dira sediko go nomoro ye kgolo gomme o dire sefapano go nomoro ye nnyane. (2)

130	103	131	113

3. Ngwala dinomoro tše di latelago ka mantšu: (3)

a. Nomoro yeo e lego magareng ga 178 le 180

____

b. Nomoro yeo e fetago 199 ka nomoro ye tee __________________________________

c. Nomoro yeo e fetwago ke 100 ka ye tee ____________________________________

4. Na boleng bja nomoro yeo e thaletšwego ke eng? (2)

a. <u>6</u>4 = _______

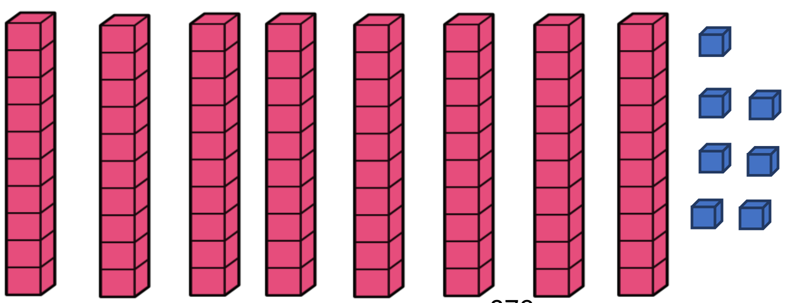
b. 14<u>5</u> = _______

5. Hlahlamolla dinomoro tšeo di latelago: (2)

a. 254 = ________________________________

b. 209 = ________________________________

6. Ngwala lefokopalo le karabo ya dinomoro tšeo di latelago: (3)



7. Ngwala dinomoro tšeo di latelago go tloga go ye nnyane go ya go ye kgolo (1)

32, 54, 9, 28, 98, 61, 82

8. Feleletša dinomoro tšeo di latelago: (2)

a. 200+80 +1 = ___________

b. 200+ 2 = _________

9. Feleletša tšeo di latelago go bopa nomoro ya 14: (6)

Hlakantšha

1 + 13 = 14	13 + 1 = 14
2 + 12 = ______	
5 + 9 = ______	
3 + 11 = ______	

Ntšha

14 - 13 = 1	14 – 1 = 13
14 - 12 = ______	
14 - 9 = ______	
14 - 11 = ______	

10. Mesong Lebo o tlile a swere diapola tše 19 gomme a ja tše 6. Na o setše ka diapola tše kae? ________________________ (2)

APPENDIX K: PRE-TEST AND POST-TEST MEMORANDUM IN SEPEDI

1. Ngwala dinomoro tse di latelago ka mantšu: (2)
    - c. 68 masome tshela seswai
    - d. 132 lekgolo masome tharo pedi
2. Dira sediko go nomoro ye kgolo gomme o dire sefapano go nomoro ye nnyane. (2)

130	103 **x**	(131)	113

3. Ngwala dinomoro tse di latelago ka mantšu: (3)

a. Nomoro yeo e lego magareng ga 178 le 180

lekgolo masome šupa senyane

b. Nomoro yeo e fetago 199 ka nomoro ye tee

makgolo pedi

c. Nomoro yeo e fetwago ke 100 ka ye tee

masome senyane

4. Na boleng bja nomoro yeo e thaletšwego ke eng? (2)

a. 64 = 60 goba masome tshela

b. 145 = 5 goba 5

5. Hlahlamolla dinomoro tšeo di latelago: (2)

a. 254 = 200 + 50 + 4

b. 209 = 200 + 9

6. Ngwala lefokopalo le karabo ya dinomoro tšeo di latelago: (3)

80 + 9 = 89

7. Ngwala dinomoro tšeo di latelago go tloga go ye nnyane go ya go ye kgolo (1)

32, 54, 9, 28, 98, 61, 82

9, 28, 32, 54, 61, 82, 98

8. Feleletša dinomoro tšeo di latelago: (2)

a. 200+80 +1 = 281

b. 200+ 2 = makgolo pedi

9. Feleletša tšeo di latelago go bopa nomoro ya 14: (6)

Hlakantšha

1 + 13 = 14	13 + 1 = 14
2 + 12 = 14	**12 + 2 = 14**
5 + 9 = 14	**9 + 5 = 14**
3 + 11 = 14	**11 + 3 = 14**

Ntšha

14 - 13 = 1	14 – 1 = 13
14 - 12 = 2	**14 – 2 = 12**
14 - 9 = 5	**14 – 5 = 9**
14 - 11 = 3	**14 – 3 = 11**

10. Mesong Lebo o tlile a swere diapola tse 19 gomme a ja tse 6. Na o šetše ka diapola tse kae? 19 – 6 = 13 (2)

APPENDIX L: PRE-TEST AND POST-TEST IN ENGLISH

Name of school: _______________ Name of learner: _________________

Mathematics: Post-test Date: _____________________

Grade 3: ___________ Total: 25

3. Write the following numbers in words: (2)
   e. 68 _________________________________
   f. 132 _______________________________

4. Circle the biggest number and make a cross over the smallest number. (2)

130	103	131	113

3. Write the following as number names: (3)

a. the number between 178 and 180 ___________________________________

b. the number that is one more than 199 ________________________________

c. the number that is one less than 100 __________________________________

4. What is the value of the underlined digit? (2)

a. <u>6</u>4 = ______

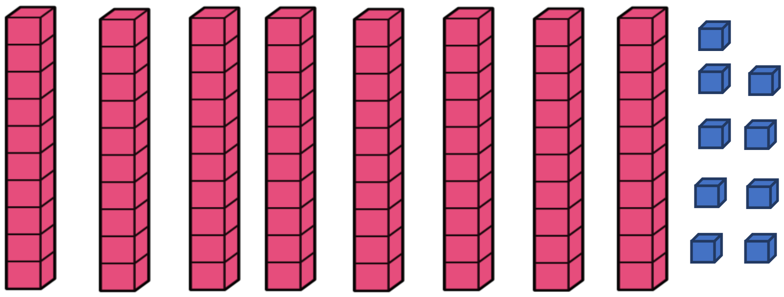
b. 14<u>5</u> = ______

5. Break the following numbers: (2)

a. 254 = ______________________________

b. 209 = ______________________________

6. Write the number sentence and the answer of the following number: (3)



____

7. Write the following numbers from the smallest to the biggest: (1)

32, 54, 9, 28, 98, 61, 82

____

8. Complete the following numbers: (2)

a. 200+80 +1 = __________

b. 200+ 2 = ________

9. Find all the family numbers of 14: (6)

Addition

1 + 13 = 14	13 + 1 = 14
2 + 12 = _____	
5 + 9 = ______	
3 + 11 = ______	

Subtraction

14 - 13 = 1	14 - 1 = 13
14 - 12 = _____	
14 - 9 = ______	
14 - 11 = _____	

10. In the morning Lebo has 19 apples. During lunch time she eat 6 apples. How many apples are left? ______________________ (2)

APPENDIX M: PRE-TEST AND POST-TEST MEMORANDUM IN ENGLISH

1. Write the following numbers in words: (2)
   g. 68 sixty-eight
   h. 132 one hundred and thirty-two

2. Circle the biggest number and make a cross over the smallest number. (2)

130	103 **x**	131 (circled)	113

3. Write the following as number names: (3)

   a. the number between 178 and 180
   one hundred and seventy-nine
   b. the number that is one more than 199
   two hundred
   c. the number that is one less than 100
   ninety-nine

4. What is the value of the underlined digit? (2)
   a. 64 = 60 or sixty
   b. 145 = 5 or five

5. Break the following numbers: (2)

   a. 254 = 200 + 50 + 4

   b. 209 =200 + 9

6. Write the number sentence and the answer of the following number: (3)

   80 + 9 = 89

7. Write the following numbers from the smallest to the biggest: (1)

   32, 54, 9, 28, 98, 61, 82

   9, 28, 32, 54, 61, 82, 98

8. Complete the following numbers: (2)

   a. 200+80 +1 = 281

b. 200+ 2 = 202

9. Find all the family numbers of 14: (6)

Addition

1 + 13 = 14	13 + 1 = 14
2 + 12 = 14	**12 + 2 = 14**
5 + 9 = 14	**9 + 5 = 14**
3 + 11 = 14	**11 + 3 = 14**

Subtraction

14 - 13 = 1	14 - 1 = 13
14 - 12 = 2	**14 – 2 = 12**
14 - 9 = 5	**14 – 5 = 9**
14 - 11 =3	**14 – 3 = 11**

10. In the morning Lebo has 19 apples. During lunch time she eat 6 apples. How many apples are left? 19 – 6 = 13 (2)

APPENDIX N: SAMPLE OF SEPEDI SCRIPT

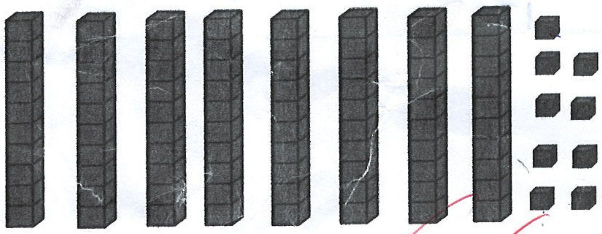
44

Grade 3: B　　　　　　　　　　　　Total: 25　　10/25

1. Ngwala dinomoro tse di latelago ka mantsu: (2)
   a. 68 Masome tšhela seswai
   b. 132 ~~teso~~ lekgolo tee masome tharopedi
2. Dira sediko go nomoro ye kgolo gomme o dire sefapano go nomoro ye nnyane. (2)

130	103	131	113

3. Ngwala dinomoro tse di latelago ka mantsu: (3)
   a. Nomoro yeo e lego magareng ga 178 le 180
   Lekgolo tee masome supaseswai
   b. Nomoro yeo e fetago 199 ka nomoro ye tee
   Makgolo pedi
   c. Nomoro yeo e fetwago ke 100 ka ye tee
   Lekgolo tee tee
4. Na boleng bja nomoro yeo e thaletswego ke eng? (2)
   a. 64 = 6
   b. 145 = 1
5. Hlahlamolla dinomoro tseo di latelago: (2)
   a. 254 = Makgolo pedi masome hlanonne
   b. 209 = Makgolo pedi masome senyane
6. Ngwala lefokopalo le karabo ya dinomoro tseo di latelago: (3)



10+10+10+10+10+10+10+10+9 = 89　　3

7. Ngwala dinomoro tseo di latelago go tloga go ye nnyane go ya go ye kgolo (1)

32, 54, 9, 28, 98, 61, 82

9, 28, ~~92~~, 32, 54, 61, 82, 98,

(1)

8. Feleletsa dinomor tseo di latelago: (2)

a. 200+80 +1 = ~~290~~ 209

b. 200+ 2 = 202

(1)

9. Feleletsa tseo di latelago go bopa nomoro ya 14: (6)

Hlakantsha

1 + 13 = 14	13 + 1 = 14
2 + 12 = 14	12 + 2 = 14
5 + 9 = 14	5 + 9 = 14
3 + 11 = 14	3 + 11 = 14

(1)

Ntsha

14 - 13 = 1	14 – 1 = 13
14 - 12 = 1	14 - 1 = 12
14 - 9 = 5	14 - 5 = 9
14 - 11 = 3	~~14-1~~ 14 - 3 = 11

(2)

10. Mesong Lebo o tlile a swere diapola tse 19 gomme a ja tse 6. Na o setse ka diapola tse kae? 12 (2)

APPENDIX O: SAMPLE OF ENGLISH SCRIPT

8

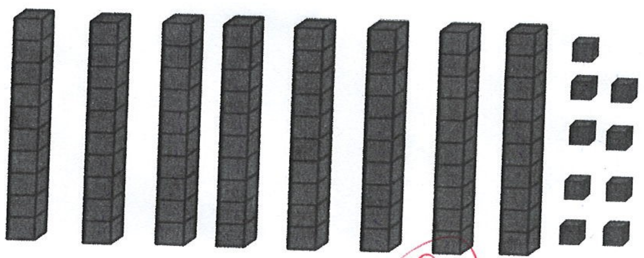
Grade 3: GKA

Total: 25 (12)

1. Write the following numbers in words: (2)
   a. 68 sixty eighty
   b. 132 one hundred and thirty two (1)
2. Circle the biggest number and make a cross over the smallest number. (2) (1)

(130)	1~~0~~3	131	113

3. Write the following as number names: (3)
   a. the number between 178 and 180
   one hundred and seventy nine
   b. the number that is one more than 199
   two hundred (3)
   c. the number that is one less than 100
   ninety nine
4. What is the value of the underlined digit? (2)
   a. 64 = 60 (1)
   b. 145 = 50
5. Break the following numbers: (2)
   a. 254 = 20+10+5+2+2
   b. 209 = 20+10+0+3+3+3
6. Write the number sentence and the answer of the following number: (3)



8 x 9 = 89 (1)

7. Write the following numbers from the smallest to the biggest: (1)

32, 54, 9, 28, 98, 61, 82

~~9~~ 9 61 ~~28~~ 28 32 54 82

8. Complete the following numbers: (2)

a. 200+80 +1 = 281

b. 200+ 2 = 202

9. Find all the family numbers of 14: (6)

Addition

1 + 13 = 14	13 + 1 = 14
2 + 12 = 14	12+2=14
5 + 9 = 14	9+5=14
3 + 11 = 14	11+3=14

Subtraction

14 - 13 = 1	14 - 1 = 13
14 - 12 = 2	~~[illegible]~~ 15-2=13
14 - 9 = 5	~~9-14=13~~ 16-3=13
14 - 11 = 13	~~[illegible]~~ 17-4=13

10. In the morning Lebo has 19 apples. During lunch time she eat 6 apples. How many apples are left? 13 (2)

APPENDIX P: INTERVIEW QUESTIONS

Researcher: Tinyiko Florence Sambo

Topic: Strategies to enhance performance of Foundation Phase learners in diverse mathematics classrooms.

Supervisor: ____

Participant: ____

Date: ____

Time: ____

INTERVIEW QUESTIONS

1. What are your opinions about teaching mathematics in the diverse classrooms?
2. Which factors affect performance of Grade 3 learners in diverse mathematics classrooms?
3. How can the learning needs of all learners in diverse mathematics classrooms be accommodated?
4. What kind of strategies are followed to ensure that effective teaching and learning in diverse classrooms takes place?
5. How can you be supported in teaching mathematics in Grade 3 diverse classrooms effectively and efficiently?
6. Is there anything that was not asked but you will like the researcher to know?

APPENDIX Q: EXAMPLE OF INTERVIEW WITH GRADE 3 TEACHER

R- Researcher

Q- Question

P- Participant

PQ – Probing question

R: Good afternoon

P: Good afternoon

R: The topic of my research is "**Strategies to enhance performance of Foundation Phase learners in diverse mathematics classrooms."**

R: As explained in the letter that I have sent to you; I would like to ask you few questions that will help me with my study. The first question is: What are your opinions about teaching mathematics in the diverse mathematics classrooms?

P: It is challenging, and it slows teaching and learning process. It does not allow the teacher to meet the learning needs of all learners in the classroom.

R: How does it slows teaching and learning?

P: We are teaching learners who speak different languages, and we have learners who come from other African countries who can't even speak Sepedi, so it is difficult when teaching in the classroom. Because we also teach learners with different abilities, it is not easy to pay attention to "slow" learners and if we try to focus on them, we delay other learners who "catches" very fast.

Q2: What do you think can affect the performance of Grade 3 learners in diverse mathematics classroom?

P: Most learners cannot read and write properly. When we give them homework, they don't do the work. Some parents write homework for their learners in their books instead of helping them to do the work. Pushing learners to the next grade even if they have failed or because they cannot repeat the grade more than two times or be in a phase more four years, causes learners to be in Grade 3 without enough knowledge. Some of the learners do not pay attention during teaching and learning, some of them cannot concentrate in class and they don't finish classwork.

Q3: How can the learning needs of all learners in diverse mathematics classroom be accommodated?

P: Getting to know all the learners in the classroom is important so that I know who do well and who do not do well in class. I also the use of teaching and learning resources helps to accommodate all learners in the teaching and learning.

Q4: What kind of strategies do you follow to ensure that effective teaching and learning in the diverse classroom takes place?

P: Because we are teaching learners maths in English, I sometimes switch to Sepedi to explain some of the words to help them understand. I use number cards, word cards and number charts to help learners in counting and writing numbers. Since learners are few in class, I can pay attention to learners who are not doing well in class by moving around and help them individually.

Q5: How do you assess your learners?

P: I do both informal and formal assessments. I give learners classwork and homework every day to write as informal assessments. Learners do continuous assessment in the form of oral and write task that come with lesson plans that we are provided by National Education Collaboration Trust (NECT) programme. Planner and tracker has the tasks that are ready to be used to assess after completing a topic.

Q6: How can you be supported in teaching mathematics in Grade 3 mathematics classroom effectively and efficiently?

P: If we can have enough teaching aids to put on the walls to help learners in learning, it can assist us. I also think that slow learners starting from Grade 1 should be in one class so that the teacher teaches them at their own pace and support them according to their learning needs.

Q7: Is there anything that was not asked but you will like the researcher to know?

P: Like now with Education Assistances (EAs), if they were appointed permanently, it would be better because they can help with learners who learn fast, and I can focus on the learners who are struggling.

APPENDIX R: OBSERVATION SCHEDULE

Researcher: Tinyiko Florence Sambo

Topic: **Strategies to enhance the performance of Foundation Phase learners in diverse mathematics classrooms**

Supervisor: ____

Participant: ____

Date: ____

Time: ____

Lesson observation 1: The researcher will observe the following from the teacher's lesson:

1. How teaching and learning in mathematics classroom takes place?
2. The types of teaching strategies used during teaching.
3. How the teacher facilitates activities and the type of activities the learners are engaged with?
4. The questions used to guide the learners towards the lesson involvement and assessment used.
5. How teachers accommodate learners who experience learning barriers.
6. The purpose of assessing learners during or after the lesson.
7. The type of resources used during teaching and learning.

Lesson observation 2: The researcher will observe the following during teaching and learning:

- How effectively do teachers apply the teaching strategies in the classrooms?
- How the teachers handle learners' responses from the questions asked.
- The interaction between teachers and learners; and amongst the learners during teaching and learning.
- How teachers support learners who experience some difficulties during teaching and learning?
- How learners behave towards each other during teaching and learning?

- How effective are all learners involved during teaching and learning?
- How the teacher (especially in the experimental group) applies the intervention strategies in the classroom?
- Are learners able to do self-assessment on the concepts learned?

APPENDIX S: STATISTICAL RESULTS FOR PRE-TEST AND POST-TEST

27 Jun 2021, 14:21:42

Excel was used or data management, and Stata Release 15 was used for data analysis. T-test was used to compare the two study groups, the experimental and the control groups. The results were interpreted at 95% confidence limit (2-sided). In other words, the results were declared significant if the p-value was less than 0.05.

Note:

If p < 0.05 Results are significant

If $p \geq 0.05$ **then the results are not significant**

Question 1

-> condition = Post

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	68	1.264706	.101822	.8396454	1.061468	1.467943
Experime	55	1.454545	.1032084	.765414	1.247625	1.661466
combined	123	1.349593	.0730002	.8096117	1.205082	1.494105
diff		-.1898396	.1464147		-.479706	.1000269

```
    diff = mean (Control) - mean (Experime)                    t = -1.2966
Ho: diff = 0                                   degrees of freedom =      121

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.0986         Pr (|T| > |t|) = 0.1972          Pr (T > t) = 0.9014
```

The above table indicates that in the post-test, the control and experimental groups' performances were not significantly different (p = 0.1972).

-> condition = Pre-test

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]

Control	74	.8918919	.1028429	.8846881	.6869263	1.096858
Experime	57	.9473684	.1074338	.8111071	.7321527	1.162584
combined	131	.9160305	.0743247	.8506845	.7689881	1.063073
diff		-.0554765	.1504177		-.3530816	.2421285

```
    diff = mean (Control) - mean (Experime)                    t =  -0.3688
Ho: diff = 0                                  degrees of freedom =      129

    Ha: diff < 0                Ha: diff! = 0               Ha: diff > 0
 Pr (T < t) = 0.3564         Pr (|T| > |t|) = 0.7129      Pr (T > t) = 0.6436
```

The above table indicates that in the pre-test, the control and experimental groups' performances were not significantly different (p = 0.7129).

The rest of the tables are interpreted like the above tables

Question 2

-> condition = Post

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	68	.9117647	.0999018	.8238116	.7123598	1.11117
Experime	55	.9636364	.127032	.9420945	.7089525	1.21832
combined	123	.9349593	.0789271	.8753438	.7787153	1.091203
diff		-.0518717	.1593282		-.3673038	.2635605

diff = mean (Control) - mean (Experime) t = -0.3256
Ho: diff = 0 degrees of freedom = 121

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.3727 Pr (|T| > |t|) = 0.7453 Pr (T > t) = 0.6273

-> condition = Pre-test

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	74	.7567568	.0938912	.8076825	.5696319	.9438816
Experime	57	.7192982	.1112539	.8399487	.4964299	.9421666
combined	131	.740458	.0715468	.8188903	.5989113	.8820048
diff		.0374585	.1448346		-.2491003	.3240173

diff = mean (Control) - mean (Experime) t = 0.2586
Ho: diff = 0 degrees of freedom = 129

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.6018 Pr (|T| > |t|) = 0.7963 Pr (T > t) = 0.3982

Question 3

-> condition = Post

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	68	1.058824	.128956	1.063399	.8014262	1.316221
Experime	55	1.127273	.1761055	1.306034	.7742024	1.480343
combined	123	1.089431	.105814	1.173534	.8799615	1.2989
diff		-.0684492	.213607		-.4913406	.3544422

diff = mean (Control) - mean (Experime) t = -0.3204
Ho: diff = 0 degrees of freedom = 121

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.3746 Pr (|T| > |t|) = 0.7492 Pr (T > t) = 0.6254

-> condition = Pre-test

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	74	.5135135	.104052	.8950892	.3061382	.7208889
Experime	57	.9649123	.1501146	1.133341	.6641965	1.265628
combined	131	.7099237	.0896843	1.026484	.5324939	.8873534
diff		-.4513988	.1771958		-.801985	-.1008125

diff = mean (Control) - mean (Experime) t = -2.5475
Ho: diff = 0 degrees of freedom = 129

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.0060 Pr (|T| > |t|) = 0.0120 Pr (T > t) = 0.9940

Question 4

-> condition = Post

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	68	.75	.092224	.7604987	.5659201	.9340799
Experime	55	.9272727	.115629	.8575276	.6954506	1.159095
combined	123	.8292683	.0727475	.8068083	.6852574	.9732791
diff		-.1772727	.1460312		-.46638	.1118346

diff = mean (Control) - mean (Experime) t = -1.2139
Ho: diff = 0 degrees of freedom = 121

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.1136 Pr (|T| > |t|) = 0.2271 Pr (T > t) = 0.8864

-> condition = Pre-test

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	74	.7027027	.085467	.7352146	.5323673	.8730381
Experime	57	.6140351	.1024585	.7735444	.4087861	.819284
combined	131	.6641221	.065571	.7504941	.5343978	.7938465
diff		.0886676	.1325423		-.1735705	.3509057

diff = mean (Control) - mean (Experime) t = 0.6690
Ho: diff = 0 degrees of freedom = 129

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.7476 Pr (|T| > |t|) = 0.5047 Pr (T > t) = 0.2524

Question 5

```
condition = Post

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      68    .8823529    .1079163    .8899004    .6669512    1.097755
Experime |      55    1.327273    .1218669    .9037893    1.082944    1.571601
---------+--------------------------------------------------------------------
combined |     123    1.081301     .082924    .9196711    .9171446    1.245457
---------+--------------------------------------------------------------------
    diff |           -.4449198     .162512               -.7666552   -.1231844
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                      t =  -2.7378
Ho: diff = 0                                     degrees of freedom =      121

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.0036         Pr (|T| > |t|) = 0.0071          Pr (T > t) = 0.9964


-> condition = Pre-test

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      74    1.135135    .1024041    .8809137     .931044    1.339226
Experime |      57    .9649123     .129982    .9813422    .7045271    1.225297
---------+--------------------------------------------------------------------
combined |     131    1.061069    .0809194    .9261643    .9009794    1.221158
---------+--------------------------------------------------------------------
    diff |            .1702229    .1631634                  -.1526    .4930457
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                      t =   1.0433
Ho: diff = 0                                     degrees of freedom =      129

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.8506         Pr (|T| > |t|) = 0.2988          Pr (T > t) = 0.1494
```

Question 6

```
condition = Post

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      68    1.470588    .1282533    1.057603    1.214594    1.726583
Experime |      55    1.745455    .1426497    1.057919    1.459459     2.03145
---------+--------------------------------------------------------------------
combined |     123    1.593496    .0957844      1.0623    1.403881    1.783111
---------+--------------------------------------------------------------------
    diff |           -.2748663    .1918215               -.6546276     .104895
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                      t =  -1.4329
Ho: diff = 0                                     degrees of freedom =      121

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.0772         Pr (|T| > |t|) = 0.1545          Pr (T > t) = 0.9228
```

```
-> condition = Pre-test

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      74    1.121622    .1261052    1.084798    .8702943    1.372949
Experime |      57    1.175439    .1585547    1.197062    .8578153    1.493062
---------+--------------------------------------------------------------------
combined |     131    1.145038    .0988021    1.130841    .9495701    1.340506
---------+--------------------------------------------------------------------
    diff |           -.053817    .2000042               -.4495301    .3418961
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                       t =  -0.2691
Ho: diff = 0                                     degrees of freedom =      129

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.3941         Pr (|T| > |t|) = 0.7883          Pr (T > t) = 0.6059
```

Question 7

```
-> condition = Post

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      68    .7647059    .0518221    .4273363    .6612685    .8681433
Experime |      55    .6181818    .0661134    .4903101    .4856324    .7507312
---------+--------------------------------------------------------------------
combined |     123     .699187    .0415207    .4604873    .6169925    .7813814
---------+--------------------------------------------------------------------
    diff |           .1465241    .0827888               -.0173783    .3104264
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                       t =   1.7699
Ho: diff = 0                                     degrees of freedom =      121

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.9604         Pr (|T| > |t|) = 0.0793          Pr (T > t) = 0.0396
```

```
-> condition = Pre-test

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      74    .4864865    .0615824    .5297516     .363753      .60922
Experime |      57    .4736842    .0667227    .5037454    .3400226    .6073458
---------+--------------------------------------------------------------------
combined |     131     .480916    .0451411     .516663    .3916098    .5702222
---------+--------------------------------------------------------------------
    diff |           .0128023    .0913973               -.1680296    .1936341
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                       t =   0.1401
Ho: diff = 0                                     degrees of freedom =      129

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.5556         Pr (|T| > |t|) = 0.8888          Pr (T > t) = 0.4444
```

Question 8

-> condition = Post

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	68	1.529412	.0824094	.679565	1.364922	1.693902
Experime	55	1.672727	.0862794	.6398653	1.499747	1.845707
combined	123	1.593496	.0598071	.6632928	1.475102	1.71189
diff		-.1433155	.1200792		-.381044	.094413

diff = mean (Control) - mean (Experime)   t = -1.1935
Ho: diff = 0   degrees of freedom = 121

Ha: diff < 0   Ha: diff! = 0   Ha: diff > 0
Pr (T < t) = 0.1175   Pr (|T| > |t|) = 0.2350   Pr (T > t) = 0.8825

-> condition = Pre-test

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	74	.8108108	.1030373	.8863605	.6054577	1.016164
Experime	57	1.245614	.1070237	.8080113	1.03122	1.460008
combined	131	1	.0766289	.877058	.8483989	1.151601
diff		-.4348032	.1503661		-.7323061	-.1373003

diff = mean (Control) - mean (Experime)   t = -2.8916
Ho: diff = 0   degrees of freedom = 129

Ha: diff < 0   Ha: diff! = 0   Ha: diff > 0
Pr (T < t) = 0.0022   Pr (|T| > |t|) = 0.0045   Pr (T > t) = 0.9978

Question 9

-> condition = Post

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Control	68	2.441176	.2392393	1.972818	1.963653	2.9187
Experime	55	2.890909	.2826912	2.096494	2.324147	3.457671
combined	123	2.642276	.1833137	2.033047	2.279389	3.005164
diff		-.4497326	.3679483		-1.178183	.278718

diff = mean (Control) - mean (Experime)   t = -1.2223
Ho: diff = 0   degrees of freedom = 121

Ha: diff < 0   Ha: diff! = 0   Ha: diff > 0
Pr (T < t) = 0.1120   Pr (|T| > |t|) = 0.2240   Pr (T > t) = 0.8880

```
-> condition = Pre-test

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      74     .972973    .1477625    1.271101    .6784827    1.267463
Experime |      57    2.052632    .2825558    2.133249    1.486604    2.618659
---------+--------------------------------------------------------------------
combined |     131    1.442748    .1552224    1.776601    1.135659    1.749837
---------+--------------------------------------------------------------------
    diff |           -1.079659    .2995839               -1.672393   -.4869245
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                       t =  -3.6039
Ho: diff = 0                                     degrees of freedom =      129

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.0002         Pr (|T| > |t|) = 0.0004          Pr (T > t) = 0.9998
```

Question 10

```
-> condition = Post

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      68          .5    .0610847    .5037175    .3780744    .6219256
Experime |      55    1.036364    .0969697    .7191465    .8419511    1.230776
---------+--------------------------------------------------------------------
combined |     123    .7398374    .0598071    .6632928    .6214433    .8582315
---------+--------------------------------------------------------------------
    diff |           -.5363636    .1105043                -.755136   -.3175913
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                       t =  -4.8538
Ho: diff = 0                                     degrees of freedom =      121

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.0000         Pr (|T| > |t|) = 0.0000          Pr (T > t) = 1.0000
```

```
-> condition = Pre-test

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      73    .5205479    .0678816    .5799806    .3852285    .6558674
Experime |      57    1.017544    .1046872    .7903713    .8078301    1.227258
---------+--------------------------------------------------------------------
combined |     130    .7384615    .0632586    .7212591    .6133028    .8636202
---------+--------------------------------------------------------------------
    diff |           -.4969959    .1202084               -.7348487   -.2591431
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                       t =  -4.1345
Ho: diff = 0                                     degrees of freedom =      128

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.0000         Pr (|T| > |t|) = 0.0001          Pr (T > t) = 1.0000
```

Percentage

```
-> condition = Post

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      68    46.29412    2.536914    20.91993    41.23042    51.35782
Experime |      55    55.05455    3.010131    22.32373     49.0196    61.08949
---------+--------------------------------------------------------------------
combined |     123    50.21138    1.975569    21.91012    46.30055    54.12222
---------+--------------------------------------------------------------------
    diff |           -8.760428    3.909485               -16.50028   -1.020572
------------------------------------------------------------------------------
    diff = mean(Control) - mean(Experime)                         t =  -2.2408
Ho: diff = 0                                     degrees of freedom =      121

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0134         Pr(|T| > |t|) = 0.0269          Pr(T > t) = 0.9866
```

The experimental and control groups performed significantly differently (p = 0.0269). In particular, the experimental groups scored higher mean or average (55.05455) than their control counter parts (46.29412) in the post-test.

```
-> condition = Pre-test

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      74    31.62162    2.471511    21.26074    26.69591    36.54734
Experime |      57    40.70175    3.263104    24.63589    34.16497    47.23854
---------+--------------------------------------------------------------------
combined |     131    35.57252    2.022191    23.14504    31.57186    39.57318
---------+--------------------------------------------------------------------
    diff |           -9.080133    4.015849               -17.02559   -1.134677
------------------------------------------------------------------------------
    diff = mean(Control) - mean(Experime)                         t =  -2.2611
Ho: diff = 0                                     degrees of freedom =      129

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0127         Pr(|T| > |t|) = 0.0254          Pr(T > t) = 0.9873
```

Total

```
condition = Post

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      68    11.57353    .6342286    5.229983     10.3076    12.83945
Experime |      55    13.76364    .7525327    5.580932     12.2549    15.27237
---------+--------------------------------------------------------------------
combined |     123    12.55285    .4938922     5.47753    11.57514    13.53055
---------+--------------------------------------------------------------------
    diff |           -2.190107    .9773712               -4.125071   -.2551429
------------------------------------------------------------------------------
    diff = mean(Control) - mean(Experime)                         t =  -2.2408
Ho: diff = 0                                     degrees of freedom =      121
```

```
    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.0134         Pr (|T| > |t|) = 0.0269         Pr(T > t) = 0.9866


-> condition = Pre-test

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
 Control |      74    7.905405    .6178778    5.315186    6.673977    9.136834
Experime |      57    10.17544     .815776    6.158974    8.541243    11.80963
---------+--------------------------------------------------------------------
combined |     131     8.89313    .5055478    5.786259    7.892964    9.893296
---------+--------------------------------------------------------------------
    diff |           -2.270033    1.003962               -4.256397   -.2836693
------------------------------------------------------------------------------
    diff = mean (Control) - mean (Experime)                       t =  -2.2611
Ho: diff = 0                                     degrees of freedom =      129

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.0127         Pr (|T| > |t|) = 0.0254         Pr(T > t) = 0.9873

. for var q1 - q10 percent total: bys group: ttest X, by(condition )
```

Caparisons between the post and the pre-tests

Question 1

```
-> group = Control

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      68    1.264706     .101822    .8396454    1.061468    1.467943
Pre-test |      74    .8918919    .1028429    .8846881    .6869263    1.096858
---------+--------------------------------------------------------------------
combined |     142    1.070423    .0738836    .8804245    .9243598    1.216485
---------+--------------------------------------------------------------------
    diff |             .372814    .1450436                 .086055     .659573
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   2.5704
Ho: diff = 0                                     degrees of freedom =      140

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.9944         Pr (|T| > |t|) = 0.0112         Pr(T > t) = 0.0056


-> group = Experimental

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      55    1.454545    .1032084     .765414    1.247625    1.661466
Pre-test |      57    .9473684    .1074338    .8111071    .7321527    1.162584
---------+--------------------------------------------------------------------
combined |     112    1.196429    .0780218    .8257051    1.041823    1.351034
---------+--------------------------------------------------------------------
    diff |             .507177     .149132                .2116324    .8027217
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   3.4009
```

```
Ho: diff = 0                                   degrees of freedom =      110

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.9995         Pr (|T| > |t|) = 0.0009         Pr(T > t) = 0.0005
```

Question 2

```
-> group = Control

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      68    .9117647    .0999018    .8238116    .7123598     1.11117
Pre-test |      74    .7567568    .0938912    .8076825    .5696319    .9438816
---------+--------------------------------------------------------------------
combined |     142    .8309859    .0684983    .8162519    .6955694    .9664024
---------+--------------------------------------------------------------------
    diff |            .1550079    .1369829               -.1158147    .4258306
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   1.1316
Ho: diff = 0                                   degrees of freedom =      140

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.8701         Pr (|T| > |t|) = 0.2597         Pr(T > t) = 0.1299


-> group = Experimental

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      55    .9636364     .127032    .9420945    .7089525     1.21832
Pre-test |      57    .7192982    .1112539    .8399487    .4964299    .9421666
---------+--------------------------------------------------------------------
combined |     112    .8392857    .0846615    .8959727    .6715234    1.007048
---------+--------------------------------------------------------------------
    diff |            .2443381    .1685152               -.0896195    .5782957
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   1.4499
Ho: diff = 0                                   degrees of freedom =      110

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.9250         Pr (|T| > |t|) = 0.1499         Pr(T > t) = 0.0750
```

Question 3

```
-> group = Control

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      68    1.058824     .128956    1.063399    .8014262    1.316221
Pre-test |      74    .5135135     .104052    .8950892    .3061382    .7208889
---------+--------------------------------------------------------------------
combined |     142    .7746479    .0850381    1.013346    .6065333    .9427624
---------+--------------------------------------------------------------------
    diff |              .54531    .1645011                .2200824    .8705376
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   3.3149
Ho: diff = 0                                   degrees of freedom =      140

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
```

```
 Pr (T < t) = 0.9994         Pr (|T| > |t|) = 0.0012          Pr(T > t) = 0.0006


-> group = Experimental

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      55    1.127273    .1761055    1.306034    .7742024    1.480343
Pre-test |      57    .9649123    .1501146    1.133341    .6641965    1.265628
---------+--------------------------------------------------------------------
combined |     112    1.044643    .1151271    1.218391    .8165109    1.272775
---------+--------------------------------------------------------------------
    diff |            .1623604    .2308168               -.2950642    .6197851
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   0.7034
Ho: diff = 0                                     degrees of freedom =      110

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.7584         Pr (|T| > |t|) = 0.4833          Pr(T > t) = 0.2416

-> bys group: ttest q4, by( condition )
```

Question 4

```
-> group = Control

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      68         .75     .092224    .7604987    .5659201    .9340799
Pre-test |      74    .7027027     .085467    .7352146    .5323673    .8730381
---------+--------------------------------------------------------------------
combined |     142    .7253521    .0625311    .7451438    .6017325    .8489718
---------+--------------------------------------------------------------------
    diff |            .0472973    .1255566               -.2009348    .2955294
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   0.3767
Ho: diff = 0                                     degrees of freedom =      140

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.6465         Pr (|T| > |t|) = 0.7070          Pr(T > t) = 0.3535


-> group = Experimental

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      55    .9272727     .115629    .8575276    .6954506    1.159095
Pre-test |      57    .6140351    .1024585    .7735444    .4087861     .819284
---------+--------------------------------------------------------------------
combined |     112    .7678571    .0781689    .8272623    .6129602    .9227541
---------+--------------------------------------------------------------------
    diff |            .3132376    .1542064                .0076367    .6188385
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   2.0313
Ho: diff = 0                                     degrees of freedom =      110

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.9777         Pr (|T| > |t|) = 0.0446          Pr(T > t) = 0.0223
```

Question 5

-> group = Control

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Post	68	.8823529	.1079163	.8899004	.6669512	1.097755
Pre-test	74	1.135135	.1024041	.8809137	.931044	1.339226
combined	142	1.014085	.0747826	.8911377	.8662444	1.161925
diff		-.2527822	.1487058		-.5467816	.0412172

diff = mean (Post) - mean (Pre-test) t = -1.6999
Ho: diff = 0 degrees of freedom = 140

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.0457 Pr (|T| > |t|) = 0.0914 Pr(T > t) = 0.9543

-> group = Experimental

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Post	55	1.327273	.1218669	.9037893	1.082944	1.571601
Pre-test	57	.9649123	.129982	.9813422	.7045271	1.225297
combined	112	1.142857	.0904525	.9572591	.9636195	1.322095
diff		.3623604	.1784404		.0087335	.7159874

diff = mean (Post) - mean (Pre-test) t = 2.0307
Ho: diff = 0 degrees of freedom = 110

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.9777 Pr (|T| > |t|) = 0.0447 Pr(T > t) = 0.0223

Question 6

-> group = Control

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Post	68	1.470588	.1282533	1.057603	1.214594	1.726583
Pre-test	74	1.121622	.1261052	1.084798	.8702943	1.372949
combined	142	1.288732	.0908241	1.082295	1.109179	1.468285
diff		.3489666	.1800594		-.0070205	.7049537

diff = mean (Post) - mean (Pre-test) t = 1.9381
Ho: diff = 0 degrees of freedom = 140

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.9727 Pr (|T| > |t|) = 0.0546 Pr(T > t) = 0.0273

```
-> group = Experimental


Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      55    1.745455    .1426497    1.057919    1.459459     2.03145
Pre-test |      57    1.175439    .1585547    1.197062    .8578153    1.493062
---------+--------------------------------------------------------------------
combined |     112    1.455357    .1097619    1.161611    1.237857    1.672858
---------+--------------------------------------------------------------------
    diff |            .5700159    .2137534                .1464068    .9936251
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   2.6667
Ho: diff = 0                                     degrees of freedom =      110

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.9956         Pr (|T| > |t|) = 0.0088          Pr(T > t) = 0.0044
```

Question 7

```
-> group = Control

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      68    .7647059    .0518221    .4273363    .6612685    .8681433
Pre-test |      74    .4864865    .0615824    .5297516     .363753      .60922
---------+--------------------------------------------------------------------
combined |     142    .6197183    .0420867     .501521    .5365158    .7029208
---------+--------------------------------------------------------------------
    diff |            .2782194    .0812135                .1176559    .4387829
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   3.4258
Ho: diff = 0                                     degrees of freedom =      140

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.9996         Pr (|T| > |t|) = 0.0008          Pr(T > t) = 0.0004


group = Experimental

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      55    .6181818    .0661134    .4903101    .4856324    .7507312
Pre-test |      57    .4736842    .0667227    .5037454    .3400226    .6073458
---------+--------------------------------------------------------------------
combined |     112    .5446429    .0472684    .5002413    .4509775    .6383083
---------+--------------------------------------------------------------------
    diff |            .1444976    .0939761               -.0417409    .3307361
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   1.5376
Ho: diff = 0                                     degrees of freedom =      110

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.9365         Pr (|T| > |t|) = 0.1270          Pr(T > t) = 0.0635
```

Question 8

-> group = Control

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Post	68	1.529412	.0824094	.679565	1.364922	1.693902
Pre-test	74	.8108108	.1030373	.8863605	.6054577	1.016164
combined	142	1.15493	.0729638	.8694645	1.010685	1.299174
diff		.718601	.1334049		.4548523	.9823496

diff = mean (Post) - mean (Pre-test) t = 5.3866
Ho: diff = 0 degrees of freedom = 140

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 1.0000 Pr (|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

-> group = Experimental

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Post	55	1.672727	.0862794	.6398653	1.499747	1.845707
Pre-test	57	1.245614	.1070237	.8080113	1.03122	1.460008
combined	112	1.455357	.0716244	.7580011	1.313429	1.597286
diff		.4271132	.1380396		.1535511	.7006754

diff = mean (Post) - mean (Pre-test) t = 3.0941
Ho: diff = 0 degrees of freedom = 110

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.9987 Pr (|T| > |t|) = 0.0025 Pr(T > t) = 0.0013

Question 9

-> group = Control

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Post	68	2.441176	.2392393	1.972818	1.963653	2.9187
Pre-test	74	.972973	.1477625	1.271101	.6784827	1.267463
combined	142	1.676056	.1507645	1.796566	1.378005	1.974107
diff		1.468203	.276289		.9219653	2.014442

diff = mean (Post) - mean (Pre-test) t = 5.3140
Ho: diff = 0 degrees of freedom = 140

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 1.0000 Pr (|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

-> group = Experimental

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Post	55	2.890909	.2826912	2.096494	2.324147	3.457671
Pre-test	57	2.052632	.2825558	2.133249	1.486604	2.618659
combined	112	2.464286	.2029102	2.1474	2.062206	2.866366
diff		.8382775	.3998151		.0459378	1.630617

```
    diff = mean (Post) - mean (Pre-test)                         t =   2.0967
Ho: diff = 0                                   degrees of freedom =      110

    Ha: diff < 0              Ha: diff! = 0              Ha: diff > 0
 Pr (T < t) = 0.9808       Pr (|T| > |t|) = 0.0383      Pr(T > t) = 0.0192
```

Question 10

-> group = Control

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Post	68	.5	.0610847	.5037175	.3780744	.6219256
Pre-test	73	.5205479	.0678816	.5799806	.3852285	.6558674
combined	141	.5106383	.045704	.5427051	.420279	.6009976
diff		-.0205479	.0917774		-.2020083	.1609124

```
    diff = mean (Post) - mean (Pre-test)                         t =  -0.2239
Ho: diff = 0                                   degrees of freedom =      139

    Ha: diff < 0              Ha: diff! = 0              Ha: diff > 0
 Pr (T < t) = 0.4116       Pr (|T| > |t|) = 0.8232      Pr(T > t) = 0.5884
```

-> group = Experimental

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Post	55	1.036364	.0969697	.7191465	.8419511	1.230776
Pre-test	57	1.017544	.1046872	.7903713	.8078301	1.227258
combined	112	1.026786	.0711414	.7528902	.8858142	1.167757
diff		.0188198	.1429397		-.2644531	.3020927

```
    diff = mean (Post) - mean (Pre-test)                         t =   0.1317
Ho: diff = 0                                   degrees of freedom =      110

    Ha: diff < 0              Ha: diff! = 0              Ha: diff > 0
 Pr (T < t) = 0.5523       Pr (|T| > |t|) = 0.8955      Pr(T > t) = 0.4477
```

Percentage

-> group = Control

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Post	68	46.29412	2.536914	20.91993	41.23042	51.35782
Pre-test	74	31.62162	2.471511	21.26074	26.69591	36.54734
combined	142	38.64789	1.869111	22.27303	34.95278	42.34299
diff		14.6725	3.54423		7.665363	21.67963

diff = mean (Post) - mean (Pre-test) t = 4.1398
Ho: diff = 0 degrees of freedom = 140

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 1.0000 Pr (|T| > |t|) = 0.0001 Pr(T > t) = 0.0000

-> group = Experimental

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Post	55	55.05455	3.010131	22.32373	49.0196	61.08949
Pre-test	57	40.70175	3.263104	24.63589	34.16497	47.23854
combined	112	47.75	2.315679	24.50685	43.16133	52.33867
diff		14.35279	4.447318		5.539251	23.16633

diff = mean (Post) - mean (Pre-test) t = 3.2273
Ho: diff = 0 degrees of freedom = 110

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 0.9992 Pr (|T| > |t|) = 0.0016 Pr(T > t) = 0.0008

Total

-> group = Control

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Post	68	11.57353	.6342286	5.229983	10.3076	12.83945
Pre-test	74	7.905405	.6178778	5.315186	6.673977	9.136834
combined	142	9.661972	.4672778	5.568258	8.738196	10.58575
diff		3.668124	.8860575		1.916341	5.419907

diff = mean (Post) - mean (Pre-test) t = 4.1398
Ho: diff = 0 degrees of freedom = 140

Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0
Pr (T < t) = 1.0000 Pr (|T| > |t|) = 0.0001 Pr(T > t) = 0.0000

-> group = Experimental

Two-sample t test with equal variances

```
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
    Post |      55    13.76364    .7525327    5.580932     12.2549    15.27237
Pre-test |      57    10.17544     .815776    6.158974    8.541243    11.80963
---------+--------------------------------------------------------------------
combined |     112     11.9375    .5789199    6.126712    10.79033    13.08467
---------+--------------------------------------------------------------------
    diff |            3.588198    1.111829                1.384813    5.791583
------------------------------------------------------------------------------
    diff = mean (Post) - mean (Pre-test)                          t =   3.2273
Ho: diff = 0                                     degrees of freedom =      110

    Ha: diff < 0                 Ha: diff! = 0                 Ha: diff > 0
 Pr (T < t) = 0.9992         Pr (|T| > |t|) = 0.0016          Pr(T > t) = 0.0008
```

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APPENDIX T2: EDITING CERTIFICATE

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