EXPLORING GRADE 2 MATHEMATICS CLASSROOMS AS SITES OF INCLUSIVE PRACTICE

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PLAGIARISM DECLARATION

I, Pamela Lilian Mubviri, hereby declare that this research is my own work, submitted for the Degree of Master of Education to the University of the Witwatersrand, Johannesburg, and no part of it has been copied from another source (unless indicated as a quote). All phrases, sentences and paragraphs taken directly from other work have been cited and the reference recorded in full in the reference list. This report has not been submitted for any other degree or examination at any other university.

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Dedications

This research report is dedicated to my parents Nokuthula and Albert Nderezina who sacrifice everything to make sure I attain the best education and for always encouraging me to further my studies.

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Abstract

Literature shows that South African mathematics education is in crisis. This study sought to look at inclusion practices during the teaching of mathematics. The main objective of this study therefore was to investigate the role of inclusion in a grade 2 mathematics classroom in a former Model C school located in the North of Johannesburg while teaching a mathematical concept known as 'bridging through ten'. Inclusion was introduced into the classroom by conducting an eight-day bridging through ten intervention program which made use of the five tools of mathematical resilience. The tools of mathematical resilience used include; 'the growth zone model', 'the ladder of accessibility', 'the explore-options-actions framework', 'the grid of communications' and 'the relaxation response'. To execute this investigation, this study utilized a mixed methods approach and made use of case studies of three learners that represented three different clusters of the research results. The two instruments of data collection used were a mathematical resilience questionnaire and a bridging through ten test both used as pre and post-tests to compare the results before and after the intervention. This allowed me to establish the feelings and attitudes of learners towards mathematics before and after an inclusive environment. The results obtained indicated that there was a positive shift of beliefs and attitudes towards mathematics from the pre to post-questionnaire for most learners and also displayed a better understanding of the concept of bridging through ten from the pre to post-mathematics tests.

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Key words

Mathematical resilience, bridging through ten, number sense, inclusive education

List of acronyms and abbreviations

A	Agree
ANAs	Annual National Assessments
C	Contaminated
CAPS	Curriculum Assessment Policy Statement
D	Disagree
N	Neutral
DBSTs	District-Based Support Teams
DBE	Department of Basic Education
OECD	Organization for Economic Co-operation and Development
SACMEQ	Southern and Eastern African Consortium for Monitoring and Educational Quality
SBSTs	School-Based Support Teams
SIAS Policy	Policy on Screening, Identification, Assessment and Support
TIMMS	Trends in International Mathematics and Science Study
UNESCO	United Nations Educational, Scientific and Cultural Organization

Definitions (DBE, 2014)

Full-service schools

Ordinary schools that are inclusive and welcoming of all learners in terms of their cultures, policies and practices. Such schools increase participation and reduce exclusion by providing support to all learners to develop their full potential irrespective of their background, culture, abilities or disabilities, their gender or race. These schools will be strengthened and orientated to address a full range of barriers to learning in an inclusive education setting to serve as flagship schools of full inclusivity.

Special schools

Schools equipped to deliver a specialized education programme to learners requiring access to high-intensive educational and other support either on a full-time or a part-time basis.

District-based Support Team (DBST)

A management structure at district level, the responsibility of which is to coordinate and promote inclusive education through: training; curriculum delivery; distribution of resources; infrastructure development; identification, assessment and addressing of barriers to learning. The DBST must provide leadership and general management to ensure that schools within the district are inclusive centres of learning, care and support.

School-based Support Teams (SBSTs)

Teams established by schools in general and further education, as a school-level support mechanism, whose primary function is to put co-ordinated school, learner and teacher support in place. Leadership for the SBST is provided by the school principal to ensure that the school becomes an inclusive centre of learning, care and support. This team is the same as an Institution-level Support Team.

Special Schools Resource Centre's (SSRCs)

Special schools equipped to accommodate learners who need access to high-intensity educational support programmes and services, as well as providing a range of support services to ordinary and full-service schools.

CHAPTER 1: INTRODUCTION

1.1. Introduction

The focus of this research is particularly centered in the South African context, which has a history of low mathematics results. Human, Van der Walt and Posthuma (2015) contend that there is need for intervention in foundation phase mathematics education with evidence from the Annual National Assessments (ANAs). They show that Grade 3 learners scored an average of 28% for numeracy in 2010 and in 2011 only 17% of learners achieved at least 50%. In 2012 only 37% learners achieved at least 50% for numeracy (DBE, 2012). These results are evidence that there is an urgent need for interventions aimed at improving these results.

1.2. Problem Statement

There have been several researchers investigating inclusion in education specifically looking at learners with special needs, but little attention seems to be paid to the meaning of inclusion of all learners in primary mathematics education, in terms of what promotes or inhibits mathematics practice within classrooms as well as the approaches required to enhance inclusion in mathematics classrooms. One of the possible reasons for low performance in mathematics could be the lack of creating inclusive classrooms. The Education White paper 6 (DBE, 2001) gives definitions of inclusive education among which it states that inclusion "..is about enabling education structures, systems and learning methodologies to meet the needs of all learners, changing attitudes, behavior, teaching methodologies, curricula and the environment to meet the needs of all learners, maximizing the participation of all learners in the culture and the curricula of educational institutions and uncovering and minimizing barriers to learning, empowering learners by developing their individual strengths and enabling them to participate critically in the process of learning".

However, according to Donohue and Bornman (2014) South Africa is having a hard time in implementing inclusive education. So, I decided to look at mathematical classrooms in particular to see whether mathematical resilience can be an approach that can cater for the needs of all learners in mathematics teaching and learning in foundation phase classrooms and thus encouraging more inclusive spaces. One of the ways of achieving inclusion in the mathematics classroom is by running pre and post-tests with a selection of intervention lessons focused on developing number sense through the bridging through ten strategy. In addition, questionnaires were used at the beginning and the ending of the intervention to determine whether learners had seen the usefulness of mathematical resilience.

1.3. Inclusive education

In general, inclusion has to do with people's diversity, overcoming barriers (Topping, 2012) and being able to empower all learners as well as being able to meet human differences and create meaningful participation in the education system (Barton, 1997). Inclusion and exclusion can also be interpreted as students' participation or alienation (Nilholm, 2006). From an inclusive perspective, education is for all learners and should be adjusted according to the specific needs of the learners, and the pedagogy should put their learning in the center (Liasidou, 2012). Inclusion is then an important notion in South Africa where the classrooms are very diverse.

Göransson and Nilholm (2014) distinguish four categories of definitions of inclusion: 'placement' definition, 'specified individualized', 'general individualized' and a 'community' definition. The 'placement' definition refers to learners with disabilities in general classrooms. The 'specified individualized' definition refers to inclusion as a way of meeting the social and academic needs of learners with disabilities. The 'general individualized' definition refers to inclusion as a way of meeting social and academic needs of all learners. The 'community' definition refers to creating special communities. The 'general individualized' is one of the definitions which I used to underpin how inclusion needs to be understood in this study.

Asp-Onsjö (2006) cited in Roos (2014), divided inclusion into three parts: 'spatial' inclusion, 'didactical' inclusion and 'social' inclusion. Spatial inclusion refers to how much time a learner spends in the same room as his or her classmates. Social inclusion concerns the way in which learners interact with peers. Didactical inclusion refers to the learner's participation in relation to the subject taught in the classroom, in this case mathematics. For the purposes of this research I will be looking at didactical inclusion; that is learners' participation in relation to mathematics specifically the topic of bridging through ten.

Farrell (2004), introduces four conditions of inclusion: 'presence', 'acceptance', 'participation' and 'achievement' which should be present for a school to be a truly inclusive school. Schmidt (2013) uses the term inclusion when analyzing the possibility for the teacher to teach mathematics in a way that includes all learners in a regular classroom which proceeds to look at how classroom management affects students' opportunities to be included. In Diversity in Mathematics Education Center for Learning and Teaching (DiME, 2007), inclusion is discussed in terms of access to the mathematics taught for all students which is what this study seeks to explore in foundation phase mathematics classrooms. Other issues discussed in inclusive education include, giving "space for learner voices" (Tomlin, 2002), need for meaningful interventions in order to assist marginalized learners (DiME, 2007) and the use of tasks rooted in known contexts for the learners to have access to those tasks (Cahnmann and Remillard, 2002). These characteristics of inclusion also happen to be some of the principles of mathematical resilience according to Johnston-Wilder and Lee (2010).

When inclusive pedagogies and practices are not employed in the learning environment then learners are said to be excluded. According to Findon and Johnston-Wilder (2017), exclusion may manifest as a result of the teaching and learning process not meeting the learning needs of the learner; teaching and learning process not corresponding to the learning styles of the learner; the language of instruction and learning materials is not comprehensible; learner going through negative and discouraging experiences at school or in the program. Williams (2007) suggests that learners who feel persistently excluded can result in depression and helplessness. Such negative emotions are known to shut down normal cognitive functions and this makes inclusion important in mathematics classrooms in South Africa where mathematics education is in crisis. This study explores how mathematical resilience is a construct that can be utilized to introduce inclusion in foundation phase mathematics classrooms.

1.4. Conceptual Framework: Mathematical Resilience

Mathematical resilience is the conceptual framework that informs this study. Its tools that were used to teach bridging through ten in an inclusive manner during the intervention program include 'The growth zone model', 'The Grid of Communication Skills', 'The ladder of accessibility', 'The relaxation response' and 'The explore-actions-options framework'. Johnston–Wilder and Lee (2010) believe that being mathematically resilient allows one to learn mathematics effectively and they define mathematical resilience as a learner's attitude towards mathematics which empowers them to keep working at mathematics even when they face difficulties during their learning.

Mathematics resilience can be developed by having a ‘growth mindset’, having the belief that making mistakes builds fluency and will lead to success, being reflective, working hard and engaging in mathematics discussions (Johnston-Wilder and Lee, 2010). What seems to hinder the development of mathematical resilience is too much focus on the acquisition of skills and an over regard for correct answers and speed in calculation which increases learners’ anxiety, a disconnection between maths learnt at school and real life, the belief that making mistakes is a sign of carelessness and the lack of exposure to different methods and strategies for problem solving (Johnston –Wilder and Lee, 2010). A more detailed explanation of mathematical resilience and its tools is provided in chapter 2.

1.5. Bridging through ten

The pre and post-mathematics test as well as the intervention was focused on bridging through ten using number lines. Thompson (1999), posits that bridging through ten is a calculation strategy that involves adding or subtracting some units to a number close to ten. Bridging through ten is also one of the methods which promote the development of higher order number sense which is needed for overall success in mathematics. Amongst a variety of purposes of number sense in mathematics learning, Berch (2005) claims that bridging through ten can increase fluency and flexibility with operations such as addition and subtraction. Therefore, the mastery of bonds from 1 to 10 is critical, the ability to split the second number is also critical in bridging through ten, also splitting the number and the focus on making a ten or multiples of ten (Thompson, 1999). In addition, number lines were used as visual representations to support learners in grasping the concept of bridging through ten (Woods et al. 2017) and to facilitate the move from concrete counting strategies to calculation strategies.

1.6. Brief Methodology

This research was conducted in a co-education former Model C school in the North of Johannesburg in a grade 2 classroom with 43 learners. However due to some consent forms not being signed and the contamination of some questionnaires, only the work of 22 boys and girls is analyzed in the analysis chapter. It utilized a mixed research method which combines both qualitative and quantitative approaches (Johnson and Onwuegbuzie, 2004). This method allowed me to collect numerical data through a pre and post-test as well as from a pre and post-questionnaire and be able to explain these results using qualitative methods. An eight-day intervention program focused on teaching bridging through ten using the principles of mathematical resilience was run. This program was an attempt to introduce inclusion in the grade 2 classroom. The intervention took place after the pre-questionnaire and pre-mathematics test and before the post-questionnaire and test so that progress before and after the intervention could be monitored. Important to note, is that although the intervention made use of inclusive practices using mathematical resilience tools, the focus of this study is on finding out if teaching and learning mathematics in an inclusive environment makes a difference in learners' understanding of mathematics.

1.7. Ethics

Firstly, all data collection only commenced when clearance had been granted by the University of the Witwatersrand ethics committee as well as the Gauteng Department of Education. The school principal, SGB, the teacher whose class I worked with, the learners and their parents and guardians were all given consent forms (Appendices 4-7) informing them of the research project, what it entails, that they could discontinue their participation at any time and there would not be consequences for that. Finally, the consent forms highlighted that pseudonyms would be used in place of the name of the school as well as learners' names. They also indicated that the research data would be kept in a safe place and would be destroyed in 3-5 years.

1.8. Research Questions

The aim of my study was to explore grade 2 mathematics classrooms as sites of inclusive practice by establishing a relationship between mathematical resilience and mathematics performance. This was achieved by answering the following questions:

1. What were the predominant shifts in attitudes and feelings (mathematical resilience) from pre to post-questionnaires?
2. What were the mathematical gains (bridging through ten) visible from the pre to post-mathematical test?
3. What needs to be considered when developing an inclusive foundation phase mathematics classroom in order to improve mathematical results?

1.9. Aims and Objectives

The aims and objectives of this study are listed below:

- Find out if children’s feelings and attitudes towards mathematics affect their performance,
- To assess any shifts in mathematical understanding of bridging through ten,
- Find out if Mathematical Resilience is an effective approach to create more inclusive mathematics classrooms.

1.10. Structure of the research report: Chapter summary

The structure of this research is as follows:

Chapter 1 introduces the research report by outlining the problem statement which gives the rationale for this study. This chapter also outlines the aims and objectives of the study and the three research questions that guide this research. The chapter also briefly discusses the introduction to inclusive education, conceptual framework of mathematical resilience, bridging through ten, methodology, ethics and the structure of this report.

Chapter 2 reviews the literature on exclusion and inclusion, making explicit the problems around the implementation of inclusive education in South Africa, literature on developing number sense and bridging through ten. This chapter also discusses the conceptual framework of mathematical resilience making note of the five tools used in the intervention program.

Chapter 3 focuses on the methodology of this study. It discusses the research design, research site, research participants, instruments used to collect data, the intervention program and a brief section of how data analysis was done. This chapter further discusses the ethical considerations, issues of validity and reliability as well as a briefing on this research report.

Chapter 4 analyzes the results of the pre and post questionnaires and tests in the following order; analysis of pre-questionnaire, pre-mathematics test, post- questionnaire, post-mathematics test, comparison of the pre and post questionnaire and test, discussion of three learners’ results and finally the conclusion.

Chapter 5 discusses the key findings of this study by answering the three research questions provided. It concludes this report by outlining recommendations as well as limitations of this research.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Literature Based Rationale

The aim of this chapter is to discuss the literature-based rationale and conceptual framework for this study. The chapter begins with a discussion on inclusion and exclusion mostly in South Africa also looking at policies that inform inclusive education in the country. A discussion on number sense, which must be present for one to do bridging through ten, follows. A brief definition of bridging through ten is provided next. Finally, an explanation of mathematical resilience which is the conceptual framework that informs this study concludes the chapter.

2.1.1. Inclusion and Exclusion

The understanding of inclusion starts with knowledge of exclusion. Exclusion is the lack of formal or epistemological access to education because of socio-cultural factors or individual and family factors (Fleisch, Shindler and Perry, 2010). Formal access refers to access into an educational institution while epistemological access refers to accessing school knowledge in the educational institution. This could mean that learners attend mathematics classes but do not gain the required mathematical knowledge maybe because of the teaching methods being employed. Ntombela and Raymond (2013, p. 2) contend that barriers to learning are therefore not just physical but that attitudes found in society also disable people from having equal opportunities as others in a society. This research therefore seeks to explore a grade two classes' epistemological access to mathematics through employing tools of mathematical resilience to achieve inclusion.

Ntombela and Raymond (2013, p. 7-8) mostly discuss exclusion in terms of learners that attend school but do not gain epistemological access from the institutions. The reason is that the system concentrates on deficits within learners to marginalize them instead of also acknowledging their social contexts which could be the reason for their breakdown in learning. Therefore, the factors identified that could be leading to the exclusion of learners are language, inflexible curriculum, attitudes towards difference, lack of parental involvement and inaccessible as well as unsafe learning environments.

According to Slee (2011, p. 153), “Inclusive education declares its commitment to identifying and dismantling educational exclusion”, but the main concern is whether inclusive education has succeeded in doing that since its introduction. Slee (2011, p. 111) also maintains that, “Inclusive education calls on our ability to recognize and understand the mechanics of exclusion. It then invites us to work, bit-by-bit, towards reconstructing ourselves, and our approaches to education consistent with changing contexts and changing populations in new times.”

According to Ntombela and Raymond (2013, p. 3), inclusive education as defined in the Education White paper 6, (which is the official policy for inclusive education in South Africa) involves the appropriate support of everyone in order for them to learn. It also says that difference should be acknowledged so as to welcome learners from different cultural backgrounds and also the adaptation of strategies that facilitate learning.

The Educational White paper 6 in Ntombela and Raymond (2013, p. 3) further defines inclusive education as one that opens up the learning culture in schools, enhances learners’ ability to participate critically, and also assess and modify attitudes, teaching methodologies, teaching environments and curricular in terms of learners’ needs. According to UNESCO (1994, p. 6) cited in Miles and Singal (2010), “schools should accommodate all children regardless of their physical, intellectual, social, linguistic or other conditions. This should include disabled and gifted children, street and working children, children from remote or nomadic populations, children from linguistic, ethnic, or cultural minorities and children from other disadvantaged or marginalized areas and groups”. The vocabulary I wish to be noticed in the definitions I have outlined is, ‘all students’ instead of only those with disabilities as a lot of people tend to assume that this is what inclusive education is about.

Even with the introduction of inclusive education in South Africa through the Education White Paper 6 (DBE, 2001) and the Policy on Screening, Identification, Assessment and Support (SIAS Policy) (DBE, 2014), some schools still seem to believe in practicing non-inclusive pedagogies such as streaming. The reason for this could be that teachers and school administrators could be struggling with the implementation of inclusive practices at classroom level despite the establishment of District-based Support Teams (DBSTs), Special School Resource Centre’s, Full-Service Schools and the School-based

Support Teams (SBSTs).

Makoelle (2012) also found that there is limited literature of how inclusive pedagogy is conceptualized, operationalized and implemented in South Africa which is probably the reason why inclusive pedagogic practice in the South African classrooms has not improved despite the implementation of inclusive policies such as the Education White paper 6 and SIAS policy.

Despite the confusion on the conceptualization of inclusive pedagogies, some authors have written on the subject. Florian and Black-Hawkins (2011) contend that inclusive pedagogies are strategies to teaching and learning that involve extending what is generally available to everybody, instead of providing for all by differentiating for some. This means that approaches that provide learning opportunities for all learners to participate in the classroom are used rather than those that work for most and some learners and through this, difference is valued. Inclusive pedagogies also involve focusing on what is to be taught rather than who is learning it. They focus on what learners can do rather than on what they cannot do, also using a variety of grouping strategies rather than ability grouping that separates.

Liasidou (2012) on the other hand conceptualizes inclusive pedagogies as using differentiation in a way that is 'socially just', 'non-discriminatory', and 'non-segregatory' and that takes into consideration the diversity of learners. One way of achieving socially just inclusive pedagogies is by using 'The principles of Universal Design for Learning' (UDL). According to Liasidou (2012, p. 42) UDL "..entails strategically designing courses and devising teaching methods intended to meet learner diversity on the basis of ability, learning style, race, ethnicity, and other characteristics..". The main intentions of UDL are to promote multiple and flexible methods using 'multiple intelligences', the promotion of flexible methods of participation and outcomes as well as the promotion of diverse and flexible methods of expression to develop a variety of intelligences. With the use of such inclusive pedagogies that value difference and various identities, inclusive education would be possible. The use of mathematical resilience tools for teaching mathematics could be viewed as an inclusive pedagogy.

Donohue and Bornman (2014) explore the challenges of realizing inclusive education specifically in South Africa. They discuss school-level and cultural-level barriers to inclusion in South Africa. In terms of school-level, they claim that about 70% of children of school-going age with disabilities are out of school and that those who attend school are in special schools even though there are inclusive education policies (The Education White Paper 6) which was published in 2001. The introduction of the inclusive education policy in 2001 was to ensure that learners considered to have disabilities would attend the same schools with those considered not to have disabilities. But it seems that such is not happening in schools. Zollers, Ramanathan and Yu (1999) cited in Donohue and Bornman (2014) suggest that successful inclusion depends on the attitudes and actions of school staff. These two authors contend that this could be a result of lack of clarity in the policy in terms of its goals and because of poor implementation of the policy on the ground. This policy was meant to allow for an integrated education system suitable for the needs of all learners despite ability.

Cultural-level barriers to inclusive education involve attitudinal, cultural barriers and community involvement in realizing inclusive education in low- income countries. According to Donohue and Bornman (2014), participation of people with disabilities is influenced by the culture and values of community members meaning that if a community is unaccepting of people with disabilities the oppressive practices will continue to prevail. Groce (2004) gives an example of how some children with disabilities do not attend school, as it is believed that they cannot learn, or they are disruptive.

Donohue and Bornman (2014) argue that despite the school-level and cultural-level barriers to inclusive education, the main problems obstructing the implementation of inclusive education in South Africa have to do with ambiguities in Education White Paper 9 (DBE, 2001). They contend that there is a gap between policy and practice and for this gap to be closed, there must be clarification on the goals as well as how these can be met by the Department of Education.

The broad key strategies for establishing inclusive education in Education White Paper 6 (DBE, 2001) include improvement of existing special schools and conversion of some to special schools, mobilization of about 300 000 children with disabilities who are out of school, conversion of some mainstream schools to full service schools, raising awareness to school staff about inclusive education, establishment of district-based support teams and the implementation of a national advocacy campaign. According to Donohue and Bornman (2014), the strategies mentioned above are evidence that the inclusive policy document lacks detail and does not give much guidance on how to implement it in practice. It is also evident that although the Education White Paper 6 (DBE, 2001) talks about inclusion for all learners, its attention is focused on learners with disabilities.

Another challenge in the implementation of inclusive education has to do with insufficient funding of schools by the Department of Education so they can make adjustments to the infrastructure. Also, the current body of teachers feel they lack the knowledge to accommodate diverse learners in their classrooms in a way that they can tailor the curriculum to suit the needs of all individuals (Donohue and Bornman, 2014 and Walton, 2011).

According to Engelbrecht, Nel, Smit and Van Deventer (2015), the White Paper 6 (DBE, 2001) covered relevant propositions for an inclusive education system such as principles of social justice, human rights healthy environment, participation, integration and equitable access to education. However, these authors believe that the White Paper 6 was dependent on a deficit approach in terms of support for educational needs (Engelbrecht, Nel, Nel and Tlale, 2015).

The White Paper 6 (DBE, 2001), proposed to convert 30 mainstream schools to full-service schools in the short-term and about 500 schools in the long term of over a period of 20 years. The report on the progress of inclusive education (DBE, 2015) showed that so far there are 407 designated full-service schools that are not yet physically upgraded and only 106 schools in the whole of South Africa that have been upgraded. Motshegka (2010a) cited in Walton (2011) posits that there are only eight schools that have completed their conversion to full-service schools since 2001, which is a completely different story from the report (DBE, 2015). It is clear therefore, that there is a gap between the idealistic conceptualization of inclusive education policy documents in South Africa and implementation on the ground (Engelbrecht et al., 2015). Therefore, my intention of implementing an inclusive strategy on the ground, even if it is a small-scale intervention.

According to Badat and Sayed (2014) cited in Engelbretch et al. (2015), the implementation of inclusive education, 14 years after the introduction of White Paper 6, continues to experience serious challenges as a result of the history of fundamental economic inequalities during the Apartheid era, and inadequate physical and human resources.

Ntombela and Raymond (2013, p. 9) contend that for there to be inclusive education, there needs to be a shift from mainstreaming to inclusion. The difference between these two being that mainstreaming tries to fit learners into the system and ‘normal routines. Inclusion instead recognizes difference, supports learners for the benefit of all and overcomes barriers to learning.

Ntombela and Raymond (2013, p. 12-13) put forward some suggestions of how inclusion can be implemented and overcome barriers taking into account the South African context of some teachers being trained under apartheid. They suggest that professional development of teachers is needed so they may know what they have to do. Also the school and the education system should raise awareness of inclusive education. Lastly there should be community development to provide children with such things as positive role models, good health care and motivation.

More than a decade after the Education White Paper 6 was drawn, a new policy (SIAS Policy) was established by the South African Department of Education. According to DBE (2014, p. 11), “the SIAS policy is aimed at improving access to quality education for vulnerable learners and those who experience barriers to learning, including: Learners in ordinary and special schools who are failing to learn due to barriers of whatever nature (family disruption, language issues, poverty, learning difficulties, disability, etc.).” SBSTs and DBSTs were established in line with the objectives of this policy for providing support to teachers with regards to inclusive pedagogies. Such support systems include training, curriculum delivery assistance and assessment. It is to be noted that despite such great efforts by the DBE to introduce inclusion in South African classrooms, quite a number of teachers still seem to be lacking in terms of how to implement inclusive pedagogies.

2.1.2 An inclusive pedagogy in a mathematics classroom

There is limited literature on inclusive mathematics classrooms especially in the South African context. According to Roos (2019), in mathematics education the term inclusion is used in curriculum as well as in research but is always dealt with implicitly in all that research. Meaning that none of the researchers concentrate on the actual role of inclusion in mathematics teaching and learning. This research shows that inclusion is used both for an ideology and a way of teaching. These two uses are mostly treated separately and independently of each other. Roos (2019, p. 25) suggests that, “..if sustainable development of inclusion in mathematics education is to be promoted, scholars need to connect and interrelate the operationalization and meanings of inclusion in both society and in mathematics classrooms, and take students’ voices into consideration in research.”

Teachers should be aware that when designing lessons for inclusive mathematics classrooms, they should pay specific attention to the definition and use of mathematical symbols in different contexts and encourage the use of mathematical vocabulary in classrooms. This creates opportunities for students to engage in mathematical talk which enhances understanding in the subject (Geary, 2004).

Griffin, League, Griffin and Jungah (2013) contend that there are approaches which can be used for learners struggling in mathematics such as 'screening all students for mathematics difficulties' and monitoring student progress to plan for differentiated instruction. Also illustrating problems visually and graphically and building fluency of mathematics facts.

2.1.3 Developing number sense

According to Roodt (2018) the South African education system is in crisis more especially in the mathematics and sciences as most learners entering grade one are unable to finish their 12 years of schooling with a good mathematics pass. In the rankings done by the Organisation for Economic Co-operation and Development (OECD) for mathematics and science tests in 2015, out of 76 countries South Africa came out 75th. Also, in the 2013 Southern and Eastern African Consortium for Monitoring and Educational Quality (SACMEQ) evaluations for reading and mathematics, out of 16 countries South Africa ranked 8th. In the Trends in International Mathematics and Science Study (TIMMS) out of 49 countries that were tested for maths proficiency in 2015, South Africa came out second worst (Roodt, 2018). Seeing how dismally the country is generally performing in mathematics, it is only natural that the immediate focus would be on improving the results and not inclusive education although I believe that the use of inclusive pedagogies could be the first step in improving mathematics results.

Narrowing down the South African mathematics education crisis I chose to look at foundation phase which is where a good foundation for mathematics should be laid. The South African curriculum document, the Curriculum Assessment Policy Statement (CAPS) document in DBE (2011) shows that by the end of grade three, learners should be able to add up to 999 as well as subtract from 999. This is however not the case as a lot of children have challenges utilizing the counting and calculation strategies and as a result, they rely heavily on unit counting and modelling which leads to a lot of inaccurate answers. The first step to solving this problem is for foundation phase learners to develop number sense in order to fast-track the movement to more advanced methods of problem solving.

In trying to establish a definition of number sense there is little consensus among researchers (Berch, 2005; McIntosh et al., 1992; Verschaffel, Greer, and De Corte, 2007 cited in Torbeyns, Obersteiner and Verschaffel, 2012). However, Berch (2005) distinguished between a 'lower-order' and 'higher-order' number sense. The lower-order characterization of number sense involves having instincts about quantity, accurate perception of small numerosities, counting, grasping simple arithmetic operations (Berch, 2005, p. 334) and the representation and manipulation of the mental number line which is essentially the knowledge that small quantities are on the left while the larger quantities are on the right hand side (Dehaene, 2001). According to Woods, Geller and Basaraba (2017), visual representations such as the number line create mental representations on the order of numbers and play an important role in the transition from concrete to visual and finally abstract representations of mathematics concepts which subsequently develop number sense. These authors contend that number lines are one of the most powerful tools to support the learning of mathematics concepts. Diezmann & Lowrie (2006) cited in Woods et al. (2017) maintain that number lines facilitate the 'making of comparisons, understanding place value, and modelling mathematical operations' such as addition and subtraction.

Higher-order number sense is much more complex and Berch, (2005, p. 334) defines it as "a deep understanding of mathematical principles and relationships, a high degree of fluency and flexibility with operations and procedures, a recognition of and appreciation for the consistency and regularity of mathematics, and a mature facility in working with numerical expressions - all of which develop as a byproduct of learning through a wide array of mathematics education activities". McIntosh et al. (1992, p. 5) cited in Torbeyns et al (2012) contend that higher-order number sense plays a role in the knowledge and facility with numbers, knowledge and facility with operations and applying knowledge and facility of number and operations to computations. Verschaffel, Greer and De Corte (2007) criticize this framework by saying that it is too broad. According to Torbeyns (2012, p. 63) lower order number sense is a part of higher order thus higher order develops from lower order characterization of number sense.

Andrews and Sayers (2014) talk about Foundational and Applied number sense instead of lower-order and higher-order. They contend that Foundational number sense develops during the first years of formal learning and involves general number related activities. On the other hand, Applied number sense includes foundational number sense and involves number related activities important for life after school which leads to adaptive expertise.

Robinson et al (2002) cited in Andrews and Sayers (2014) maintain that children do not possess number sense, rather they attain it meaning that the teacher has to consciously build it by exploring number relationships and patterns and different methods of calculation (Griffin 2004 cited in Andrews and

Sayers, 2014). It is important to note that the development of number is a gradual process that develops through exploration of number. One way that number sense was developed in this study was by the teaching and testing of bridging through ten to grade 2 learners through the use of number lines, which spoke to developing high order number sense.

2.1.4 Bridging through ten

Certain authors such as Carpenter and Moser (1984), Thompson (1999) and Wright, Martland and Stafford (2006) discuss addition and subtraction counting and calculation strategies. The addition counting strategies for foundation phase learners given by Carpenter and Moser (1984) include counting all, counting on from first, counting on from larger, recall and derived facts. Subtraction strategies are separating from, adding on, matching, counting down from, and counting up from given. As learners gain an understanding of addition and subtraction, they should be able to move from direct modeling strategies such as these mentioned above to calculation strategies. Thompson (1999) distinguishes between counting and calculation strategies. Calculation strategies being the more sophisticated those that learners should be moving towards. Calculation strategies for both addition and subtraction include, Doubles facts (subtraction), Near-doubles (addition and subtraction), Bridging through ten (addition and subtraction) and Compensation. The counting and calculation strategies are not discussed in detail except for Bridging through ten which is the focus in this study.

Karantzis (2010, p. 5) terms bridging through ten ‘calculation based on the first number’, or ‘N10’. The methods used in the study are c) and d) as seen below. This author shows different ways of working with this strategy as shown in table 2.1 below:

Table 2.1: Bridging through ten calculation strategies

Addition	Subtraction
a) First the units and then the tens of the second addend are added to the first: 54+25: 54+5=59, 59+20=79	b) First the units and then the tens of the subtrahend are subtracted from the minuend (e.g. 68-26: 68- 6=62, 62-20=42)
c) First the tens and then the units: 54+25: 54+20=74, 74+5=79)	d) First the tens and then the units (E.g. 68-26: 68-20=48, 48-6=42).
e) Separate the second addend in another way: 54+25 = (54+10+10) +5=79.	

Thompson (1999), defines bridging through ten as a calculation strategy that involves adding or subtracting some units to a number close to ten in order to work with the friendly number ten. Example: 8+6, taking 2 from 6 to add it to 8 so as to work with 10+4. The skills required to execute this strategy successfully according to Thompson (1999) include the ability to:

- "recognize a number in the teens as comprising a ten and a single-digit number for example 16 and 10 and 6;
- partition any two-digit number less than 20 in this way;
- partition any single-digit number in different ways e.g. 7 as 3 and 4; 5 and 2; 1 and 6; subtract any single-digit number from 10 (know 'complements in 10') and selecting the most appropriate combination to jump to ten".

Askew (2013, p. 1) asserts that "..evidence shows that flexible and efficient (fluent and reasoned) knowledge of number bonds to 20 correlates with success at the end of primary schooling, yet the evidence is that many South African students are over-reliant on inefficient counting methods". This is a concerning issue as it becomes difficult to then move learners from counting strategies to more efficient ones such as bridging through ten if they are struggling with their bonds. Askew (2013) argues that this could be the case because teachers could be treating addition and subtraction bonds as 'everyday/spontaneous' concepts that do not need to be taught in mathematics classrooms. This author therefore suggests that the learning of number bonds then needs to be treated as 'scientific' concepts which are consciously and intentionally taught during maths lessons in foundation phase classrooms so that they can become internalized. Once learners have internalized addition and subtraction number bonds, they are able to apply this knowledge to more complex methods of problem solving such as bridging through ten. In order to test the effectiveness of bridging through ten a pre and post-test was administered to the learners, which will be discussed in chapter 3.

2.2. Conceptual Framework: Mathematical Resilience

One of the aims of my study include finding out if learners' feelings, beliefs and attitudes towards mathematics affect their ability to learn the subject. The construct of mathematical resilience could be a possible approach that could create an inclusive classroom by countering anxiety, feelings of failure and helplessness in mathematics. The principles of mathematical resilience correspond with the tenets of inclusive education therefore that is the reason for selecting it as the conceptual framework of this study.

Johnston-Wilder and Lee (2010) define mathematical resilience as, "...a learner's stance towards mathematics that enables pupils to continue learning despite finding setbacks and challenges in their mathematical learning journey." There are two aspects of resilience namely psychological and physical resilience that contribute to the understanding of mathematical resilience. Psychological resilience allows individuals to respond positively after experiencing trauma. In mathematics learning, trauma may be brought about by teachers focusing too much on the acquisition of skills, solutions of routine problems and preparations for tests and examinations. Physical resilience on the other hand makes sure that pupils will not 'break and crumble' when they experience new and difficult mathematics concepts (Johnston-Wilder and Lee, 2010). Other important aspects of mathematical resilience according to Lee and Johnston-Wilder (2017, p. 2) are:

- "Having a growth mindset, such that learners believe their mathematical capabilities can be developed through dedication and hard work;
- knowing that mathematics can be of personal value, is of value in the world and that the learner is valued within the community of learners;
- knowing how to work at learning mathematics, and;
- Knowing how to find appropriate support to stay in the growth zone".

According to Johnston-Wilder and Lee (2010), learners that are mathematically resilient learn mathematics effectively as they are able to use already known strategies and approaches to learn and understand new and unknown mathematics. Such learners will know the value of discussing and questioning their mathematical ideas while using appropriate mathematical vocabulary. Most importantly, mathematically resilient learners are confident about their ability to learn new mathematics and actively seek understanding as they know that it is their responsibility to do so.

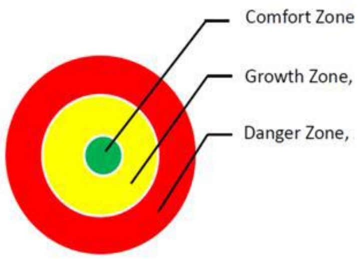
Teachers can help learners to develop and foster mathematical resilience by including opportunities for learners to solve problems, engage in discussion and practical work, gain experience of more complex situations and allowing them to see that mathematics requires logical thinking, it is active, social and reflective. The fact that learners will be given the opportunity to master bridging through ten allows them the ability to work with complex situations. Some of the tools that can be used to develop resilience in the teaching and learning of mathematics include using 'The growth zone model', 'The grid of communication skills', 'The ladder of accessibility', 'The relaxation response' and 'The explore-actions-options' framework.

2.3. Tools that promote mathematical resilience

2.3.1 The Growth Zone model

Findon and Johnston-Wilder (2017, p. 46) posit that the growth zone model represents the ways that learners experience learning. It helps learners distinguish between their comfort zone, the growth zone and the danger zone. In the comfort, zone learners are confident in their problem-solving skills and it is a safety zone in which they do not experience stress. In the growth zone they are challenged but still willing to take risks, learn from their mistakes, and seek support and assistance. The danger zone is where learners feel out of control, excluded, experience stress and insecurity to learn effectively. Figure 2.2 below presents the levels of the growth zone model.

Figure 2.1. Growth Zone Model (Johnston-Wilder et al, 2013)



2.3.2 The Grid of Communication Skills

The purpose of using this tool is to acknowledge that there are different communication styles and in the mathematics classroom it is vital to use communication styles that do not silence the learner but give them a voice. Msimanga (2017) in Adler and Sfard (2017, p. 145) asserts that there is interactive-authoritative and interactive-dialogic communication styles that exist. When the interactive-authoritative communication style is in use, the teacher is the one guiding the discussion of a certain concept meaning that there is very limited space for learners' voices. However, the interactive-dialogic communication style allows for learner involvement through conversation and interactivity which is important in the mathematics classroom for better understanding of concepts. Msimanga 2017 in Adler and Sfard (2017, p. 145) maintains that interactive dialogic is the preferred communication style in mathematics classrooms because it allows the teacher to draw on learners' ideas without judgement, allows for deep meaning making, for construction of their own understanding of the concept. Most importantly this communication style provides opportunities for teachers to find out and clarify misconceptions as well as to adapt to the learners' preferred learning language.

2.3.3. The ladder of accessibility

This tool involves using teaching techniques to help to bridge the gap between the learner's current understanding and the teacher's understanding of a topic. Learning trajectories in Realistic Mathematics Education (RME) provide a framework that can be used to achieve this. Clements & Sarama, (2004b, p. 83) conceptualize learning trajectories as, "descriptions of children's thinking and learning in a specific mathematical domain, and a related, conjectured route through a set of instructional tasks designed to engender those mental processes or actions hypothesized to move children through a developmental progression of levels of thinking, created with the intent of supporting children's achievement of specific goals in that mathematical domain". In this study, developmental progression levels will be used for bridging through ten.

According to Clements and Sarama (2014, p. 2), learning trajectories consist of three parts namely the goal, developmental progression and instructional activities. The mathematical concept (bridging through ten) to be taught would be the goal while the developmental progression would be the sequence used in the teaching. The sequence used to teach bridging through ten would be to plot the first number on the number line, then split the second number, add to make 10 and add the last number to 10. The instructional activities would be the tasks used to develop and enhance understanding of the mathematical concept. According to Van den Heuvel-Panhuizen (2000) there are several principles of RME one of which is the Level principle which states that models such as the number line give learners access to formal mathematical knowledge. Number lines are used in this study to teach bridging through ten.

2.3.4. The relaxation response

This tool involves using 'The 60 second tranquiliser' which is a quick and easy breathing technique to bring about fast relief when feeling worried, tense, nervous or anxious. This exercise can be done anywhere and at any time. The steps of doing the exercise include telling oneself to take control while breathing in slowly through the nose and out through pursed lips for about 3 to 5 minutes or until a feeling of calm has been reached (https://isma.org.uk/nsad-free-downloads). This exercise can be utilized in classrooms before a test when learners are feeling anxious.

2.3.5. The explore-actions-options framework

This framework can be used where a learner is experiencing a challenging problem to promote independence. There are three stages which can be used to promote independence, perseverance and responsibility and these are 'exploration', 'challenging' and 'action planning'. The first stage of exploration involves attention giving, active listening, acceptance and empathy, questioning etc. The second stage which is challenging involves trying to look at a situation from alternative views and identifying how progress can be made from the challenging problem. The third stage action planning involves looking for ways to move forward and thinking about what will be achieved by so doing (Egan, 2002).

The importance of mathematical resilience therefore is that it is believed to allow learners to gain skills needed to function mathematically in the world beyond school which would be a useful approach especially in South Africa where mathematics education is in a crisis (Johnston-Wilder, Lee, Brindley and Garton, 2015, Johnston-Wilder, Lee, Garton, Goodlad and Brindley 2013). Although, mathematical resilience is an important approach in developing inclusive spaces, I am mindful that there could be some limitations within a South African classroom. Some of these limitations are connected to teacher-learner ratios. Another limitation is the limited resources in many of our schools and teachers who do not possess the necessary skills to develop an inclusive classroom and to teach effective mathematical strategies. In order to test whether these tools have an effect within this particular class I administered a post and a pre –test questionnaire that will be discussed in chapter three.

2.3. Conclusion

This chapter has discussed the literature on some of the tensions of realizing inclusive education in South Africa, number sense, bridging through ten and the conceptual framework of mathematical resilience that informs this study. Chapter 3 discusses the methodologies employed in the data collection process of this research.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

This chapter will discuss the research design, research site, participants, instruments and the data analysis used in this study. The main aim of this study was to explore grade 2 classrooms as sites of practice through the development of mathematical resilience in grade 2 learners. Bridging through ten lessons were taught while incorporating the tools of mathematical resilience (The growth zone model, The ladder of accessibility, The grid of communication skills, The relaxation response and The explore-actions-options framework) to see the effectiveness of teaching mathematics in an inclusive environment. In each segment, I start off by first describing the processes and methods that were followed then provide reasons and justifications for the processes and methods that were used to undertake this study.

3.2 Research Design

This study used a mixed method approach. Johnson and Onwuegbuzie (2004) define mixed methods as a type of research in which the researcher combines both quantitative and qualitative approaches, concepts and techniques in answering research questions. Muijs (2011) maintains that mixed methods are flexible in the sense that they allow what we want to find out to determine the research design rather than preordained paradigm positions. Hughes (2001) contends that the quantitative and qualitative approaches differ in that the quantitative approach is usually situated within the positivism or realist (Muijs, 2011) paradigm. Positivism refers to scientific methods being used to investigate certain phenomena (Phillips, 2000). It produces numerical, statistical and measurable data. According to Aliaga and Gunderson (2000) cited in Muijs (2011, p. 1) quantitative research therefore refers to, "Explaining phenomena by collecting numerical data that are analyzed using mathematically based methods (in particular statistics)". Quantitative methods therefore cannot be used to explore a problem in depth.

Qualitative on the other hand is situated within the interpretivism or subjectivist (Muijs, 2011) paradigm. Interpretivism considers historical backgrounds, cultural contexts and beliefs of the participants involved in the study (Scott, 2013). It takes into account meanings, explanations, and descriptions of why things happen the way they do. The principal reasons for using a mixed method approach are that it can provide stronger evidence for a conclusion through the use of different research methods and that the use of both qualitative and quantitative methods can produce ‘more complete knowledge’ required to inform theory and practice. Therefore, quantitative methods allowed me to collect numerical data while qualitative approaches allowed for in-depth explanations of that numerical data. Quantitative data was collected from both the bridging through ten test as well as from the questionnaires, whose results were also quantified to check for the percentage of mathematical resilience. Questionnaires were used to also collect qualitative data in an attempt to explain the mathematics test results as well as to monitor any shifts in beliefs and attitudes of the grade 2 learners.

While the questionnaires determined the level of learners’ mathematical resilience, the mathematics test became an indicator to check if being mathematically resilient, through learning in an inclusive environment has an effect in mathematics results.

3.3 Research Site

This research was conducted in a former Model C school in the North of Johannesburg. The average number of learners per class is 40 at the school. The reason for this choice of location was that this school was willing to accommodate the researcher and that it was easily accessible.

3.4 Research Participants

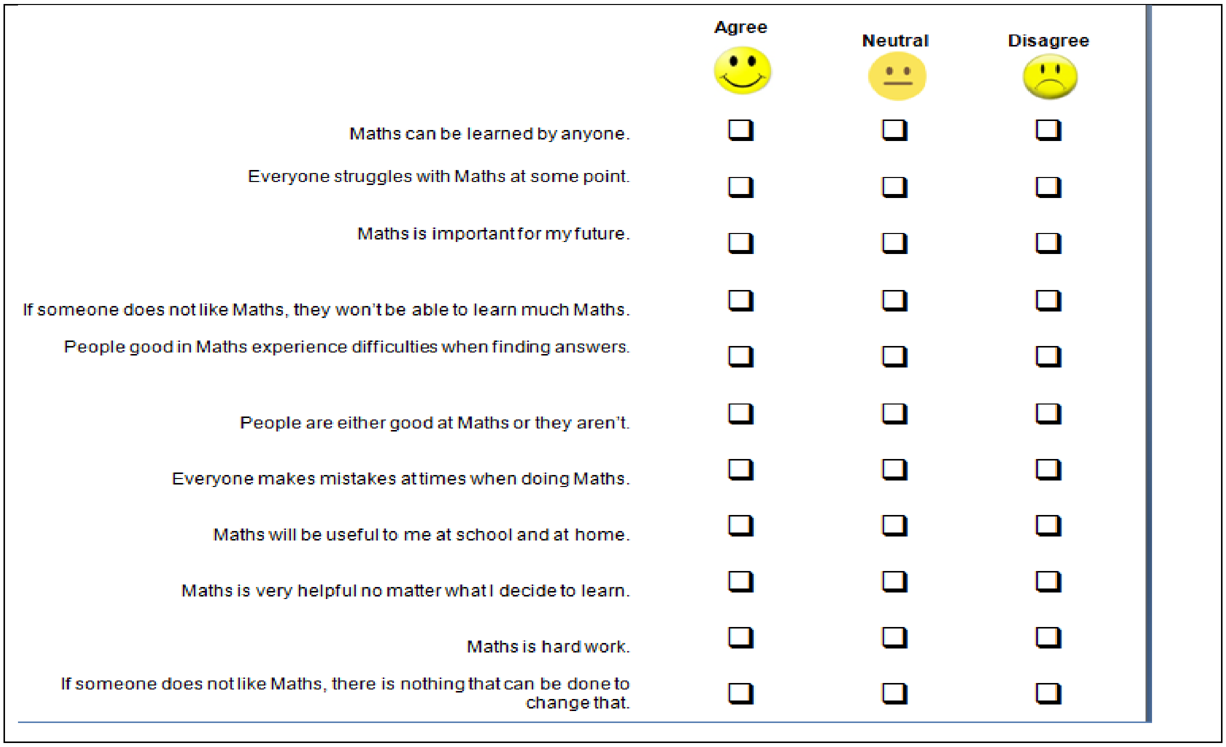
Non-probability sampling specifically convenience sampling was used for this study and this technique is characterized by using participants that are readily available (Taherdoost, 2016. p. 22). This sampling technique was utilized as the school allocated a grade 2 classroom that was available and able to accommodate the researcher. One grade 2 class was involved in the study in which questionnaires, pre and post-tests and intervention lessons were conducted. The learners’ ages ranged between 8 and 9 years old. The grade 2 classroom consisted of 43 learners, both boys and girls who participated in writing the tests, filling out questionnaires as well as partook in the eight-lesson intervention program. However, due to some parents not giving consent for their children’s work to be used in the analysis, some learners being absent when tests and questionnaires were completed and the contamination of some questionnaires, the work of only 22 learners will be used in the analysis and writing of the report meaning that the results presented for this study are of 22 grade 2 boys and girls.

3.5. Research Instruments

The research instruments used for this study include a mathematics test (Appendix 2), and a questionnaire (Appendix 1). According to Cohen, Manion and Morrison (2011), a questionnaire is a widely used tool for collecting survey information in research which provides structured information that can easily be applied. Issues that arise from using questionnaires in research are mostly ethical such as that respondents should not be coerced into completing questionnaires but rather encouraged and issues of consent, confidentiality and anonymity (Cohen et al, 2011). For this study, learners and their parents were given consent forms which assured them of their confidentiality. Also, learners were only required to write their class codes instead of names to ensure confidentiality and anonymity. The reason why their codes were required was so that their questionnaires could be compared with their mathematics test.

A structured three-point Likert scale adapted from Kooken, Welsh, McCoach, Johnston-Wilder, Lee, (2013) was used for this study as a measure of the learners' mathematical resilience. A pre-questionnaire was filled out before the pre-test and the intervention program in order to establish the learners' beliefs and attitudes towards mathematics as well as a means to measure their mathematical resilience. The original mathematical resilience questionnaire was used by Johnston-Wilder and Lee (2010) for high school learners so it was modified to suit grade 2 learners. A total of 22 learners, both boys and girls completed the pre and post questionnaire which had a total of 31 questions. Each question was read out for the learners because of their age (8-9 years old) and to avoid misreading while they ticked the box that best applied to them per question. The learners could either tick the box under Agree, Neutral or Disagree. To assist with understanding the questionnaire, three emotion icons were placed under Agree, Neutral and Disagree. Some learners left certain questions blank as they did not tick any of the three options while others ticked all the options per question even though an instruction was given that they could only tick one option per question. However, this will not be discussed in detail in the analysis as the focus is on the number of valid responses. The first 2 sections of the questionnaire completed by the grade twos were focused on learners' beliefs and conceptions of mathematics as well as the perceived usefulness of the subject in their future. The last section which is the last 10 questions, were centered on learners' feelings and attitudes towards mathematics. See the sample of the type of questions in Figure 3.1

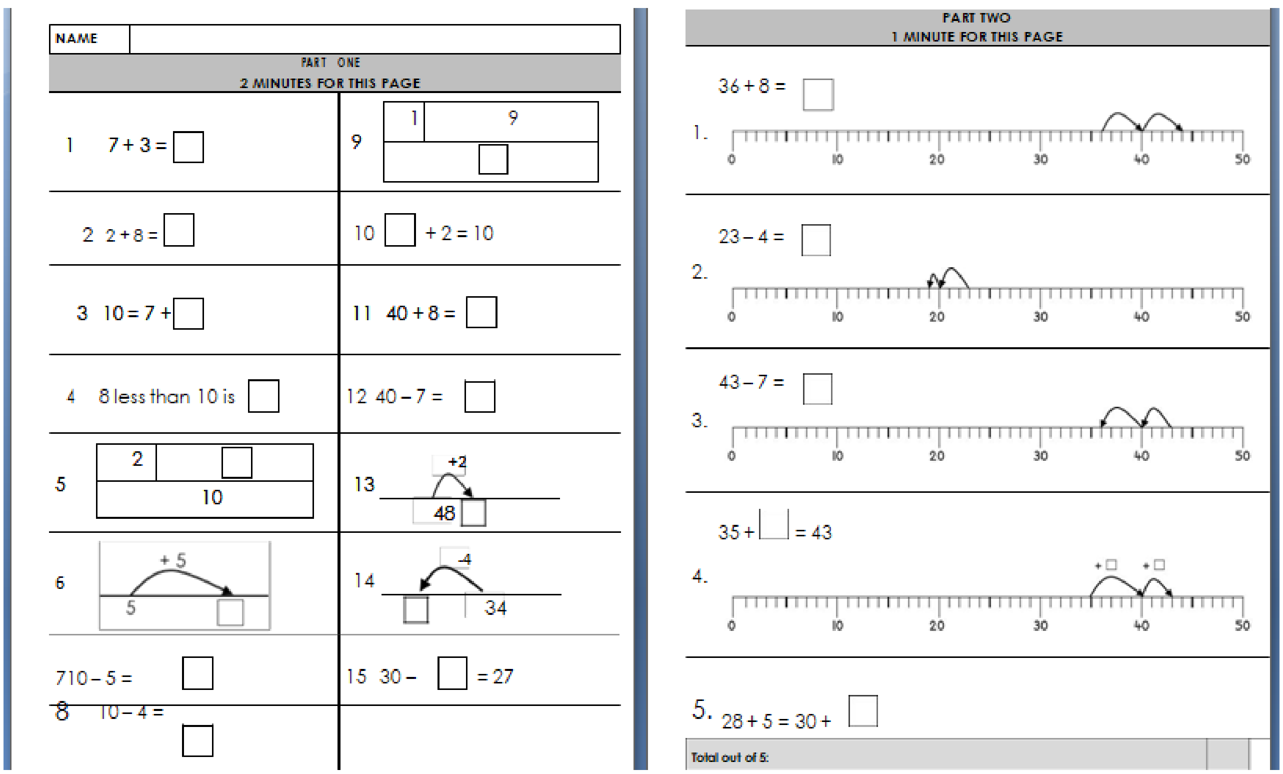
Figure 3.1. Sample of questions in questionnaire



	Agree	Neutral	Disagree
Maths can be learned by anyone.	❑	❑	❑
Everyone struggles with Maths at some point.	❑	❑	❑
Maths is important for my future.	❑	❑	❑
If someone does not like Maths, they won't be able to learn much Maths.	❑	❑	❑
People good in Maths experience difficulties when finding answers.	❑	❑	❑
People are either good at Maths or they aren't.	❑	❑	❑
Everyone makes mistakes at times when doing Maths.	❑	❑	❑
Maths will be useful to me at school and at home.	❑	❑	❑
Maths is very helpful no matter what I decide to learn.	❑	❑	❑
Maths is hard work.	❑	❑	❑
If someone does not like Maths, there is nothing that can be done to change that.	❑	❑	❑

Cohen et al (2011) maintain that tests are a powerful method of gathering numerical research data. A standardized bridging through ten test (Appendix 2) adapted from Wits Maths Connect was used as the pre and post-test and was written by the whole class of 43 learners but only the tests of 22 boys and girls who wrote both tests were analyzed in this report. Problems which usually arise from the use of pre and post-tests include different content being tested and a differing level of difficulty. To deal with such issues, the exact same test was used as both the pre and post-test which made sure that the same content was tested and that the level of difficulty was similar. Some advantages of using standardized tests include that they have already been piloted and refined, are easy to administer and mark and that they save time as researchers do not have to spend time piloting and refining them (Cohen et al, 2011). The test consisted of two parts; the first part had 15 addition and subtraction rapid recall problems which had to be completed within 2 minutes. The second part of the test contained 5 addition and subtraction problems which had to be solved using number lines and had to be completed within a minute. However, these grade 2 learners were given 10 minutes to complete the test because the learners were not close to finishing in the stipulated 3 minutes in the pre-test. Learners were not provided with any feedback with regards to the tests as the aim of the tests was to assess whether the intervention lessons would have made any difference in the children's understanding of bridging through ten. The pre and post-tests were set according to what was taught to the learners in the eight intervention lessons. The main aim of this research was to explore whether applying tools of mathematical resilience can help to curb exclusion in mathematics classrooms therefore the mathematics test was used as an indicator to show any shifts in results before and after the intervention. See the sample below of the type of questions in Figure 3.2.

Figure 3.2: Sample of questions in bridging through ten mathematics test



In chapter 4, three case studies of some of the learners who participated in this study are reviewed in an attempt to analyze the results of the research project. A case study according to Adelman et al. (1980) cited in Cohen et al (2011) is "the study of an instance in action. The single instance is of a bounded system, for example a child, a clique, a class, a school, a community". In this case, the instance is of three children out of a group of 22 were chosen to determine the relationship between their mathematical resilience scores derived from questionnaires and their bridging through ten mathematics tests. Also, case studies allow for the investigation of unique contexts and complex relationships (Cohen et al, 2011). Some of the weaknesses of case studies are that the results may not be generalized in some instances (Nisbet and Watt, 1984) and that the issues of validity and reliability may be difficult to demonstrate. To counter such issues of reliability and validity for the three case studies in this study, the claims made were backed up by numerical data from questionnaire and test results.

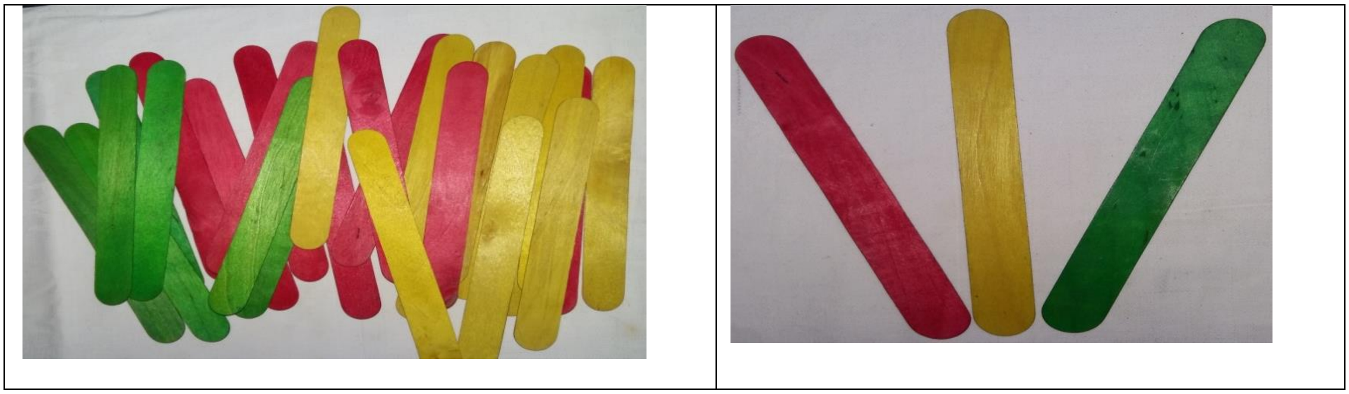
3.6. Intervention Program

3.6.1 Tools of Mathematical Resilience

The aim of this intervention program was to teach bridging through ten using the tools of mathematical resilience in an attempt to include all learners so as to discover the impact of inclusion in mathematics classrooms. Eight, 30-45-minute intervention lessons on bridging through ten were taught to the class over the course of 2 weeks with four lessons being taught each week. The lessons took place between 8a.m and 9a.m in the mornings. These lessons were taught using the tools of mathematical resilience such as using The growth zone model (Findon and Johnston-Wilder, 2017. p. 46), The grid of communication styles (Msimanga 2017 in Adler and Sfard 2017, p. 145), The ladder of accessibility (Clements & Sarama, 2004b), The relaxation response (https://isma.org.uk/pdf/free/the-60-second-tranquilliser.pdf) and The explore-actions-options framework (Egan, 2000) as an attempt to make children feel comfortable, confident in their ability to do mathematics and include all learners in the classroom.

To incorporate **The growth Zone Model**, learners were given three ice-cream sticks each, a red, yellow and green one on the first day of the intervention program. Learners were told during lessons that after every explanation they could put up the green stick if they were comfortable and did not need help with what was said. They could put up the yellow stick if they needed a bit of clarification and they could put up the red stick if they thought they were in danger due to a total lack of understanding of what was going on. Figure 3.3 displays the sticks given to the grade 2 learners for the purpose described in this paragraph.

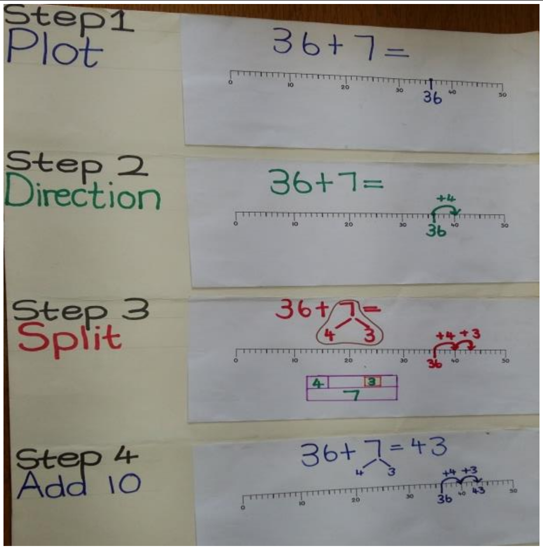
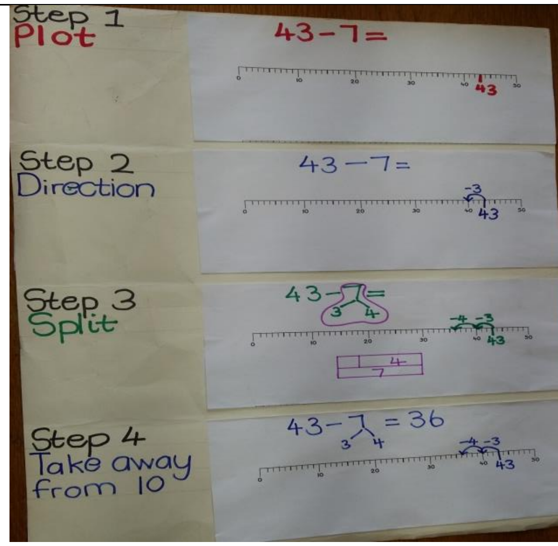
Figure 3.3: The growth zone model ice-cream sticks



The grid of communication styles allowed for the interactive-dialogic communication style (Msimanga, 2017 in Adler and Sfard, 2017) to be utilized in all the intervention lessons. This communication style enhanced and allowed for deep meaning making and the clarification of any misconceptions to occur on the spot. Learners were told to feel free and participate by saying whatever was on their mind regarding what was being discussed without any judgments.

The ladder of accessibility allows for clear sequences to be used in lessons so as to enhance the understanding of the learners (Clements and Sarama, 2014, p. 2). The sequence used to teach bridging through ten in this study was to plot the first number on the number line, then split the second number, add to make 10 and add the last number to 10. A poster with the sequences was done and put up throughout the intervention program. Figure 3.4 is a picture of the posters showing progression of bridging through ten using a number line that were put up for the learners.

Figure 3.4: Bridging through ten progression charts

Addition poster	**Subtraction poster**
	

To utilize **The relaxation response**, the 60 second tranquilizer was used (https://isma.org.uk/pdf/free/the-60-second-tranquilliser.pdf**).** Learners were advised that this technique was to be implemented whenever they were feeling anxious, stressed, worried and scared just before tests and assessments. They were instructed to close their eyes and breathe in slowly through their nose and out through their lips about ten times or until they felt better.

The explore-actions-options framework (Egan, 2000) was employed during the intervention program. Three stages of exploration were used to achieve this. The first stage of exploration involved for example attention giving, active listening, and questioning a learner who had put up a red stick to signal that they were in danger. The second stage involved trying to look at alternative ways of explanation and identifying how progress could be made from the challenging problem. The third stage action planning involved looking for ways for the learner to move forward in their problem solving. This tool allowed for a one on one between the learners and the teacher during the program. The above paragraphs have outlined how the tools of Mathematical Resilience were implemented during the intervention program. I now give a brief description of the structure of the intervention lessons.

3.6.2 Structure of the intervention program

The intervention program was based on the bridging through ten teacher's guides by the Wits Maths Connect. The lessons were meant to be 10 minutes long but in order to incorporate the tools of mathematical resilience; the lessons in this study were conducted for about 30 to 45 minutes. The first part of the lesson was a 5-minute mental warm up where the learners had to make to 10, make to 20 and jump to the next 10 to orient them and prepare them for bridging through ten tasks. An example of this activity from the guide is as follows:

Pop Fizz (Teacher (T) says a number, learners (L) respond)

Make to 10

T: 3, L: 7; T: 6, L: 4 and so on.

Make to 20

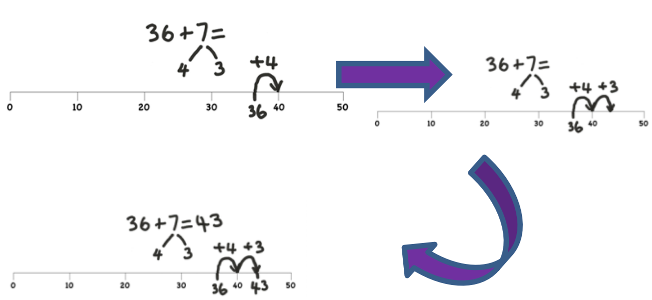
T: 3, L: 17; T: 16: L: 4 and so on.

Jumping to the **next** ten…

T: 47, L: 3; T: 58: L: 2; T: 32, L: 8 and so on.

After the 5-minute oral a problem was posed then demonstrated on the board by the teacher to show how to plot, determine direction, split and add to 10. In the following sessions learners would first be given a problem in which they had to verbalize the steps to solving that problem using bridging through 10 for revision purposes then the teacher would then demonstrate the problem for that particular day. The picture below, Figure 3.5 is an example of the steps that the teacher typically demonstrated on the board for a problem 36+7:

Figure 3.5: Bridging through ten lesson steps



The teacher would then give individual tasks to check for understanding. After the individual tasks, learners were required to discuss in partners on how they solved the problem and this way they tested each other's' understanding as well as enhanced each other's' understanding. If a learner put up a yellow or red stick while working on their problem, any of the other learners that understood better would attend to that learner to assist and if after that learner was still having challenges then the teacher would go on assist that learner. This allowed the lessons to be very interactive and instill a culture of assisting one another on the part of the learners and created a more inclusive classroom through the introduction of inclusive pedagogies that allow the participation of all learners (Florian and Black-Hawkins, 2011). Table3.1. below summarizes the Intervention lesson structure.

Table 3.1. Intervention lesson structure

Steps of lesson	**Description of step**
1. 5 minute mental warm up	Teacher and learners do a 5 minute mental warm up by making to 10, making to 20 and jumping to the next 10.
2. Revision	Teacher and learners revise problem/s posed day before
3. Teacher led task	Teacher demonstrates task for the day
4. Individual task	Learners individually work on given problems
5. Pair and group tasks	Learners discuss process of working out the problem in pairs and in groups

The next table3.2 below gives a summary of the tasks that were tackled on each of the eight lessons in the intervention program. It is evident that lessons 1 to 4 dealt with addition and lessons 5 to 8 dealt with subtraction. The problems were taken as is from the bridging through ten teacher guides from Wits Maths Connect. On some days during the intervention program certain learners could work quickly and were therefore giving extra problems similar to one on the schedule in table 3.2.

Table 3.2: Schedule of intervention lessons

Lesson 1 14/08/2018	Lesson 2 15/08/2018	Lesson 3 16/08/2018	Lesson 4 17/08/2018	Lesson 5 20/08/2018	Lesson 6 21/08/208	Lesson 7 22/08/2018	Lesson 8 23/08/2018
Task 36+7=	Tasks 27+8= 37+8=	Tasks 35+8= 25+8= 36+9=	Tasks 26+8= 35+8= 17+6=	Task 43-7=	Tasks 27-8= 37-8=	Tasks 35-8= 25-8= 36-9=	Tasks 26-9= 35-8= 42-6=

3.7. Data Analysis

The data that was analyzed for this study was derived from the pre and post-test scripts, completed questionnaires and the intervention program. 43 boys and girls participated in the study but the work of only 22 grade 2 boys and girls will be analyzed in this report. The pre and post- test results were coded to allow for comparison of the results. Each participant's pre and post tests were compared to check for any improvement in the understanding of the concept of bridging through ten. The pre-questionnaire and post- questionnaire results were also compared to assess if there were any shifts in the feelings and attitudes of the participants towards mathematics. Questionnaires were used to also calculate the percentage of mathematical resilience. First, each learners' questionnaires were checked for the total number of valid questions answered, meaning that they had to have completed the same question both in the pre-questionnaire and in the post questionnaire. If for example a learner had not completed question 5 or had ticked more than one option for question 5 in the pre test but went on to complete that question properly in the post questionnaire, that question was regarded as contaminated and not counted in the total number of questions answered by that learner.

After determining how many valid questions each learner had answered, the number of questions that showed resilience were counted meaning that in the first part above the black line it was the number of questions in which the learner had ticked Agree and the number of questions in which the learner had ticked Disagree in the second part below the black line. The total number was divided by 31 which is the total number of questions in the questionnaire to calculate percentage of mathematical resilience. If the learner ticked Neutral, it was interpreted as uncertain of which the number of such responses was also counted. The two-tailed/two-sample student's t-test was used for the verification of the mathematics test results to check if there was a significant improvement from the pre-test to the post-test. As stated by Bakkabulindi (2015) in Okeke & Van Wyk (2015), the Student's two-sample test is one of the tools used for comparative data analysis. In this study the data that was compared was of the 22 learners' pre and post mathematics test results. After comparison and calculations, the confidence level that shows a significant change in scientific research is 0.05 or 95%, which means that there is a 5% or less chance that the results are random and 95% chance or more that the results are significant. After doing the test it was found that my pre and post-test were regarded as significant in terms of the validity of the test.

3.8. Ethical considerations

Information sheets and consent forms were given to the school principal, SGB, teacher whose learners participated, the learners as well as the parents of the participants (Appendices 4-7). The information sheets included information that assured all parties involved that the names of the school and those of the learners will be kept anonymous, that the completed questionnaires and test scripts will only be used by the researcher and her supervisor and that they would be destroyed in 3-5 years and that the participation of the learners is completely voluntary and they could withdraw at any time with no penalties. Furthermore, instead of names of learners, codes were used for example 'Learner 3', to enable comparison of the pre and post tests and as well as pre and post-questionnaires.

The study was only conducted when all the learners had signed their consent forms. However, some parents and guardians did not sign consent forms for their children, therefore only the work of learners whose consent forms were signed by them and their parents/guardians is used for this report. The research only commenced when ethics clearance by the University of the Witwatersrand and a clearance to conduct research by the Department of Education had been granted.

3.9. Reliability and Validity

Methodological triangulation was utilized to ensure validity in this study. Cohen et al (2011) define triangulation as the use of more than two research methods in the study of human behavior. In this case questionnaires, tests and intervention lessons were used. The time given to complete the mathematics test (10 minutes) was the same for both the pre and the post tests to ensure consistency between the two.

Cohen et al (2011) assert that reliability is the ‘consistency’, ‘precision’ and ‘accuracy’ over time of the research instruments by participants. To ensure reliability of the tests and questionnaires in this study, the exact same test was used as a pre and post-test with appropriate interval between them, all participants wrote the same tests, the tests were standardized, clear and unambiguous. The test also tested what it was supposed to test in terms of content as an intervention program on bridging through ten was run. The questionnaire was read out to the learners in both the pre and post questionnaire to avoid misreading and to override any issues with reading proficiency.

3.10. Research Report

This research report narrates the processes undergone to explore grade 2 mathematics classrooms as sites of inclusive practice through the use of mathematical resilience principles. Its aim is to answer the three research questions outlined in chapter one. To answer these questions I made use of a mixed method approach together with a case study approach. Chapter one introduced the study and justified the need for the research through the rationale. Chapter 2 provided the relevant literature and the conceptual framework for this study. Chapter 3 presented the methodology employed in this research. The next chapter (4) presents the results of the mathematics test and those of the questionnaire and provides an analysis of these results. The last chapter, 5, concludes the research report by presenting the main findings through answering the three research questions guiding this study, outlining the limitations and recommendations for future studies.

CHAPTER 4: ANALYSIS OF RESULTS

4.1. Introduction

The aim of this chapter is to present the findings of this study that sought to explore grade 2 mathematics classrooms as sites of inclusive practice through the use of mathematical resilience tools. The aims and objectives of this study were to, assess any shifts in mathematical understanding of bridging through ten, find out if children's feelings and attitudes towards mathematics affect their performance, find out if mathematical resilience is an effective approach to create more inclusive mathematics classrooms.

The research questions that this study sought to answer were as follows:

1. What were the predominant shifts in attitudes and feelings (mathematical resilience) from pre to post questionnaires?
2. What were the mathematical gains (bridging through ten) visible from the pre to post-mathematical test?
3. What needs to be considered when developing an inclusive foundation phase mathematics classroom in order to improve mathematical results?

This study was conducted in a grade 2 classroom of 43 learners both boys and girls of which all learners completed the pre and post-questionnaires as well as wrote the pre and post-tests and also engaged in the eight-lesson intervention program. However, the findings to be presented in this chapter are of 22 grade 2 learners both boys and girls who have written both the pre and post mathematics tests and questionnaires and also gave consent for their results to be analyzed and used in the writing of the research report. The analysis of results will not compare the performance of girls and boys but rather will focus on describing the results of the questionnaire and test before and after the intervention.

Two instruments were used to investigate the research questions in this study, a questionnaire (Appendix 1) and a test (Appendix 2). A pre- questionnaire was completed by the grade 2 learners followed by the writing of a pre-test on bridging through ten on the same day. An intervention of 8 lessons on bridging through ten (four addition and four subtraction-see Table3.2) followed and thereafter a post-questionnaire and post-mathematics test were completed by the grade 2 class again on the same day. The study was conducted in this order so as to monitor the impact before and after the intervention. Whilst, the intervention may have raised some interesting insights about teaching and learning, the focus of this study aimed at what the tests revealed.

The analysis will be structured in the following order; analysis of pre-questionnaire, pre-mathematics test, post- questionnaire, post-mathematics test, comparison of the pre and post questionnaire and test, discussion of three learners' results that exemplify three interesting cases about inclusive classrooms and finally the conclusion.

4.2. Pre-Questionnaire results

Table 4. 1 below shows the overall results per question of the pre-questionnaire by the 22 grade two learners. The first column outlines the 31 questions asked that were completed by the learners. The second column shows the number of learners that agreed with each of the questions while the third column outlines the number of learners that were neutral to each of the questions. The fourth column displays the number of learners that disagreed with each of the 31 questions. The last column gives figures of contaminated (more than one option ticked) or questions that were not answered. Contaminated results are not discussed in this report but have been indicated for clarity and transparency purposes.

The grade two learners completed the questionnaire in sequence from question 1 up to 31 as seen in Appendix 1. However, the structure of the questionnaire has been altered for analysis purposes as will be seen below. All the questions above the black line are those that the learners had to agree with to show mathematical resilience, while all the questions below the black line are those that the learners had to disagree with to show mathematical resilience and this order has been highlighted in red for clarity while reading the table.

Table 4.1: Pre-questionnaire results

	Pre -questionnaire			
	A	**N**	**D**	**C**
Q1: Maths can be learned by anyone.	11	4	0	7
Q2: Everyone struggles with Maths at some point.	8	8	1	5
Q3: Maths is important for my future.	11	4	2	5
Q5: People good in Maths experience difficulties when solving problems.	13	5	1	3
Q7: Everyone makes mistakes at times when doing Maths.	15	5	1	1
Q8: Maths will be useful to me at school and at home.	16	5	1	0
Q9: Maths is very helpful no matter what I decide to learn.	15	3	2	2
Q10: Maths is hard work.	15	2	3	2
Q12: I am looking forward to the lessons with you.	13	5	0	4
Q13: People in my class sometimes have problems with Maths.	10	10	0	2
Q15: People who are good at Maths may fail a hard Maths test.	10	6	2	4
Q16: Knowing Maths will help with my job in future.	13	2	2	5
Q17: Knowing Maths helps me to know harder sums.	17	1	0	4
Q19: Making mistakes helps me to learn Maths better.	6	3	10	3
Q21: It would be difficult to succeed in life without Maths.	8	3	7	4
Q22: Going to Maths lessons after school is not a problem.	8	8	1	5
Q24: I am usually at ease during maths tests.	12	3	3	4
Q26: I almost never get nervous while taking maths tests.	11	6	2	3
Q27: I usually don't worry about doing Maths.	9	7	3	3
Q29: I have usually been at ease in maths lessons.	12	5	2	3
Q4: If someone is not a Maths person, they won't be able to learn much Maths.	9	6	2	5
Q6: People are either good at Maths or they aren't.	14	6	1	1
Q11: If someone does not like Maths, there is nothing that can be done to change that.	14	5	0	3
Q14: Everyone can either do Maths or not do Maths.	10	12	0	0
Q18: Some people cannot learn Maths.	13	5	0	4
Q20: Only clever people can do Maths.	14	2	1	5
Q23: I get really nervous during maths tests.	8	6	3	5
Q25: I get a sinking feeling when I think of trying hard maths sums.	11	7	0	4
Q28: Mathematics makes me feel uneasy and confused.	7	8	5	2
Q30: Mathematics makes me feel uncomfortable and nervous	10	9	1	2
Q31: My mind goes blank and I am unable to think clearly when working on mathematics.	9	7	4	2

In Table 4.1, above the black line it is evident that the question that 17 out of 22 learners agreed with the most was question 17 and it states that, "Knowing Maths helps me to know harder sums". None of the learners disagreed with this question indicating how strongly most of the learners believe that knowing maths will assist them in their understanding of more complex sums. Question 19 had the least number of agrees of 6 and it states that; “Making mistakes helps me to learn Maths better”, indicating that in the pre-questionnaire, only about 6 out of the 22 grade two learners believed that there is room for mistakes in mathematics. However, Johnston-Wilder and Lee (2010, p. 41) contend that the development of mathematical resilience requires that learners try out new things, experiment, make mistakes and identify those mistakes themselves. This implies that making mistakes is an important part of learning mathematics and learners who understand this could be more mathematically resilient than those who view making mistakes as negative. Likewise, inclusive classrooms in South Africa should promote the notion that failure is an important teaching tool in building learners’ confidence so as to avoid the negative emotions that come which failure which are known to shut down normal cognitive functions (Williams, 2007)

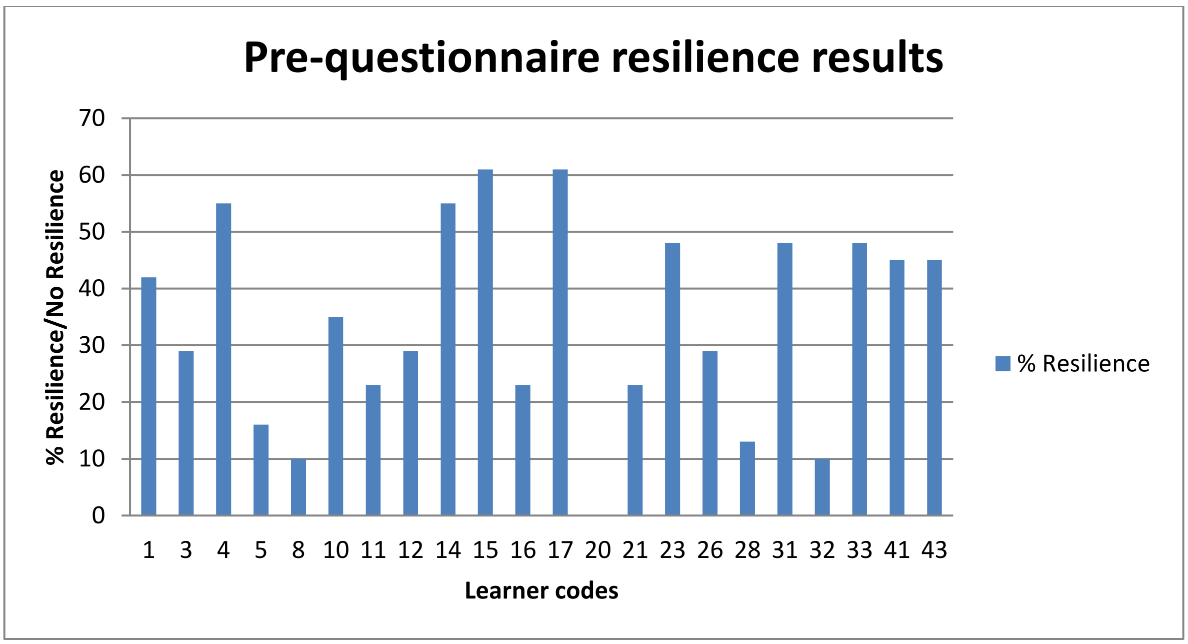
Below the black line, the question that learners disagreed with the most showing mathematical resilience was question 28 stating that, “Mathematics makes me feel uneasy and confused.” This indicates that at least 5 learners out of 22 were confident about their mathematical abilities in the pre-questionnaire. The next question with a high number of disagrees of 4 was question 31 stating that, “My mind goes blank and I am unable to think clearly when working on mathematics”. This indicates that only 4 out of 22 grade 2 learners are able to make sense of what is being learnt without any panic. In other words, for these questions learners showed little mathematical resilience. Therefore, developing an inclusive classroom was harder as learners seemed to feel powerless when it came to mathematics, which is why inclusive education sees a need for meaningful interventions together with inclusive pedagogies in order to assist marginalized students (DiME, 2007).

What the results generally showed was that of the 22 learners, 17 learners agreed that knowing maths helps them to work out harder sums, 15 agreed that maths is hard work, 15 agreed that everyone makes mistakes at times when doing maths indicating the evidence of mathematical resilience. On the other hand, out of the 22 learners some learners indicated that if someone does not like maths, there is nothing that can be done to change that, that some people cannot learn maths and that everyone can either do maths or not do maths. Having this belief about mathematic shows the lack of a ‘growth mindset’ (Dweck, 2000) and therefore mathematical resilience. In inclusive classrooms it is critical that learners believe that there is support when learning a subject, if they believe that they cannot master a subject then the classroom does not become a site of inclusion (Ntombela and Raymond, 2013). Having analyzed the overall results of the pre-questionnaire per question in this section, the next section takes a closer look at the resilience results of individual learners.

4.2.1: Pre-questionnaire individual mathematical resilience results

Figure 4.1 below summarizes the analysis of individual pre questionnaire mathematical resilience results of all 22 grade two learners. A table illustrating the same results is available in Appendix 8.

Figure 4.1: Pre-questionnaire resilience results



The vertical axis displays the percentages of resilience while the horizontal axis displays the learners' codes. This graph shows that most learners' resilience is above 20% except for four learners (learners 5, 8, 28 and 32) whose mathematical resilience is below 20%. The highest mathematical resilience in the pre-questionnaire was 61% attained by learners 14 and 17. The lowest percentage for mathematical resilience of 0% was attained by learner 20. This result suggests that learner 20 has zero mathematical resilience implying that she/he lacks positive self-belief and perseverance when faced with mathematical difficulties. Positive self-belief and perseverance are some of the characteristics that depict the presence of mathematical resilience (Lee and Johnston-Wilder, 2013). Generally, this graph shows only four learners who scored a mathematical resilience of 50% and above (learners 4, 14, 15 and 17) while the majority of the group is between 20% and 49%. The next section discusses the results of the pre-mathematics test which was written soon after the completion of the pre-questionnaire.

4.3 Pre-mathematics test results

Figure 4.2 below is a summary of the pre-test results in graphical form. A table illustrating these results is in Appendix 9.

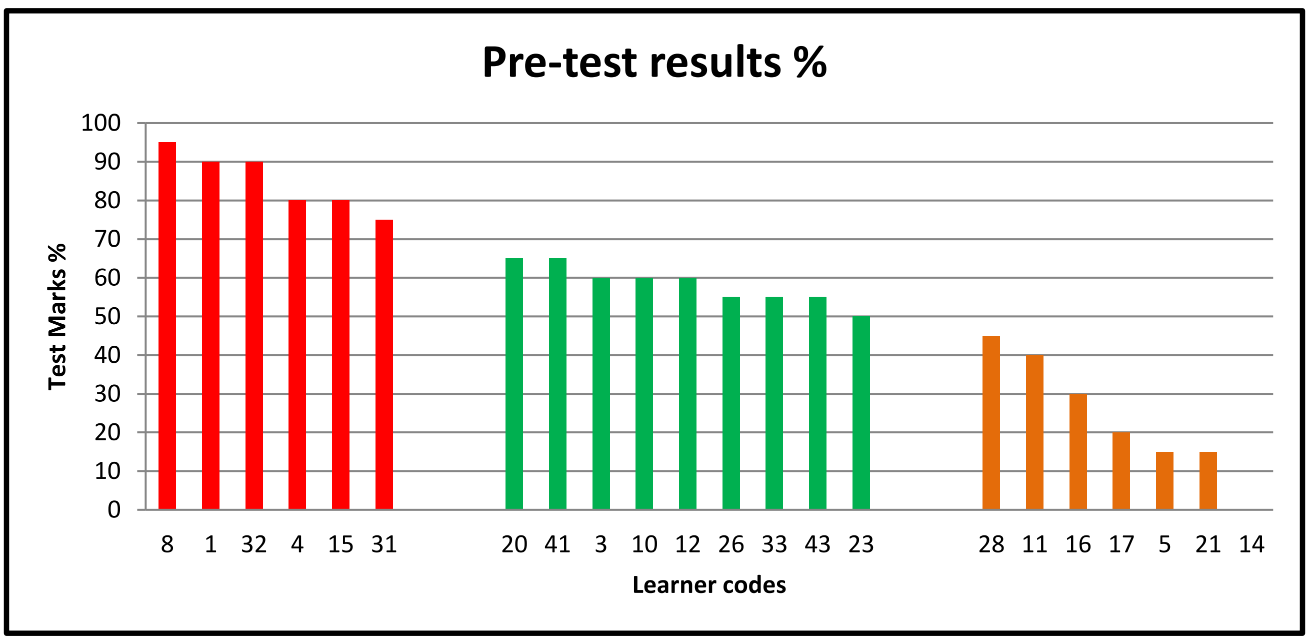
Figure 4.2: Graph summarizing the Pre-test results.

Key:

Weak: 0% - 49%

Average: 50% - 69%

Top: 70% - 100%



This graph shows that 95% was the highest mark attained by one learner (learner 8) while 0% was the lowest mark attained by one learner (learner 14) in the pre-test. The red bars show the results of the top learners who have achieved between 100% and 70%, the green bars show the results of the average learners who have achieved between 69% and 50% and the orange bars represent the results of the weak learners who have achieved between 0% and 49%. 6 out of 22 learners came out as top perfomers, 9 out of 22 came out as average and 6 came out of 22 came out as weak perfomers in the pre- mathematics test of bridging through ten. Overall, 15 learners out of 22 (68%) passed the test with 50% and above while 6 out of 22 learners (27%) failed the test with 49% and below.

The implication of these results is that those learners who passed by 50% and above which are the Top and Average groups were able to plot a number on the number line, split two digit numbers for example knowing that the number 26 is made up of 20 and 6, knew the direction to move in when doing subtraction (backwards) and addition (forwards) using number lines, and know their bonds for example that 7 and 3 make 10 in order to successfully bridge through ten (Thompson, 1999). The learners who attained less than 50% could have been struggling to cope with the demands of the test which have been mentioned above. In the next segment I analyze the results of the post-questionnaire.

4.4. Post questionnaire results

Table 4. 2 below shows the results of the post- questionnaire. It displays the number of learners who Agreed, were Neutral and those who Disagreed with each of the questions in the questionnaire at the end of the eight day intervention programme.

Question 7 which states that, “Everyone makes mistakes at times when doing Maths” had the highest number of agrees of 20. Other questions that the learners agreed with the most with 18 agrees above the black line showing mathematical resilience were questions 16 and 22. Question 16 states that, “Knowing Maths will help with my job in future”. Having 18 learners out of 22 agreeing with this statement suggests that after the intervention program more learners viewed maths not only as a school subject that has to be done but also as a skill that would be useful for their future. Other questions similar to question 16 also attained a high number of agrees of 17 such as questions 3, “Maths is important for my future” and 9, “Maths is very helpful no matter what I decide to learn”. Question 22 states that, “Going to Maths lessons after school is not a problem”. 18 out of 22 learners agreed with this question denoting an increased willingness to learn mathematics even after school hours which is a sign of increased mathematical resilience.

Below the black line, the question that the learners disagreed with the most showing mathematical resilience was question 30 stating that, “Mathematics makes me feel uncomfortable and nervous”. 4 out of 22 grade 2 learners disagreed with this statement meaning that they were comfortable doing mathematics while 10 agreed meaning they were still quite uncomfortable with mathematics even after the intervention. In terms of analysis, overall, this table shows that most learners were agreeing with the questions more than they were being neutral or disagreeing even on questions that are below the black line which they were supposed to disagree with to show mathematical resilience.

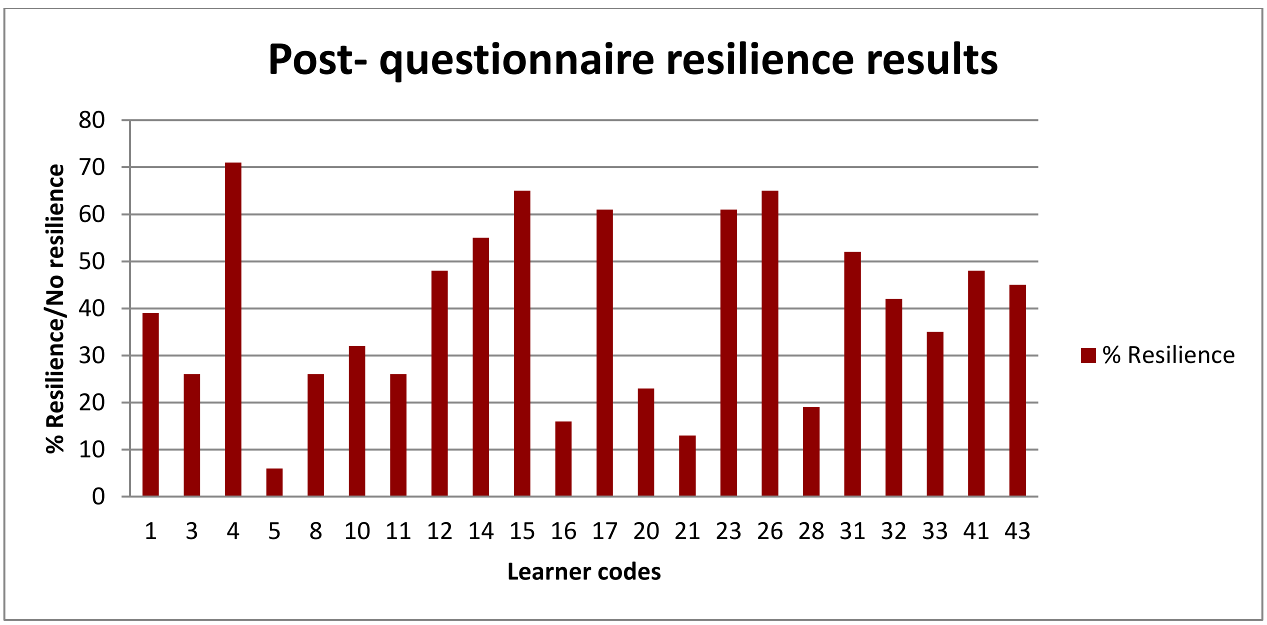
Table 4.2: Post-questionnaire results

	Post-questionnaire			
	A	**N**	**D**	**C**
Q1: Maths can be learned by anyone.	16	3	1	2
Q2: Everyone struggles with Maths at some point.	15	6	0	1
Q3: Maths is important for my future.	17	3	2	0
Q5: People good in Maths experience difficulties when solving problems.	16	5	1	0
Q7: Everyone makes mistakes at times when doing Maths.	20	1	0	1
Q8: Maths will be useful to me at school and at home.	13	6	2	1
Q9: Maths is very helpful no matter what I decide to learn.	17	3	0	2
Q10: Maths is hard work.	13	2	5	2
Q12: I am looking forward to the lessons with you.	17	4	0	1
Q13: People in my class sometimes have problems with Maths.	14	4	4	0
Q15: People who are good at Maths may fail a hard Maths test.	13	4	4	1
Q16: Knowing Maths will help with my job in future.	18	2	0	2
Q17: Knowing Maths helps me to know harder sums.	17	4	0	1
Q19: Making mistakes helps me to learn Maths better.	10	5	7	0
Q21: It would be difficult to succeed in life without Maths.	14	6	2	0
Q22: Going to Maths lessons after school is not a problem.	18	3	0	1
Q24: I am usually at ease during maths tests.	13	5	3	1
Q26: I almost never get nervous while taking maths tests.	12	7	2	1
Q27: I usually don't worry about doing Maths.	15	5	1	1
Q29: I have usually been at ease in maths lessons.	14	3	1	4
Q4: If someone is not a Maths person, they won't be able to learn much Maths.	15	4	2	1
Q6: People are either good at Maths or they aren't.	13	7	1	1
Q11: If someone does not like Maths, there is nothing that can be done to change that.	12	8	0	2
Q14: Everyone can either do Maths or not do Maths.	14	8	0	0
Q18: Some people cannot learn Maths.	13	8	1	0
Q20: Only clever people can do Maths.	16	2	3	1
Q23: I get really nervous during maths tests.	11	8	2	1
Q25: I get a sinking feeling when I think of trying hard maths sums.	17	3	2	0
Q28: Mathematics makes me feel uneasy and confused.	10	7	3	2
Q30: Mathematics makes me feel uncomfortable and nervous	10	7	4	1
Q31: My mind goes blank and I am unable to think clearly when working on mathematics.	13	7	1	1

4.4.1: Post-questionnaire individual mathematical resilience results

Figure 4.3 below summarizes the post questionnaire individual resilience results. The same procedures followed in the analysis of the pre-questionnaire and its calculations of the resilience percentages were also followed in the post-questionnaire. The vertical axis displays the percentages of mathematical resilience per learner while the horizontal axis displays the learners' codes. The resilience of learners in the post questionnaire seems to range from 6% to 71%. The highest percentage of mathematical resilience achieved in the post-questionnaire is 71% attained by learner 4 while the lowest is 6% attained by learner 5. There are 7 out of 22 learners who scored a mathematical resilience percentage of 50% and more while the rest of the learners range between 20% and 49%. Only 4 out of 22 learners (5, 16, 21 and 28) have a mathematical resilience of less than 20%. Generally, what is evident in Figure 4.3 is that most learners' mathematical resilience percentages seem to be higher than those of the pre-questionnaire. The next section analyzes post-mathematics test results.

Figure 4.3: Graph summarizing post questionnaire resilience results



4.5. Post mathematics-test results

Figure 4.4. summarizes the post-mathematics test results in graphical form.

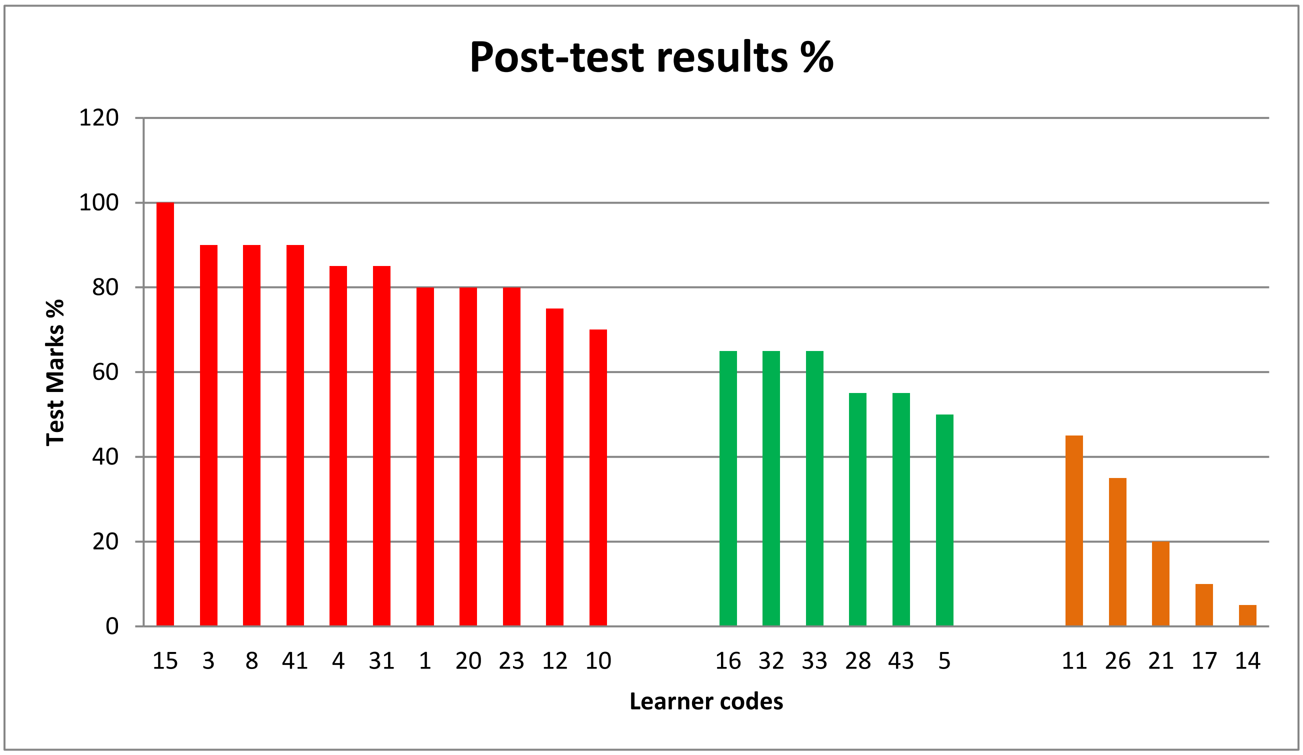
Figure 4.4: Post- mathematics Test results

Key

Top: 100%-70%

Average: 69%-50%

Weak: 49%-0%



The red bars in this graph represent top learners who scored between 70% and 100% while the green bars represent average learners whose scores range between 50% and 69%. The orange bars constitute weak learners who scored less than 50%. This graph shows that 100% was the highest mark attained by one learner while 5% was the lowest mark attained by one learner. Overall, 17 out of 22 learners (77%) passed the test with 50% and above and 5 learners out of 22 (23%) failed the test with 49% and below. This graph shows that 11 out of 22 learners are in the top achievers range (red bars), 6 learners in the average range and 5 in the weak range. These results suggest that the learners who passed by 50% and above were able to successfully bridge through ten (Thompson, 1999). The learners who acquired less than 50% could have been struggling to execute the above mentioned skills that allow one to effectively bridge through ten. In general, what I have observed is that there are more learners with the 100% to

70% which are the red bars and less in the 0% to 49% which are the orange bars. The next section compares the pre and post-questionnaires and mathematics results.

4.6. Comparison of pre and post results

This section will compare pre and post-questionnaire results to examine if there were any shifts in beliefs and attitudes of the learners towards mathematics as a subject. The results of the pre and post-mathematics tests will also be compared so as to assess any improvements in the learners' performance after the intervention programme.

4.6.1. Comparison of pre and post questionnaire results

Table 4.3 below compares the results of the pre-questionnaire as well as those of the post-questionnaire. The columns highlighted in red are those that would show mathematical resilience. The part above the black line shows that learners ticked agree in the post-questionnaire more than they had in the pre questionnaire showing a positive shift in their beliefs and attitudes towards mathematics. For example, the highest number of agrees in the pre-questionnaire was 17 while it was 20 in the post-questionnaire. The question with the highest number of agrees in the pre-questionnaire was, "Knowing Maths helps me to know harder sums" while the question with the highest number of agrees in the post-questionnaire was, "Everyone makes mistakes at times when doing Maths". This is a very important positive shift in attitude for one to be considered mathematically resilient as it suggests that the learner will not give up on their work even though they do not come right the first time. This claim is supported by Johnston-Wilder and Lee (2010, p.41) who maintain that, "Mathematically resilient pupils believe that, if they persevere and make mistakes and take wrong turns, then ultimately they will be far more likely to succeed.". This is an important shift to be celebrated in that inclusive classrooms require learners who feel safe to fail as unsafe learning environments contribute to the exclusion of learners (Ntombela and Raymond, 2013).

For questions above the black line which learners had to agree with to show mathematical resilience, the number of agrees increased in the post-questionnaire except for three questions that is questions 8, 10 and 17. The number of learners who agreed with question 8 decreased from 16 to 13 while they decreased from 15 to 13 for question 10 and stayed the same for question 17 which had the highest number of agrees in the pre-questionnaire. Question 8 states that, "Maths will be useful to me at school and at home”. The decrease in the number of Agrees for this question could indicate that some learners ceased to see the usefulness of mathematics beyond school after the intervention. However, that conclusion cannot be drawn as there are questions similar to this one which attained a high number of agrees in the post-questionnaire such as questions 3 and 9 which both received 17 agrees. Question 10 states that, “Maths is hard work”. If learners think of maths as hard work, according to Johnston-Wilder and Lee (2010, p. 41), “They will know that, if they think hard, talk to others, read about mathematical ideas and reflect on the information gained, they will be able to make headway with seemingly difficult ideas and problems”. In this case, the decrease in the number of agrees could also indicate that after the intervention lessons the learners did not find maths as hard as they thought it was previously. Inclusive education also argues that it is important to find ways of making the learning experience of such a nature that learners develop the ability to persevere in the midst of difficulty (Findon and Johnston-Wilder, 2017).

Question 7 which states that, “Everyone makes mistakes at times when doing Maths,” had the highest number of agrees of 20 compared to 15 in the pre-questionnaire. However, a similar question about making mistakes in mathematics (Question 19) had the least number of agrees of 6 in the pre-questionnaire. Table 4.3 indicates an increase in the number of agrees for this question from 6 to 10 in the post-questionnaire. This symbolizes an improvement of more learners believing that making mistakes is part of the process of learning in mathematics which is one of the important characteristics of developing mathematical resilience (Johnston-Wilder and Lee, 2010).

For questions below the black line, which the learners had to disagree with to indicate mathematical resilience, 4 out of 11 questions showed an increase in the number of disagrees, 4 questions remained the same and the number of disagrees for 3 questions decreased. The major shifts that can be noticed here are with questions 30 and 31. Question 30 states that, “Mathematics makes me feel uncomfortable and nervous” and one learner disagreed with this statement in the pre-questionnaire while 4 learners disagreed with it in the post-questionnaire indicating an increase in the number of learners who are not intimidated by mathematics. Question 3 states that, “My mind goes blank and I am unable to think clearly when working on mathematics”. 4 learners disagreed in the pre-questionnaire and only one disagreed in the post-questionnaire suggesting a decrease in the number of learners able to think clearly while working on mathematics and a possible cause of this could be the introduction of new methods of working out during the intervention program. Inclusive classrooms aim is to ensure that levels of anxiety are managed in a way that learners are more productive as Williams (2007) suggests that feeling persistently excluded can result in depression and helplessness.

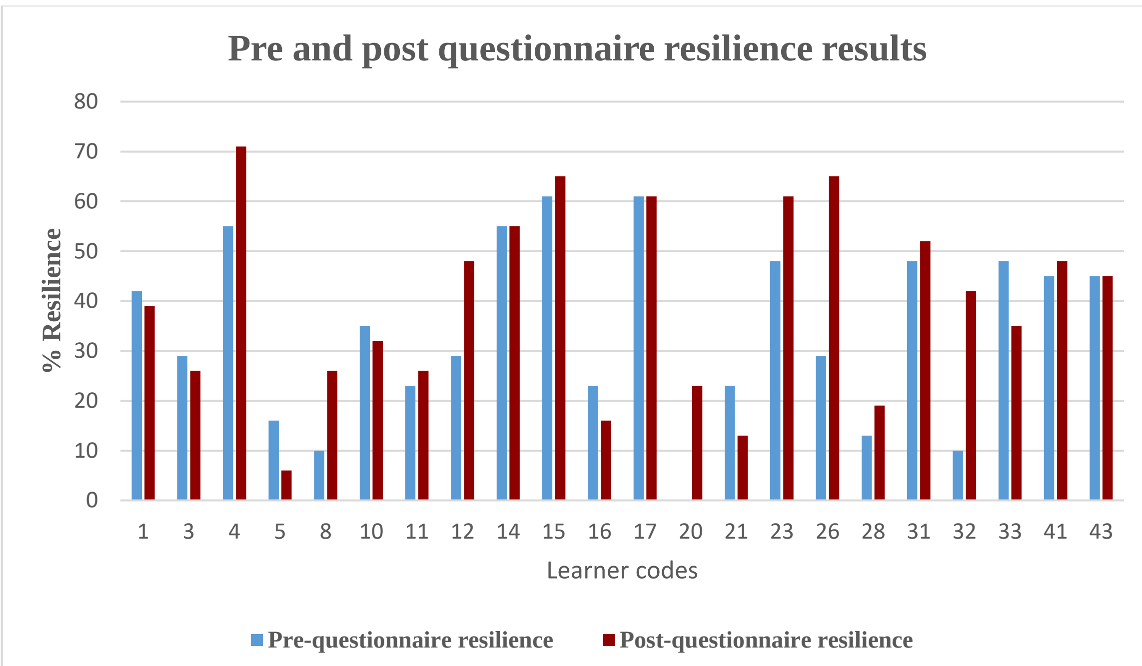
Table 4.3: Pre and post Questionnaire results

	Pre-Questionnaire			**Post-Questionnaire**		
	A	**N**	**D**	**A**	**N**	**D**
Q1: Maths can be learned by anyone.	13	4	0	16	3	1
Q2: Everyone struggles with Maths at some point.	8	8	1	15	6	0
Q3: Maths is important for my future.	11	4	2	17	3	2
Q5: People good in Maths experience difficulties when solving problems.	13	5	1	16	5	1
Q7: Everyone makes mistakes at times when doing Maths.	15	5	1	20	1	0
Q8: Maths will be useful to me at school and at home.	16	5	1	13	6	2
Q9: Maths is very helpful no matter what I decide to learn.	15	3	2	17	3	0
Q10: Maths is hard work.	15	2	3	13	2	5
Q12: I am looking forward to the lessons with you.	13	5	1	17	4	0
Q13: People in my class sometimes have problems with Maths.	10	10	1	14	4	4
Q15: People who are good at Maths may fail a hard Maths test.	10	6	3	13	4	4
Q16: Knowing Maths will help with my job in future.	13	2	2	18	2	0
Q17: Knowing Maths helps me to know harder sums.	17	1	0	17	4	0
Q19: Making mistakes helps me to learn Maths better.	6	3	10	10	5	7
Q21: It would be difficult to succeed in life without Maths.	8	3	7	14	6	2
Q22: Going to Maths lessons after school is not a problem.	8	8	1	18	3	0
Q24: I am usually at ease during maths tests.	12	3	3	13	5	3
Q26: I almost never get nervous while taking maths tests.	11	6	2	12	7	2
Q27: I usually don't worry about doing Maths.	9	7	3	15	5	1
Q29: I have usually been at ease in maths lessons.	12	5	2	14	3	1
Q4: If someone is not a Maths person, they won't be able to learn much Maths.	9	6	2	15	4	2
Q6: People are either good at Maths or they aren't.	14	6	1	13	7	1
Q11: If someone does not like Maths, there is nothing that can be done to change that.	14	5	0	12	8	0
Q14: Everyone can either do Maths or not do Maths.	10	12	0	14	8	0
Q18: Some people cannot learn Maths.	13	5	0	13	8	1
Q20: Only clever people can do Maths.	14	2	1	16	2	3
Q23: I get really nervous during maths tests.	8	6	3	11	8	2
Q25: I get a sinking feeling when I think of trying hard maths sums.	11	7	0	17	3	2
Q28: Mathematics makes me feel uneasy and confused.	7	8	5	10	7	3
Q30: Mathematics makes me feel uncomfortable and nervous	10	9	1	10	7	4
Q31: My mind goes blank and I am unable to think clearly when working on mathematics.	9	7	4	13	7	1

4.6.2 Comparison of individual mathematical resilience percentages from pre to post-questionnaires

Figure 4.5 summarizes the comparison of mathematical resilience percentages. It compares pre and post-questionnaire results for individual learners.

Figure 4.5: Summary of pre and post individual questionnaire resilience results



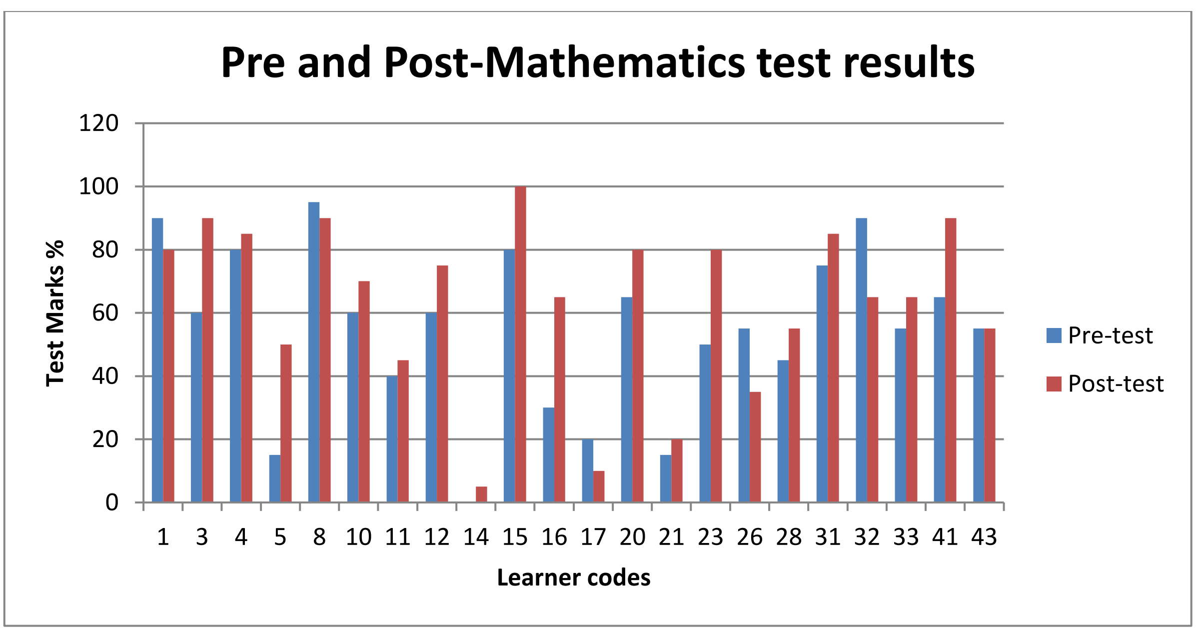
It is evident that for about half of the learners, mathematical resilience improved, and this can be attributed to the teaching methods employed during the intervention program, which attempted to include all learners through the use of mathematical resilience tools.

It is also evident from the graph that of the 22 learners that completed both questionnaires, 12 learners improved, 7 dropped and 3 stayed the same in terms of mathematical resilience from the pre to post-questionnaire. However, of 12 learners whose mathematical resilience improved, three of them (learners 8, 26, and 32) dropped from the pre to the post-mathematics. Learner 8's mathematical resilience improved from 10% to 26%. Learner 26's mathematical resilience increased from 29% to 65%. Learner 32's mathematical resilience results improved from 10% to 42%. Of the four learners who obtained the lowest results in the pre-questionnaire, three of the learners (8, 28, and 32) had improved in their perception of mathematics. The most significant is learner 32, which illustrates that the learner had developed more mathematical resilience. Even though 7 of the 22 dropped in their scores, the majority of the learners indicated an improvement in their results. An increase in the percentage of mathematical resilience means that the learners could now be more, "...adaptive; able to cope with ambiguity; expect problems and challenges; solve problems logically and flexibly; look for creative solutions to challenges; are curious and learn from experience; have an internal locus of control; are aware of their feelings; have a strong social network and are able to ask for help" (Johnston-Wilder, Lee, Garton, Goodlad and Brindley, 2013, p. 3). In other words, the classroom environment had become more inclusive as learners felt safer and more comfortable with mathematics mostly through being given opportunities to use their voice in a safe learning environment (Tomlin, 2002). In the next section I compare pre and post- mathematics test results.

4.6.3. Comparison of pre and post-mathematics test

Figure 4.6 below displays the pre and post mathematics results of the 22 learners that participated in the pre and post-mathematics test. Table illustrating the same results is available in Appendix 14.

Figure 4.6. Comparison of pre and post-mathematics Results



An overview of this graph reveals higher marks attained in the post-test compared to the pre-test. Overall, 17 out of 22 learners (77%) compared to the 15 learners out of 22 (68%) in the pre-test passed the test with 50% and above and 5 learners (23%) compared to 7 learners (32%) in the pre-test failed the test with 49% and below.

For most learners, post-test marks show an improvement from the pre-test except for 5 learners (learners 1, 8, 17, 26, 32) whose marks dropped in the post-test and one learner whose marks stayed the same (learner 43). It can be deduced from this graph that of the 22 learners that wrote the pre and post-tests, 72% of the learners improved, 5% stayed the same and 23% dropped. The learners that improved show an improvement of 5% going up to 60%. The learners who dropped show a drop of 5% up to 25%. In the pre-test, the highest mark was 95% and in the post-test the highest mark was 100%. There was one learner who had 0 in the pre-test who then moved to 1(5%) in the post-test. According to the 'Two-tailed Student's T-test' using the results of both the pre and post-mathematics test in the analysis produced a value of 0.02. This means that there is about a 2% chance that these results are random and therefore a 98% probability that there was a significant change from the pre to post-mathematics test results. According to Bakkabulindi (2015) cited in Okeke & Van Wyk (2015) the confidence level that shows a significant change in scientific research is 95% of which the percentage of significant change in this study is 98%. The results of the maths test indicated an improvement in learners' performance and thus the effectiveness of the intervention. The graph below shows how more learners became located in the first two clusters (red and green) while there were fewer learners in the yellow cluster. It is important to note that I have circled the learners who have shifted from a cluster showing an improvement in their results. In the next section, I have selected three learners as case studies who are telling particular stories about the teaching of mathematics in inclusive spaces.

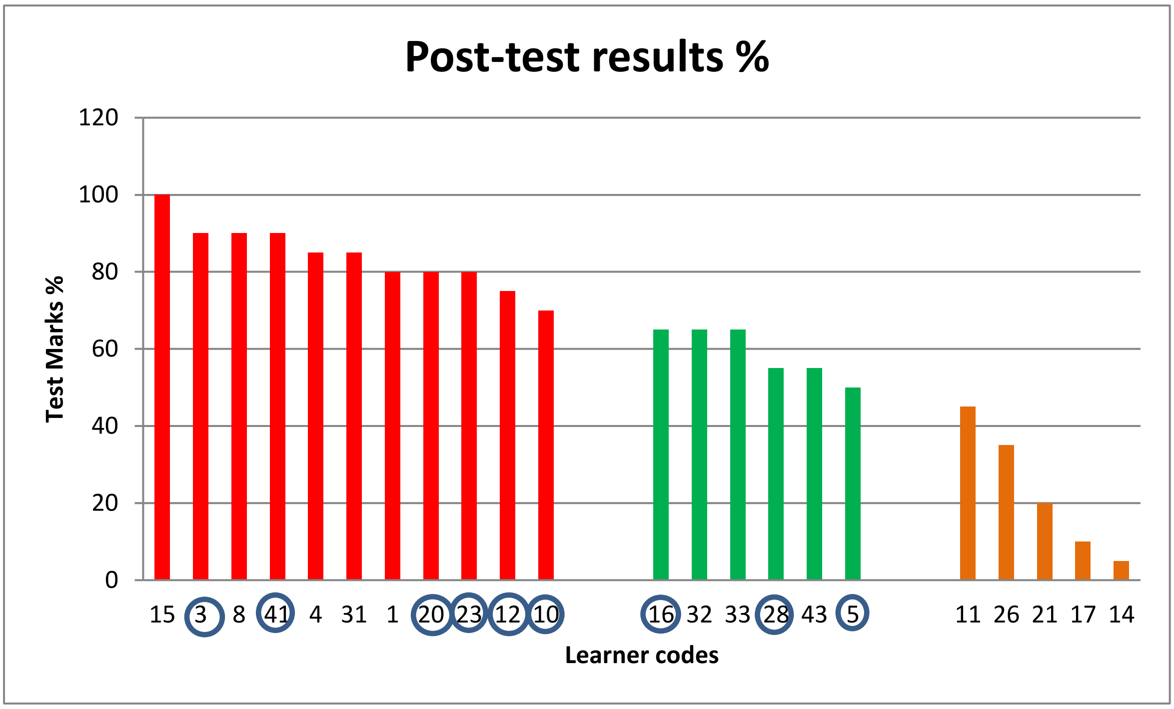
Figure 4.7: Post-test results displaying shifts

Key

Top: 100%-70%

Average: 69%-50%

Weak: 49%-0%



4.7. Analysis of three learners

In the next few pages of this chapter, I now analyze the questionnaires and mathematics tests of three learners so as to identify any shifts of beliefs, attitudes and values towards mathematics from the pre to post-questionnaire and how these made any difference in their mathematics test results. Only questions that indicated positive shifts have been included. The first learner who has been chosen is learner 4 whose mathematical resilience and mathematics test results both improved. The second learner is learner 16 whose mathematics test results improved while the mathematical resilience results dropped. The third learner is learner 26 whose mathematics results dropped while the mathematical resilience results improved. These three learners' selection provides cases of what it means to teach mathematics with an emphasis on inclusion.

4.7.1. Analysis of Learner 4

This learner improved in both the mathematics test and in terms of mathematical resilience derived from the questionnaire. Table 4.4 shows that this learner attained 55% in the pre-questionnaire and 71% in the post-questionnaire in terms of mathematical resilience. Table 4.5. shows that in the pre-mathematics test learner 4 attained 80% and 85% in the post-test showing an improvement of 5%.

Table 4.4: Learner 4 mathematical resilience results

Mathematical Resilience percentages	
Pre-Questionnaire	**Post-Questionnaire**
55%	71%

Table 4.5: Learner 4 mathematics test results

Mathematics test percentages	
Pre-test	**Post-test**
80%	85%

There are certain shifts that have been identified from this learner's pre and post questionnaire responses. Table 4.6 below represents these shifts.

Table 4.6: Learner 4 pre and post-questionnaire results

Learner 4	**Pre-Questionnaire**			**Post Questionnaire**		
	A	**N**	**D**	**A**	**N**	**D**
Q2: Everyone struggles with Maths at some point.			✓	✓		
Q10: Maths is hard work.			✓	✓		
Q12: I am looking forward to the lessons with you.		✓		✓		
Q27: I usually don't worry about doing Maths.		✓		✓		
Q29: I have usually been at ease in maths lessons.	✓			✓		
Q18: Some people cannot learn Maths.	✓				✓	
Q20: Only clever people can do Maths.	✓					✓
Q25: I get a sinking feeling when I think of trying hard maths sums.	✓					✓
Q30: Mathematics makes me feel uncomfortable and nervous	✓					✓

In the pre-questionnaire, this learner disagreed that, "Everyone struggles with Maths at some point" and that "Maths is hard work" but went on to agree in the post-questionnaire which is a positive shift in developing mathematical resilience. Question 19 states that, "Making mistakes helps me to learn Maths better" and this learner disagreed with this question both in the pre and post questionnaires. Learner 4 was uncertain about questions 12 and 27 which state that, "I am looking forward to the lessons with you" and "I usually don't worry about doing Maths" respectively. Agreeing to both these questions point to less anxiety and more interest in maths as a subject.

Before the intervention lessons, this learner agreed with the following statement; “Only clever people can do Maths, I get a sinking feeling when I think of trying hard maths sums, Mathematics makes me feel uncomfortable and nervous” but after the intervention program this learner disagreed with these statements implying that his/her beliefs advanced from believing that only clever people can do maths to believing that everyone had a chance of being able to do maths. This learner also shifted from feeling uncomfortable and nervous and the fear of trying hard maths sums to a feeling of comfort which is needed to build mathematical resilience. Johnston-Wilder and Lee (2010) maintain that learners who are mathematically resilient are aware of their strengths and weaknesses and how to deal with those weaknesses and are confident about their ability to learn new topics which can explain an increase in both mathematical resilience and maths test for this learner. In the same vein, I believe that inclusive classrooms need to prioritise both the improving of mathematical results and creating spaces for learners to be included as a right to education which can be done through the adaptation of teaching strategies and methodologies that facilitate learning (Ntombela and Raymond, 2013).

4.7.2. Analysis of learner 16

This learner improved in the mathematics test but dropped in terms of mathematical resilience. Table 4.7 shows that this learner’s mathematical resilience dropped from 23% in the pre-questionnaire to 16% in the post-questionnaire. Table 4.8 then shows that learner 16 attained 30% and 65% in the pre and post-mathematics tests respectively which shows an improvement in their mathematical ability.

Table 4.7: Learner 16 mathematical resilience results

Mathematical Resilience percentages	
Pre-Questionnaire	**Post-Questionnaire**
23%	16%

Table 4.8: Learner 16 mathematics test results

Mathematics test percentages	
Pre-test	**Post-test**
30%	65%

We now look at table 4.9 below to analyze any shifts in attitudes towards mathematics.

Table 4.9: Pre and post questionnaire results for learner 16

	Pre-Questionnaire			Post Questionnaire		
	A	N	D	A	N	D
Q22: Going to Maths lessons after school is not a problem.		✓		✓		
Q27: I usually don't worry about doing Maths.		✓		✓		
Q4: If someone is not a Maths person, they won't be able to learn much Maths.	✓				✓	
Q6: People are either good at Maths or they aren't.	✓				✓	
Q11: If someone does not like Maths, there is nothing that can be done to change that.	✓				✓	
Q20: Only clever people can do Maths.	✓					✓

According to table 4.9 three positive shifts can be noticed for questions 22, 27 and 20. Question 22 states that, "Going to Maths lessons after school is not a problem", and this learner had been neutral in the pre-questionnaire then went on to agree in the post-questionnaire. In question 27 which states that, "I usually don't worry about doing Maths", learner 16 had also been neutral in the pre-questionnaire then shifted to agree in the post-questionnaire. There are two other similar questions to question 27 which are questions 24 and 26 which state that, "I am usually at ease during maths tests" and "I almost never get nervous while taking maths tests". For these two questions is learner moved from being neutral in the pre-questionnaire to disagreeing in the post-questionnaire which could symbolize an increase in anxiety.

For question 20 which is below the black line, which states that, "Only clever people can do Maths", learner 16 shifted from agree to disagree in the post-questionnaire showing a positive shift. The belief that everyone is capable of doing mathematics is an important shift which can boost one's confidence and help them succeed in mathematics. There are three questions (4, 6 and 11) in which learner 16 shifted from agree to neutral which can either shift back to agree or to disagree with time. According to Ofsted (2008) in many mathematics classrooms there is usually an over regard for solving routive problems as well as preparation for tests which increases anxiety and has a negative effect on mathematical resilience which could explain this learner's drop in mathematical resilience and an increase in mathematical test results. I think that although the learner has increased in his mathematical result, it is just as important that he develops more mathematical resilience. The development of mathematical resilience then allows an inclusive classroom to become alive in that even if he drops in his mathematics he has self belief that he could be bettter next time.

4.7.3. Analysis of learner 26

The tables below present learner 26's pre and post-questionnaire results and pre and post-mathematics results. Table 4.10. shows that learner 26's mathematical resilience results improved from 29% in the pre-questionnaire to 65% in the post-questionnaire. Table 4.11. shows that learner 26 dropped in the mathematics test on bridging through ten from 55% in the pre-test to 35% in the post-test.

Table 4.10: Learner 26 mathematical resilience results

Mathematical Resilience percentages	
Pre-Questionnaire	**Post-Questionnaire**
29%	65%

Table 4.11: Learner 26 mathematics test results

Mathematics test percentages	
Pre-test	**Post-test**
55%	35%

Table 4.12 below shows the way learner 26 responded to the pre and post-questionnaires, whether they ticked Agree, Neutral or Disagree in each of the questions displaying the shifts in their beliefs and attitudes towards mathematics and thus their mathematical resilience.

Table 4.12: Learner 26 pre and post-questionnaire results

	Pre-Questionnaire			**Post Questionnaire**		
	A	**N**	**D**	**A**	**N**	**D**
Q1: Maths can be learned by anyone.		✓		✓		
Q2: Everyone struggles with Maths at some point.		✓		✓		
Q3: Maths is important for my future.		✓		✓		
Q5: People good in Maths experience difficulties when solving problems.		✓		✓		
Q7: Everyone makes mistakes at times when doing Maths.		✓		✓		
Q8: Maths will be useful to me at school and at home.		✓		✓		
Q9: Maths is very helpful no matter what I decide to learn.		✓		✓		
Q10: Maths is hard work.		✓		✓		
Q12: I am looking forward to the lessons with you.		✓		✓		
Q13: People in my class sometimes have problems with Maths.		✓		✓		
Q15: People who are good at Maths may fail a hard Maths test.		✓		✓		
Q19: Making mistakes helps me to learn Maths better.			✓	✓		

To show mathematical resilience, learners had to tick agree on the 20 questions above the black line and disagree on the 11 questions below the black line. In this case it is evident that the shifts occurred with questions above the black line only. In the pre-questionnaire, out of the 20 questions in which they had to tick agree, learner 26 had 8 agrees and 1 disagree. In the post-questionnaire, they had 20 agrees and 0 disagrees. Here we see an increase in the number of agrees in the post-questionnaire and a decrease in the number of disagrees. In the pre-questionnaire, out of the 11 questions in which they had to tick disagree to show mathematical resilience, learner 26 had 6 agrees and 1 disagree. In the post questionnaire, it was 11 agrees and no disagree. It can be observed that learner 26 moved from neutral showing uncertainty for 11 questions to agree in the post-questionnaire indicating a positive shift in this learner's beliefs and attitudes towards mathematics. Examples of questions in which the learner was uncertain about in the pre-questionnaire but agreed with in the post-questionnaire include questions 3, 8 and 9 which speak to the importance of mathematics beyond school which is an important realization for one to make in order to develop mathematical resilience. Other similar questions reflecting a positive shift are questions 5 and 15 which are about people good in mathematics also struggling with mathematics. This is very important especially for this particular learner who dropped in their post-test because they will not see this as a setback but as a process of learning mathematics. Even though this learner dropped in the post-mathematics test, they improved in their mathematical resilience and Johnston-Wilder and Lee (2010) claim that a mathematically resilient learner understands that these 'wrong-turns' eventually lead to success in mathematics.

4.8. Conclusion

This chapter has presented the results of the questionnaire and mathematics test on bridging through ten before and after the intervention. The results of the pre and post-questionnaires as well as those of those of the pre and post-mathematics tests have been compared in an attempt to identify any shifts that may have occurred. In both cases, of the 22 learners there were positive shifts in both the pre and post-questionnaires and pre and post-tests. Finally, three learners; one who improved in both the questionnaires and maths tests, one who improved in the maths test but dropped in the questionnaires and one who stayed the same in both tests and questionnaires were analyzed. The positive shifts in the results point to the importance of developing mathematical resilience and inclusive classrooms, which have to be the explicit intention of a teacher in a foundation, phase classroom. The next chapter aims to discuss the findings attained in the analysis chapter, answer the research questions and conclude the report.

CHAPTER 5: KEY FINDINGS AND CONCLUSION

5.1 Introduction

The main aim of this chapter is to present and discuss the main findings of this study whose main objective was to explore grade 2 mathematics classrooms as sites of inclusive practice through the use of mathematical resilience tools. This will be done through answering the three research questions that guided the study. A reflection on the comparisons between the pre and post-mathematics test as well as those of the pre and post-questionnaires and a brief highlight of the intervention program will be done in a attempt to answer the research questions. Furthermore, the limitations of the study will be discussed and recommendations for future studies given. Finally, a conclusion of the entire report will be given.

The rationale for this study was that in recent years, there has been talk about inclusive education which is usually associated with learners with disabilities even though the requirement is that it should be for all children (DBE, 2001). So, in this study I interpreted inclusion as a requirement that looks after the needs of all learners despite ability. Inclusion in mathematics classrooms is especially a subject that is scarce in all this talk about inclusive education. According to Human, Van der Walt and Posthuma (2015), there is need for intervention in foundation phase mathematics education as the Annual National Assessments (ANAs) show that learners' performance is below the required standard. This study therefore undertook to carry out one such intervention using mathematical resilience (Johnston-Wilder and Lee, 2010) as a method of including all learners in a grade 2 mathematics classroom during an intervention program to see if that would improve their performance in mathematics.

Learners were given a pre-questionnaire and a pre-mathematics test then they were engaged in eight intervention lessons over 2 weeks where bridging through ten was taught using number lines (both addition and subtraction). After the intervention, a post-questionnaire and post-mathematics test were given to the learners so as to monitor their progress before and after the intervention. The mathematics test was therefore used an indicator to monitor change in performance while the questionnaire monitored the change in learners' attitudes and beliefs on mathematics as a subject. The questionnaire and mathematics results before and after the intervention program will be compared as a way of answering the research questions in the next few pages of this chapter.

In establishing the key findings of this study, the following questions are answered:

1. What were the predominant shifts in attitudes and feelings (mathematical resilience) from pre to post questionnaires?
2. What were the mathematical gains (bridging through ten) visible from the pre to post-mathematical test?
3. What needs to be considered when developing an inclusive foundation phase mathematics classroom in order to improve mathematical results?

5.2. Key Findings

1. What were the predominant shifts in attitudes and feelings (mathematical resilience) from pre to post questionnaires?

Before and after the intervention program, grade 2 learners were given a questionnaire adapted from Kooken, Welsh, McCoach, Johnston-Wilder, Lee, (2013) to determine the level of their mathematical resilience. Tools of mathematical resilience (Growth Zone model, Ladder of accessibility, Explore-actions-options, Grid of communication skills and Relaxation response) were employed as a way to promote inclusivity in the program. The questionnaire was designed to give an insight into the learners' beliefs and attitudes about mathematics. The analysis in chapter 4 concludes that there was an overall increase in mathematical resilience of the grade 2 learners. This might mean that, for example that there were more learners in the post-questionnaire after the intervention program who believed that maths can be learned by everyone, that everyone struggles with this subject at some point, an understanding that maths is important for their future and that everyone makes mistakes at times when doing maths. However, the second part of the questionnaire in which the learners had to disagree to show mathematical resilience, starting from Q4 to Q31 did not show much of an increase in terms learners' mathematical resilience.

In the pre-questionnaire, the highest percentage of mathematical resilience was 61% compared to a high of 71% in the post-questionnaire. Also, the lowest mathematical resilience in the pre-test was 0 while it became 6% in the post-questionnaire showing a positive shift. Out of 22 learners, 12 learners improved in their mathematical resilience percentages which is a good result to achieve in eight lessons.

Some significant positive shifts in beliefs about mathematics are seen for example in table 4.3 for questions 3 and 16 which moved from 11 to 17 and 13 to 18 agrees respectively from the pre to post-questionnaire. Both these questions speak to the importance of mathematics beyond schooling. This indicates that more learners moved from the view that mathematics is merely a school subject to seeing its usefulness in their everyday lives and this is beneficial as it may develop further interest in mathematics. Another major positive shift is seen in questions 7 and 19 which speak about the role of mistakes in learning mathematics. Question 7 initially had 15 agrees and had 20 meaning that only 2 learners did not agree with this question. Question 19 improved from 6 to 10 agrees after the intervention showing that learners moved from believing that making mistakes is an act of carelessness and stupidity to an understanding that mistakes allow for further learning to take place. What the improvement in results shows is that learners can reflect on why they learn mathematics and that they can change their attitude towards mathematics. The findings also suggest that mathematical resilience as a tool has promoted inclusive practises at Grade 2 level. Learners had been given a voice to their anxieties about mathematics and the learning of mathematics.

2. What were the mathematical gains (bridging through ten) visible from the pre to post-mathematical test?

As mentioned previously in this report, a bridging through ten test was written before the intervention program to determine the learners' performance, then after the intervention program the same test was written to check for the impact of the intervention on the learners' results. The intervention program was focused on bridging through ten, this included plotting a number on a number line, determining the direction for addition and subtraction, and splitting single and two digit numbers into ten and units.

It is clear when looking at chapter 4 that there were more learners with higher marks in the post- test than in the pre-test. For example, there were 2 learners who achieved 16 in the pre-test and there were 4 learners who achieved the same mark in the post test. Also, there were no learners who got 17 out of 20 in the pre-test, yet there were four learners who got seventeen in the post test. It is also visible that there were no learners who totalized in the pre-test but one learner totalized in the post test. It can thus be concluded that there was an overall improvement in the performance of the bridging through ten mathematics tests given that 17 out of 22 learners (77%) in the pre-test compared to 15 learners out of 22 (68%) in the pre-test passed the test with 50% and above and 5 learners (23%) compared to 7 learners (32%) in the pre-test failed the test with 49% and below. These findings suggest that bridging through ten is an effective strategy in helping learners answer two digit addition and subtraction calculations and in facilitating the move from concrete to abstract calculation strategies. The findings also suggest that bridging through ten on the numberline as a representation allows learners to produce more accurate results in addition and subtraction. The improvement in results also indicates that inclusion is enhanced when learners become competent in solving mathematics problems. I think that inclusion has helped to develop postive attitudes towards mathematics as well as improved conceptaul knowledge of addition and subtraction for the learners.

3. **What needs to be considered when developing an inclusive foundation phase mathematics classroom in order to improve mathematical results?**

In order to develop inclusive foundation phase mathematics classrooms, inclusive pedagogies such as mathematical resilience can be introduced. In this study, an eight-day intervention program that aimed to promote inclusion in a grade 2 class through employing tools of mathematical resilience was run. During the intervention program, learners were given opportunities to use their voice and question any misunderstanding through the use of the Grid of communication styles which made the lessons interactive as opposed to teacher-led (Msimanga 2017 in Adler and Sfard 2017, p. 145). Through the use of the Growth Zone model, learners were able to identify if they were struggling and were given less intimidating ways of letting the teacher know through the use of different colored ice-cream sticks (Findon and Johnston-Wilder, 2017. p. 46). Learners could put up the green stick if they were comfortable with explanations given, yellow sticks if they were not sure and needed clarification and red sticks if they felt totally lost and then they would be assisted.

The ladder of accessibility was employed by teaching bridging through ten using well defined steps that were explicitly taught to the learners. These steps were reminded to them before each lesson and a chart with the steps was stuck on the wall so as to remind them while they did their work. Egan's (2002) Explore-options-actions framework was used for learners that admitted they were struggling through raising their red sticks. They were helped by other learners who had a better understanding and the teacher as well. Finally, the Relaxation response in the form of the 60 second tranquilizer was used to allow learners to calm down if they were feeling anxious or scared (https://isma.org.uk/nsad-free-downloads). It was up to the learners to determine how they felt and when to use the 60 second tranquilizer except before writing test where it was done by all learners as a teacher led activity.

Together with using a tool such as mathematical resilience, having a mathematical strategy such as bridging through ten assisted in creating an inclusive space. The inclusive space was seen when learners who could not answer questions initially could subsequently answer the same questions. I also argue that inclusive mathematics classrooms are dependent on how teachers teach specific ideas in mathematics.

In conclusion, with evidence from the results of the pre and post-questionnaire as well as those of the pre and post-mathematics test, the intervention program was a success. These tools could have made the learners feel included and at ease during their mathematics lessons which could have in turn allowed for better understanding and therefore improved results. This improvement of results can be attributed to using the tools of mathematical resilience as described above as a way of supporting learners in an inclusive classroom when teaching mathematics. Finally, inclusive classrooms can be characterised by both inclusive practices and improvement in content specific results. I think for a long-time mathematics classrooms needed to choose either the principles of inclusive education or good mathematical results. This small-scale intervention has highlighted that both these outcomes are possible in a South African context.

5.3. Limitations

The first limitation of this study is the time constraints encountered during data collection. The data collection was meant to take about 6 weeks, but the school was only able to accommodate me for only 2 weeks in which the pre and post-mathematics test and pre and post-questionnaires as well as intervention had to be done thereby limiting the shifts and changes. Therefore, a suggestion for future studies is to find a school that will accommodate the researcher for a longer period of time so as to allow at least a one-month gap between the pre and post-tests for increased validity and reliability. Also, doing an intervention over an extended period of time will ensure that learners internalize the new methods of teaching and learning which will eventually make them mathematically resilient learners, in that they will strive to find the answer even if they initially get the answers wrong.

The other limitation speaks to sample size. The results analysed in this report are only of 22 grade 2 boys and girls. This sample is also from a certain kind of context which does not entirely represent the different classrooms in South Africa meaning that the results of this study are not generalizable to different kinds of contexts and classrooms. A suggestion for a similar study would be to work with learners from different contexts and to work with a much larger sample size to enable generalization of the results of the research.

5.4. Recommendations emanating from this study

The Department of Education needs to properly train teachers on the implementation of the Education White Paper 6 (DBE, 2001) and SIAS Policy (DBE, 2014) in different contexts and also clarify any ambiguities in the policies. In the process of training teachers on the implementation of the Education White Paper 6 (DBE, 2001) and SIAS Policy (DBE, 2014), teachers could also be taught ‘The principles of Universal Design for Learning’ (UDL). The UDL will allow teachers to practice inclusive pedagogies through the use of teaching methods that are flexible and therefore promote the participation of all learners despite ability, race etc. The most significant shift that needs to be highlighted in inclusive education is that an inclusive classroom does not only cater for learners with physical disabilities but for all learners. In other words, if a teacher ensures a safe environment in selecting tools that promote inclusion and teaching effective mathematics, learners with particular disabilities will be catered for directly and indirectly. This study has highlighted the importance of selecting specific tools within mathematics classrooms that ensure that attitudes are changed by promoting inclusion.

Seeing how badly South African learners are performing in mathematics internationally, mathematics education should be prioritized especially foundation phase as this is where a good foundation should be laid. Foundation phase teachers can then gradually select specific areas of mathematics that provide specific problems and teach to that idea with purposiveness. In the case of this study it was bridging through ten, maybe another could be multiplicative reasoning. Developing competence around certain mathematical ideas is to ensure that as learners' progress and the mathematics becomes more complex they will be able to persevere and keep a positive attitude towards mathematics as a subject.

5.5. Conclusion

This study sought to explore grade 2 classrooms as sites of inclusive practice through employing the tools of mathematical resilience such as the growth zone model, the ladder of accessibility, the explore-options-actions framework, the grid of communications and the relaxation response. It utilized a mixed methods approach and made use of case studies of three learners that were representative of important insights that needs to be considered when working in an inclusive classroom when mathematics is taught. The main instruments of data collection included the use of a mathematical resilience questionnaire as well as a bridging through ten test carried out in a pre and post-test manner. Generally, the results indicated that there was a positive shift of beliefs and attitudes towards mathematics from the pre to post-questionnaire for most learners. This alludes to the fact that there was more inclusion of learners and less feelings of anxiety from the learners. The results also displayed a better understanding of the concept of bridging through ten from the pre to post-mathematics tests in the form of higher marks. These findings could be an indication that the introduction of inclusive pedagogies in foundation phase mathematics classrooms could be a step in the right direction to improving mathematics scores.

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Appendix 1: Coaching for Mathematical Resilience – questionnaire

For each of the questions below, please tick the box that best applies to you. Thank you. (Please note that the researcher will read out each question while the participants tick the box that best applies to them because of the age of the participants).

	Agree	Neutral	Disagree
Maths can be learned by anyone.	❑	❑	❑
Everyone struggles with Maths at some point.	❑	❑	❑
Maths is important for my future.	❑	❑	❑
If someone does not like Maths, they won't be able to learn much Maths.	❑	❑	❑
People good in Maths experience difficulties when finding answers.	❑	❑	❑
People are either good at Maths or they aren't.	❑	❑	❑
Everyone makes mistakes at times when doing Maths.	❑	❑	❑
Maths will be useful to me at school and at home.	❑	❑	❑
Maths is very helpful no matter what I decide to learn.	❑	❑	❑
Maths is hard work.	❑	❑	❑
If someone does not like Maths, there is nothing that can be done to change that.	❑	❑	❑

	Agree	Neutral	Disagree
I am looking forward to the lessons with you.	❑	❑	❑
People in my class sometimes have problems with Maths.	❑	❑	❑
Everyone can either do Maths or not do Maths.	❑	❑	❑
People who are good at Maths may fail a hard Maths test.	❑	❑	❑

Knowing Maths will help with my job in future.	❑	❑	❑
Knowing Maths helps me to know harder sums.	❑	❑	❑
	❑	❑	❑
Some people cannot do Maths. Making mistakes helps me to learn Maths better.	❑	❑	❑
Only clever people can do Maths	❑	❑	❑
It would be difficult to succeed in life without Maths.	❑	❑	❑

	Agree	**Neutral**	**Disagree**
Going to Maths lessons after school is not a problem.	❑	❑	❑
I get really nervous during maths tests.	❑	❑	❑
I am usually at ease during maths tests.	❑	❑	❑
I get a sinking feeling when I think of trying hard maths sums.	❑	❑	❑
I almost never get nervous while taking maths tests.	❑	❑	❑
I usually don't worry about doing Maths.	❑	❑	❑
Mathematics makes me feel uneasy and confused.	❑	❑	❑
I have usually been at ease in maths lessons.	❑	❑	❑
Mathematics makes me feel uncomfortable and nervous	❑	❑	❑
My mind goes blank and I am unable to think clearly when working on sums.	❑	❑	❑

Code..

Thank you.

The first part of this questionnaire has been modified by Sue Johnston-Wilder and Janine Brindley, who have added questions for a fourth factor to the Mathematics Resilience Scale. The second part is from Betz 1978.

Source: **Kooken, J.,** Welsh, M., McCoach, D., Johnston-Wilder, S., Lee, C. (2013). *Measuring Mathematical Resilience: An application of the construct of resilience to the study of mathematics*. Paper presented at national conference of the American Educational Research Association, San Francisco, CA.

Source: Betz, Nancy E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. Journal of Counseling Psychology, Vol 25(5), 441-448. doi: 10.1037/0022-0167.25.

Appendix 2: Bridging through ten test

PART ONE
2 MINUTES FOR THIS PAGE

1 7 + 3 = $\square$

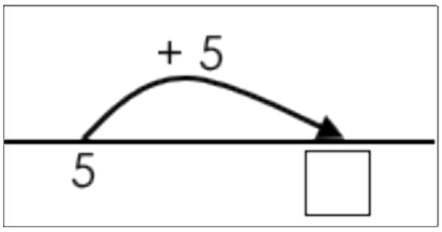
2 2 + 8 = $\square$

3 10 = 7 + $\square$

4 8 less than 10 is $\square$

5

2	$\square$
10	

6 

7 10 – 5 = $\square$

8 10 – 4 =

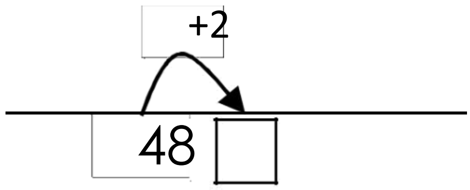
9

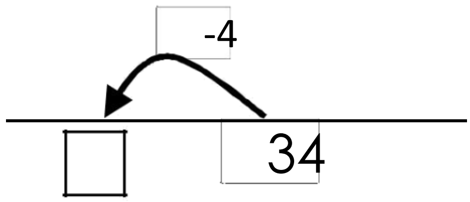
1	9
$\square$	

10 $\square$ + 2 = 10

11 40 + 8 = $\square$

12 40 – 7 = $\square$

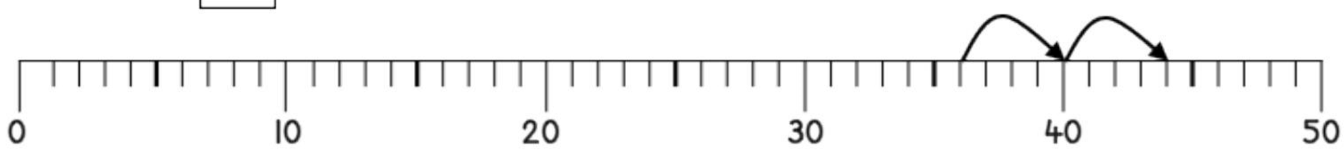
13 

14 

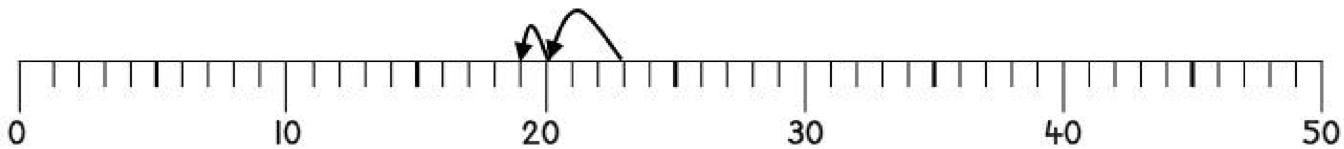
15 30 – $\square$ = 27

Total out of 15: $\square$

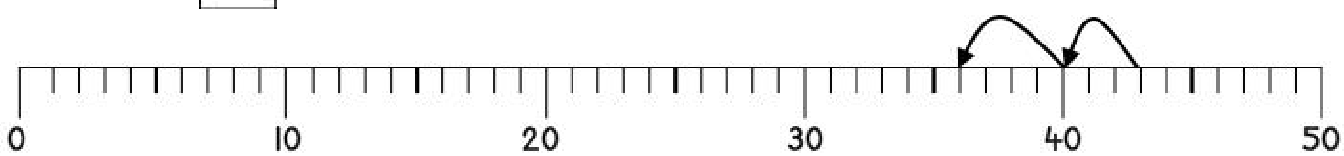
1. 36 + 8 = $\square$



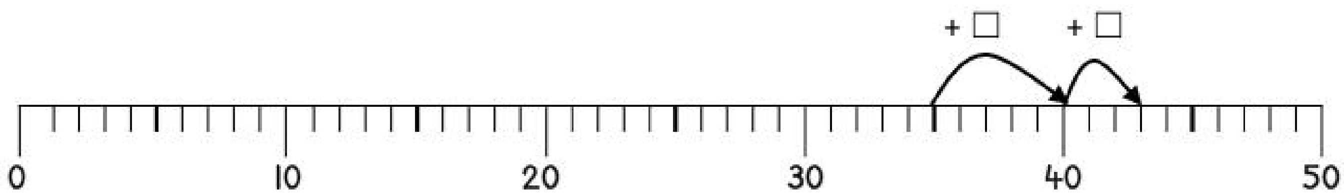
2. 23 – 4 = $\square$



3. 43 – 7 = $\square$



4. 35 + $\square$ = 43



5. 28 + 5 = 30 + $\square$

Total out of 5:	

Appendix 3: Intervention Lessons

Gr 2: Bridging through 10

Teacher Guide

BRIDGING THROUGH TEN

Introduction

The tasks here are designed to fit into the 10-minute oral and mental starter part of the lesson.

Each session starts with 1 minute of oral fluency, rehearsing key number facts that learners need to be able to answer confidently and rapidly.

There are then four sets of tasks for working on adding by bridging through 10 and four on subtracting. Some of these tasks are teacher led at the board, some are for learners to do independently.

Everyday day

1 minute mental warm up

Pop Fizz (Teacher says a number, learners respond)

Make to 10

U: 3, L: 7; T6: L4 and so

on. Make to 20

U:3, L: 17; T 16: L: 4 and so

on. Jumping to the **next** ten…

U:47, L: 3; T 58: L: 2; T: 32, L: 8 and so on.

(This is not rounding to the nearest ten but jumping to the **next** ten on the number line)

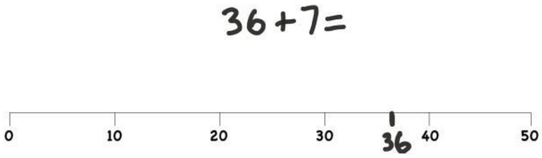
Day 1: Task sequence

Problem: 36 + 7 =

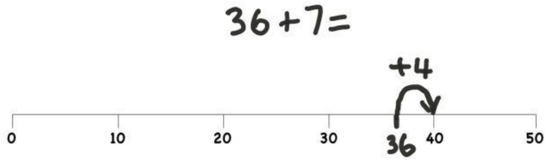
Record 36 + 7 = on the board

“Where is 36 on this number line?”

A learner to come and mark the line.



“We have to jump 7 forwards.
Let’s make one jump to the next
ten rather than jumping in 1s. What
is the next ten after 36?”



Learners to answer

“36 plus what gives 40?”

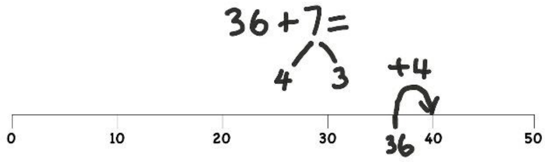
Learners to answer

Record on the number line.

“We have added 4. We need to add 7.
7 splits into 4 and what?

Learners to answer

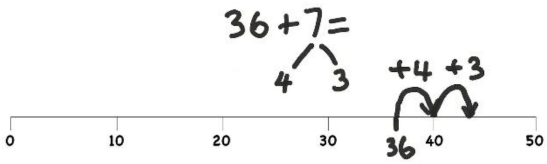
Split the 7 in 36 + 7 into 4 and 3



“How many more do we need to add?”

Learners to answer

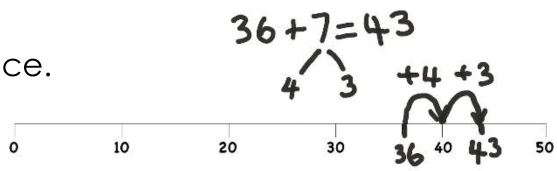
Record on the number line



“What is 40 plus 3?”

“So, 36 + 7 = 36 + 4 + 3 = 43”

Record on the number line and number sentence.



BRIDGING THROUGH TEN

Day 2

1 minute mental warm up

Pop Fizz Make to 10 or 20.

Jumping to the **next** ten …

Task sequence

Remember from before – how did we solve

36 + 7?

Let learners say the method and how it works or show on the board

As for yesterday, model at the board on the number line how to bridge through 10 to solve:

27 + 8 =

INDIVIDUAL TASKS

Ask learners to solve this sum by bridging through

ten 37 + 8 =

Encourage learners to show their working on a number line – emphasise that numbers do not have to be exactly positioned.

Encourage mental working method of jumping NOT counting in 1s.

Encourage exploring bridging through 10 in sentences by explaining their work to a partner.

BRIDGING THROUGH TEN

Day 3

1 minute mental warm up

Pop Fizz Make to 10 or 20.

Jumping to the **next** ten …

Task sequence

As done previously, model at the board on the number line how to bridge through 10 to solve:

35 + 8 =

INDIVIDUAL TASKS

Ask learners to solve these sums by bridging through ten

25 + 8 =

36 + 9 =

If any learners finish these two sums quickly, give them more to practice.

Encourage them to show their working on a number line – emphasise that numbers do not have to be exactly positioned.

Encourage mental working method of jumping NOT counting in 1s.

Encourage exploring bridging through 10 in sentences by explaining their work to a partner.

BRIDGING THROUGH TEN

Day 4

1 minute mental warm up

Pop Fizz Make to 10 or 20.

Jumping to the **next** ten …

Task sequence

INDIVIDUAL TASKS

Ask learners to solve these sums by bridging through ten

26 + 8 =

35 + 8 =

17 + 6 =

If any learners finish these three sums quickly, give them more to practice.

Encourage them to show their working on a number line – emphasise that numbers do not have to be exactly positioned.

Encourage mental working method of jumping NOT counting in 1s.

Encourage exploring bridging through 10 in sentences by explaining their work to a partner.

Day 5: Task sequence

1 minute mental warm up

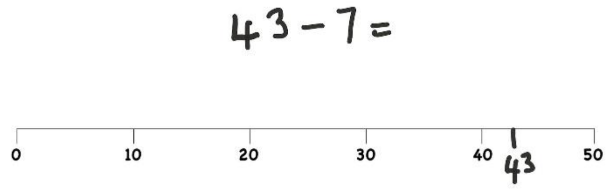
Jumping to ten **before:** T: 32, L: 2: T: 47, L: 7; T 58: L: 8; and so on.

Problem: 43 – 7 =

Record 43 – 7 = on the board

"Where is 43 on this number line?"

A learner to come and mark the line.



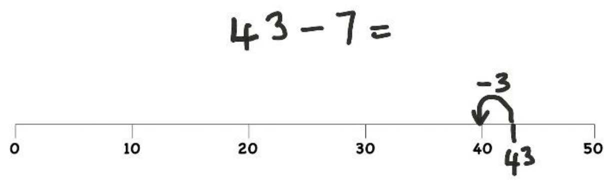
"We have to jump 7 backwards.
Let's make one jump to the ten before 43 rather than jumping in 1s. What is the ten before 43?"

Learners to answer

"43 minus what gives 40?"

Learners to answer

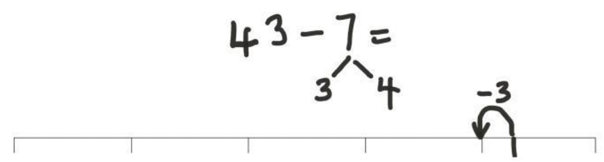
Record on the number line.



"We have subtracted 3. We need to subtract 7.
7 splits into 3 and what?

Learners to answer

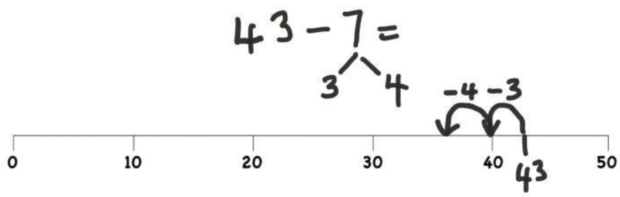
Split the 7 in 43 – 7 into 3 and 4



"How many more do we need to subtract?"

Learners to answer

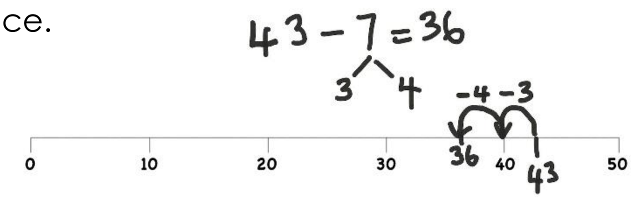
Record on the number line



"What is 40 minus 4?"

"So, 43 – 7 = 43 – 3 – 4 = 36"

Add to the number line and number sentence.



BRIDGING THROUGH TEN

Day 6

1 minute mental warm up

Pop Fizz Make to 10 or 20.

Jumping to ten **before** …

Task sequence

Remember from yesterday – how did we solve

43 – 7?

Let learners say the method and how it works or show on the board

As for yesterday, model at the board on the number line how to bridge through 10 to solve:

27 – 8 =

INDIVIDUAL TASKS

Ask learners to solve this sum by bridging through

ten 37 – 8 =

Encourage learners to show their working on a number line – emphasise that numbers do not have to be exactly positioned.

Encourage mental working method of jumping NOT counting in 1s.

Encourage exploring bridging through 10 in sentences by explaining their work to a partner.

Day 7

1 minute mental warm up

Pop Fizz Make to 10 or 20.

Jumping to ten **before …**

Task sequence

As done previously, model at the board on the number line how to bridge through 10 to solve:

35 – 8 =

INDIVIDUAL TASKS

Ask learners to solve these sums by bridging through ten

25 – 8 =

36 – 9 =

If any learners finish these two sums quickly, give them more to practice.

Encourage them to show their working on a number line – emphasise that numbers do not have to be exactly positioned.

Encourage mental working method of jumping NOT counting in 1s.

Encourage exploring bridging through 10 in sentences by explaining their work to a partner..

BRIDGING THROUGH TEN

Day 8

1 minute mental warm up

Pop Fizz Make to 10 or 20.

Jumping to ten **before** …

Task sequence

INDIVIDUAL TASKS

Ask learners to solve these sums by bridging through ten

26 – 9 =

35 – 8 =

42 – 6 =

Encourage them to show their working on a number line – emphasise rough drawings versus using a ruler for the number line.

Encourage mental working method of jumping NOT counting in 1s.

Encourage exploring of bridging through 10 in sentences.

Appendix 4: LETTER TO THE PRINCIPAL, SGB Chair **DATE: July 2018**

Dear Sir/Madam

My name is Pamela Lilian Mubviri. I am a full time Master of Education student in the School of Education at the University of the Witwatersrand. I am doing research on Exploring grade 2 mathematics classrooms as sites of inclusive practice.

My research involves establishing a relationship between the construct of mathematical resilience and inclusive practices in grade two mathematics classrooms. It involves finding out what is meant by the idea of inclusive mathematics classrooms, what promotes or inhibits mathematics practice within classrooms and what approach is required to create inclusive mathematics classrooms. I would like to pre-test the learners to find out how well they understand bridging through ten, give them questionnaires to establish their attitude towards mathematics then have intervention lessons with them using the principles of mathematical resilience such as group work, collaboration and discussions. Thereafter I will test them again to establish if there will be any improvements in their results then give them the same questionnaire to find out if their attitude towards mathematics would have changed. I will compare each learner's work from the pre-test to the post test with regard to bridging through ten as well as their questionnaire responses. Please note that the test transcripts and questionnaire responses will only be used for this study and will only be seen by my supervisor and I.

The reason why I have chosen your school is because I have heard how accommodative you are of researchers. Your school will also be easily accessible for me to teach intervention lessons for the duration of the data collection process.

I am inviting your school to participate in this research as your participation will be very valuable to my research and possibly contribute to creating more inclusive mathematics classrooms.

The research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The names of the research participants and identity of the school will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

SIGNATURE: P. L. Mubviri

NAME: Pamela Lilian Mubviri
ADDRESS: 78 Orion Street, Kensington. Johannesburg
EMAIL: 735947@students.wits.ac.za
TELEPHONE NUMBERS: 0612342948/0767372948

Appendix 5: INFORMATION SHEET LEARNERS

DATE: July 2018

Dear Learner

My name is Pamela Lilian Mubviri and I am a student in the School of Education at the University of the Witwatersrand.

I am doing a study to find out how you feel about doing mathematics, whether you feel left out or included when you are learning Maths. I also want to find out which learning methods would make you understand better and make you feel better about learning Maths. I would like to come to your school for about 4 weeks to work with you and your whole class.

Would you mind if you work with me on this study? Tick one face to show me how you feel:

 Yes  No

I would like to give you a few questions to fill out and also give you some addition and subtraction problems to answer.

This is not a test, it is not for marks and you don’t have to do it. Also, if you decide anytime that you want to stop, this is your choice and will not affect you in any way.

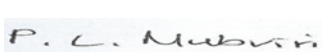
I will not be using your real name or the name of your school but I will make one up so no one can identify you. I will keep your information safe then destroy it after 3-5 years.

Your parents have also been told about the study but it is your choice to take part.

I look forward to working with you!

Please feel free to contact me if you have any questions.

Thank you

SIGNATURE: 

NAME: Pamela Lilian Mubviri
ADDRESS: 78 Orion Street, Kensington. Johannesburg
EMAIL: 735947@students.wits.ac.za
TELEPHONE NUMBERS: 0612342948/0767372948

Learner Consent Form

Please fill in the slip below if you agree to work with me:

My name is: ________________________

Would you like me to collect your documents?	**Tick one**
I agree that my answer sheets can be used for this study only.	YES/NO
Would you like to fill out a questionnaire?	
I would like to fill out a questionnaire for this study.	YES/NO
I know that I don’t have to answer all the questions asked.	YES/NO
Would you like me to test you?	
I agree to write a test for this study	YES/NO

Informed Consent

I understand that:

- My name and information will be kept safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can leave the study at any time.
- All the data collected during this study will be destroyed within 3-5 years after the project is finished.

Sign_____________________________ Date___________________________

Appendix 6: INFORMATION SHEET PARENTS **DATE: July 2018**

Dear Parent/Guardian
My name is Pamela Lilian Mubviri and I am a Master of Education student in the School of Education at the University of the Witwatersrand.

I am doing research on Exploring grade 2 mathematics classrooms as sites of inclusive practice.
My research involves establishing a relationship between the construct of mathematical resilience and inclusive practices in grade two mathematics classrooms. It involves finding out what is meant by the idea of inclusive mathematics classrooms, what promotes or inhibits mathematics practice within classrooms and what approach is required to create inclusive mathematics classrooms. I would like to pre-test your child to find out how well they understand bridging through ten, give them questionnaires to establish their attitude towards mathematics then have intervention lessons with them using the principles of mathematical resilience such as group work, collaboration and discussions. Thereafter I will test them again to establish if there will be any improvements in their results then give them the same questionnaire to find out if their attitude towards mathematics would have changed. I will compare your child's work from the pre-test to the post test as well as their questionnaire responses. Please note that the test transcripts and questionnaire responses will only be used for this study and will only be seen by my supervisor and I.

The reason why I have chosen your child's class is because I am looking to work with a grade 2 class and your child's teacher is able to accommodate me.
Would you mind if I test and give your child a questionnaire? The information collected will only be used for this project.

Your child will not be advantaged or disadvantaged in any way. S/he will be reassured that s/he can withdraw her/his permission at any time during this project without any penalty. There are no foreseeable risks in participating and your child will not be paid for this study.

Your child's name and identity will be kept confidential at all times and in all academic writing about the study. His/her individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information.
Thank you very much for your help.

Yours sincerely,

SIGNATURE: P. L. Mubviri
NAME: Pamela Lilian Mubviri
ADDRESS: 78 Orion Street, Kensington. Johannesburg
EMAIL: 735947@students.wits.ac.za
TELEPHONE NUMBERS: 0612342948/0767372948

Parent's Consent

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the research project called:

Exploring grade 2 mathematics classrooms as sites of inclusive practice

I, ______________________ the parent of ____________________

Permission to review/collect documents/artifacts	**Circle one**
I agree that my child's (test transcripts) can be used for this Study only.	YES/NO

Permission for questionnaire	
I agree that my child may fill out a questionnaire for this study.	YES/NO
I know that he/she doesn't have to answer all the questions asked.	YES/NO

Permission for test	
I agree that my child may write a test for this study.	YES/NO

Informed Consent

I understand that:

- my child's name and information will be kept confidential and safe and that my name and the name of the school will not be revealed.
- he/she does not have to answer every question and can withdraw from the study at any time.
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign___________________________ Date_________________________

Appendix 7: INFORMATION SHEET TEACHERS

Dear Sir/ Madam   Date: July 2018

My name is Pamela Lilian Mubviri. I am a full time Master of Education student in the School of Education at the University of the Witwatersrand.

I am doing research on Exploring grade 2 mathematics classrooms as sites of inclusive practice.
My research involves establishing a relationship between the construct of mathematical resilience and inclusive practices in grade two mathematics classrooms. It involves finding out what is meant by the idea of inclusive mathematics classrooms, what promotes or inhibits mathematics practice within classrooms and what approach is required to create inclusive mathematics classrooms. I would like to pre-test the learners to find out how well they understand bridging through ten, give them questionnaires to establish their attitude towards mathematics then have intervention lessons with them using the principles of mathematical resilience such as group work, collaboration and discussions. Thereafter I will test them again to establish if there will be any improvements in their results then give them the same questionnaire to find out if their attitude towards mathematics would have changed. I will compare each learner's work from the pre-test to the post test as well as their questionnaire responses. Please note that the test transcripts and questionnaire responses will only be used for this study and will only be seen by my supervisor and I.

The reason why I have chosen your school is because I have heard how accommodative you are of researchers. Would you mind if I work with your learners for about 3 times a week, 30 minutes each day for 4 weeks?

I am inviting your school to participate in this research as your participation will be very valuable to my research and possibly contribute to creating more inclusive mathematics classrooms.

Your name and that of the school as well as your identity will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

You will not be advantaged or disadvantaged in any way. The participation of your learners is voluntary, so they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating and they will not be paid for this study.

Please let me know if you require any further information.
Thank you very much for your help.
Yours sincerely,

SIGNATURE: P. L. Mubviri
NAME: Pamela Lilian Mubviri
ADDRESS: 78 Orion Street, Kensington. Johannesburg
EMAIL: 735947@students.wits.ac.za
TELEPHONE NUMBERS: 0612342948/0767372948

Teacher's Consent Form

Please fill in and return the reply slip below indicating your willingness for your class to participate in my voluntary research project called:
Exploring grade 2 mathematics classrooms as sites of inclusive practice

I, ________________________ give my consent for the following:

Permission to review/collect documents/artifacts	**Circle one**
I agree that my learners' (test transcripts) can be used for this study only.	YES/NO
Permission for test	
I agree for my learners to write a test for this study.	YES/NO
Permission for questionnaire	
I agree for my learners to fill out a questionnaire for this study.	YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____________________________ Date___________________________

Appendix 8: Summary of individual pre-questionnaire results

Learner code	**Total questions answered**	**Resilience**	**% Resilience**	**Uncertain**		**No Resilience**	
1	31	13	42%	10	32%	8	26%
3	30	9	29%	10	32%	11	35%
4	30	17	55%	3	10%	10	32%
5	10	5	16%	2	6%	3	10%
8	12	3	10%	8	26%	1	3%
10	25	11	35%	7	23%	7	23%
11	24	7	23%	9	29%	8	26%
12	29	9	29%	13	42%	7	23%
14	28	17	55%	0	0%	10	32%
15	31	19	61%	0	0%	12	39%
16	22	7	23%	9	0%	6	19%
17	30	19	61%	0	0%	11	35%
20	29	0	0%	0	0%	29	94%
21	13	7	23%	4	13%	2	6%
23	30	15	48%	9	29%	6	19%
26	31	9	29%	15	48%	7	23%
28	21	4	13%	10	48%	7	23%
31	31	15	48%	6	19%	10	32%
32	22	3	10%	13	32%	7	23%
33	27	15	48%	3	10%	9	29%
41	26	14	45%	1	3%	11	35%
43	26	14	45%	1	3%	11	35%

Appendix 9: Pre-test results

Learner	**Total /20**
	Pre-test
1	18(90%)
3	12(60%)
4	16(80%)
5	3(15%)
8	19(95%)
10	12(60%)
11	8(40%)
12	12(60%)
14	0(0%)
15	16(80%)
16	6(30%)
17	4(20%)
18	13(65%)
19	3(15%)
20	13(65%)
21	3(15%)
23	10(50%)
26	11(55%)
28	9(45%)
31	15(75%)
32	18(90%)
33	11(55%)
34	0(0%)
41	13(65%)
43	11(55%)

Appendix 10: Summary of individual post-questionnaire results

Learner code	**Total questions answered**	**Resilience**		**Uncertain**		**No Resilience**	
1	31	12	39%	11	35%	8	26%
3	30	8	26%	10	32%	12	39%
4	30	22	71%	1	3%	7	23%
5	10	2	6%	5	16%	3	10%
8	12	8	26%	0	0	4	13%
10	25	10	32%	11	35%	4	13%
11	24	8	26%	11	35%	5	16%
12	29	15	48%	9	29%	5	16%
14	28	17	55%	0	0	10	32%
15	31	20	65%	0	0	11	35%
16	22	5	16%	11	35%	6	19%
17	30	19	61%	0	0	11	35%
20	29	7	23%	19	61%	3	10%
21	13	4	13%	7	23%	2	6%
23	30	19	61%	0	0	11	35%
26	31	20	65%	0	0	11	35%
28	21	6	19%	10	32%	5	16%
31	31	16	52%	11	35%	4	13%
32	22	13	42%	0	0	9	29%
33	27	11	35%	8	26%	8	26%
41	26	15	48%	0	0	11	35%
43	26	14	45%	5	16%	7	23%

Appendix 11: Pre-test results

Learner codes	Total /20	Percentage
1	18	90%
3	12	60%
4	16	80%
5	3	15%
8	19	95%
10	12	60%
11	8	40%
12	12	60%
14	0	0%
15	16	80%
16	6	30%
17	4	20%
20	13	65%
21	3	15%
23	10	50%
26	11	55%
28	9	45%
31	15	75%
32	18	90%
33	11	55%
41	13	65%
43	11	55%

Appendix 12: Post-test results

Learner	Total/20	Percentage
1	16	80%
3	18	90%
4	17	85%
5	10	50%
8	18	90%
10	14	70%
11	9	45%
12	15	75%
14	1	5%
15	20	100%
16	13	65%
17	2	10%
20	16	80%
21	4	20%
23	16	80%
26	7	35%
28	11	55%
31	17	85%
32	13	65%
33	13	65%
41	18	90%
43	11	55%

Appendix 13: Pre and post-questionnaire (Resilience) results per individual

Learner Code	**Total questions answered**	**Resilience**		**No resilience**	
		Pre-Qst	Post-Qst	Pre-Qst	Post-Qst
1	31	42%	39%	26%	26%
3	30	30%	27%	37%	40%
4	30	57%	73%	33%	23%
5	10	50%	20%	30%	30%
8	12	25%	67%	8%	33%
10	25	44%	40%	28%	16%
11	24	29%	33%	33%	21%
12	29	31%	52%	24%	17%
14	28	61%	61%	36%	36%
15	31	61%	65%	39%	35%
16	22	32%	23%	27%	27%
17	30	63%	63%	37%	37%
20	29	0	24%	100%	66%
21	13	54%	31%	15%	15%
23	30	50%	63%	20%	37%
26	31	29%	65%	23%	35%
28	21	19%	29%	33%	24%
31	31	48%	52%	32%	13%
32	22	14%	59%	27%	42%
33	27	56%	41%	33%	30%
41	26	54%	58%	42%	42%
43	26	54%	54%	42%	27%

Appendix 14: Pre and post-test results

KEY

Improved:

Stayed the same:

Worsened

Learner	Total /20	Total/20	Increase/Decrease %
	Pre-test	Post-test	
1	18(90%)	16(80%)	-10%
3	12(60%)	18(90%)	+30%
4	16(80%)	17(85%)	+5%
5	3(15%)	10(50%)	+35%
8	19(95%)	18(90%)	-5%
10	12(60%)	14(70%)	+10%
11	8(40%)	9(45%)	+5%
12	12(60%)	15(75%)	+15%
14	0(0%)	1(5%)	+5%
15	16(80%)	20(100%)	+20%
16	6(30%)	13(65%)	+35%
17	4(20%)	2(10%)	-10%
20	13(65%)	16(80%)	+15%
21	3(15%)	4(20%)	+5%
23	10(50%)	16(80%)	+30%
26	11(55%)	7(35%)	-20%
28	9(45%)	11(55%)	+10%
31	15(75%)	17(85%)	+10%
32	18(90%)	13(65%)	-25%
33	11(55%)	13(65%)	+10%
41	13(65%)	18(90%)	+25
43	11(55%)	11(55%)	0%

Appendix 15: GDE Clearance

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**20 July 2018**
Validity of Research Approval:	**05 February 2018 – 28 September 2018** **2018/191**
Name of Researcher:	**Mubviri P.L**
Address of Researcher:	**78 Orion Street**
	Kensington
	Johannesburg, 2094
Telephone Number:	**061 234 2948 076 737 2948**
Email address:	**735947@students.wits.ac.za**
Research Topic:	**Exploring grade 2 mathematics classrooms as site of inclusive practice.**
Type of qualification	**Masters**
Number and type of schools:	**One Primary School**
District/s/HO	**Johannesburg North.**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this*

on 24/07/2018

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

....

Mr Gumani Mukatuni
Acting CES: Education Research and Knowledge Management

DATE: 24|07|2018

2

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix 16: University of Witwatersrand Ethics clearance letter

Wits School of Education

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3221 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

23 July 2018

Student Number: 735947

Protocol Number: 2018ECE019M

Dear Pamela Lilian Mubviri

Application for Ethics Clearance: Master of Education

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

Exploring grade 2 mathematics classrooms as sights of inclusive practice

The committee recently met and I am pleased to inform you that **clearance was granted**. Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

MMabety

Wits School of Education
011 717-3416

cc Supervisor – Mr Corin Mathews