Investigating grade 3 learners' changing mathematical proficiency in a maths club programme focused on number sense progression

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By

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Dedication

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- **Stott**, D., **Graven**, M., **Baart**, N., **Hebe**, G., & **Mofu**, Z. **(2017).** After school maths clubs: Investigating learner progression in an expanding intervention model. In *Proceedings of the 23rd Annual National Congress of the Association for Mathematics Education of South Africa* (pp. 313–324). Port Elizabeth: AMESA.
- **Hebe, G.E. (2016).** Investigating Grade 3 teachers' reflections of using maths clubs with a focus on progression on early arithmetic strategies, In Goba, B. & Naidoo, J. (Eds.), *Proceedings of the 22nd Annual National Congress of the Association for Mathematics Education of South Africa* (Vol. 2, p.4). Mbombela: Tshwane University of the Technology

- **Hebe, G.E. (2015).** Investigating teachers' reflections on teaching through lesson study. In S. Maoto, B. Chigonga, & K. Masha (Eds.), *Proceedings of the 21st Annual National Congress of the Association for Mathematics Education of South Africa* (Vol. 1, pp. 226–235). Polokwane: University of Limpopo.

Abstract

Recent international reports, for example TIMSS (2011 & 2015), point to serious challenges in South African learner performance in Mathematics and Science. Of greatest concern is that research findings (e.g. Graven, Venkat, Westaway and Tshesane 2013) suggest that many South African learners show signs of mathematical knowledge gaps in the lower grades. Hence, there is a need to address challenges of this nature very early in Foundation Phase. This study was undertaken with a view to contribute towards addressing mathematical challenges encountered by learners in Foundation Phase

This empirical enquiry was undertaken under the auspices of the South African Numeracy Chair Project (SANCP) at Rhodes University whose mission is to develop sustainable ways of improving quality teaching and learning of Mathematics in South Africa. A relatively new SANCP programme called Pushing for Progression (PfP) run as part of the after–school Maths Clubs to develop the number sense and four Operations in learners was used to achieve the research aims of this study. Research participants were drawn from the Maths Clubs established by the researcher in a small rural town of Ottosdal in the North West Province of South Africa.

This Study is grounded on the Vygotskian perspective and uses the interpretivist qualitative research method for data collection and analysis. Sampling was done opportunistically by enlisting participants (12 teachers and 117 learners) on the basis of their availability and willingness to participate. Pre– and post–assessment of learners' proficiency on the four Basic Operations was conducted at the beginning and at the end of the research project, respectively. This was done to determine the impact of the project on learner performance. Data analysis was done thematically and through the comparison of learner results of the pre– and post–assessment.

The findings point to the effectiveness of the PfP Programme in learner performance. This can be deduced from improved scores between pre– and post–assessment and the observations made by participant-teachers on their respective club learners' mathematical proficiencies. Accordingly, based on the findings, this study recommends, *inter alia*, that since the PfP programme is still in its early stages, similar research be conducted elsewhere. Additionally, the Department of Basic Education could consider exploring the PfP programme as one of several other strategies to help improve learner proficiency in Mathematics.

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LIST OF ACRONYMS

AMESA	Association for Mathematics Education of South Africa
ANA	Annual National Assessment
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
DHET	Department of Higher Education and Training
EGMA	Early Grades Mathematics Assessment
FFL	Foundations for Learning
NSE	National Systemic Evaluation
NSW	Not Showing Workings
NT	Non Tallies
NWDE	North West Department of Education
PfP	Pushing for Progression
SACMEQ	Southern and Eastern African Consortium for Monitoring Educational Quality
SANC	South African Numeracy Chair
SANCP	South African Numeracy Chair Project
TIMSS	Trends in International mathematics and Science Study

CHAPTER ONE: ORIENTATION TO THE STUDY

1.1. INTRODUCTION

In this chapter I orientate the reader to the study. I do this by discussing the following: a brief background and motivation for the study, the context of the study, and the rationale of the study, the research gap towards which the study seeks to contribute, the research questions guiding this study, an overview of methodology. Finally, I present an overview of the chapters of this study report.

The main purpose of this inquiry was to investigate the impact of the Pushing for Progression (PfP) Programme on the Mathematical Proficiency of Grade 3 learners who participated in this programme over a period of 15 weeks in a Maths Club context. As I point out in this chapter, the PfP is a relatively new intervention programme which forms part of the South African Numeracy Chair Project (SANCP) at Rhodes University. This project, also discussed in greater detail later in this report, came into being in response to perceptions by local and international researchers that South Africa is faced by educational challenges, particularly, in language, Mathematics and Science (Stott, 2014; Morrison, 2013). Additionally, as the findings of this study suggest (refer to Chapter 4), this study also responds to concerns similar to the one by Hoadley (2012) who writes that "one of the problems in classroom-based research has been the inability to show the impact of teaching and learning on learner achievement…much of classroom research tends towards descriptions of teaching styles" (p.198).

Rather than being merely a description of teaching styles, this study highlights how an innovative approach to learning and teaching and a stimulating environment holds the potential to enhance learner involvement and improve attainment in Mathematics. Now, I provide a background and motivation for this study.

1.2. BACKGROUND AND MOTIVATION FOR THE STUDY

Primary school Mathematics Education in South Africa is widely acknowledged to be 'in crisis' (Fleisch, 2008), particularly in township and rural schools where learner performance is far below curriculum expectations. Reports (Schollar, 2008; Spaull, 2013) reveal that South African learners achieve below required standards of the curriculum of Mathematics internationally and locally. The Trends of Mathematics and Science Study (2003, 2007, & 2011) reports highlight that South Africa was in the second position from the bottom in the

Mathematics assessment. Similarly, the SACMEQ reports (Spaull, 2013) reveal that learners in South Africa did not achieve well in Mathematics. Additionally, SACMEQ III (2007) tested rural Mathematics teachers in South Africa and the analysis of this test revealed that rural South African Mathematics teachers have a low level of content knowledge in Mathematics (Spaull, 2013). Therefore, it can be argued that if the rural Mathematics teachers' content knowledge is not improved, rural learners' Mathematics achievement cannot be elevated. Consequently, in order to improve both the quality of teaching and learning the Department of Basic Education and Department of Higher Education and Training (2011) have put in place a framework aimed at the provisioning of quality teacher education and development opportunities which will enable the teachers to access mentoring, support and training relevant to their (teachers) needs. In addition, institutions of higher learning such as Rhodes University, through specific and focused programme such as the Pushing for Progression (PfP), a programme that forms an inherent part of this study, are also making an effort to research sustainable ways to improve the quality of in-service Mathematics teachers at primary level and towards improving learner performance as a result of quality teaching and learning (Graven, 2011).

It is also worth noting that, international and local researchers (Wright, 2013, Spaull & Kotze, 2015; Graven & Venkat, 2017) point out that early intervention is vital in addressing poor learner performance in mathematics as it could help prevent underachievement in Mathematics. Furthermore, school-entry Mathematics is the predictor of later year's achievement through the learners' schooling. The learner must achieve in Mathematics so as to achieve in other aspects of the curriculum (Wright, 2013). Hence, the gap between learner performance increases through their years of schooling if underachievement in Mathematics is not addressed (Wright, Martland & Stafford, 2006; Graven, Venkat, Westaway & Tshesane, 2013). It can thus be argued that intervention strategies that seek to address challenges hindering learner achievement in Foundation Phase Mathematics need to be developed. Therefore, a study such as this one whose purpose is to explore intervention strategies that might help improve learner performance in Mathematics from Foundation Phase level is useful.

Accordingly, this study was undertaken with the view to contributing towards identifying ways in which Mathematics learning could be improved at Foundation Phase. To this end, this case study sought to explore Grade 3 learners' changing mathematical proficiency through participation in the Pushing for Progression (PfP) Programme (SANC, 2016) after–school Maths Clubs which I expand upon later. The explanation of the context of the study follows.

1.3. CONTEXT OF THE STUDY

In this section I discuss two aspects, namely; the broader challenges concerning Mathematics in South Africa as well as the role of my research within the South African Numeracy Chair Project (SANCP) in respect of addressing primary Mathematics challenges in South African schools.

The South African education system is faced with a serious challenge in which learners struggle with the basic concepts of Mathematics. In the 2003 Trends in Mathematics and Science Study (TIMSS) international study of science and mathematics teaching in various countries around the world, South African learners did not perform well, being placed at the bottom. In addition, South African learners cannot compute at their grade–appropriate level (Spaull, 2013). Graven (2015) argued that there are two systems of education in South Africa, that is, the functional system for wealthier and dysfunctional system for the poorest. The latter system is serving the majority of disadvantaged learners who live in poverty. This dysfunctional system paints a picture which suggests that the disadvantaged learners receive inferior quality of education compared to the advantaged learners (Spaull & Kotze 2015). Hence, there is a need to investigate possible solutions to the challenges encountered in Mathematics especially in our previously disadvantaged, poor performing schools. Reddy (2006) emphasises that there is no one factor that leads to poor performance and that a multitude of factors; including teacher development and the language of learning and teaching, converge and thus contribute to poor performance in Mathematics. Currently the system is concerned with monitoring (i.e. whether what is taught is in accordance with grade specific assessment, but not concerned with what is happening in the classrooms and the unequal context in which the curriculum is implemented (Spaull & Kotze, 2015; Graven, 2016). Hence, some researchers (Wright et al, 2006; Schollar, 2008) suggest that part of the solution to poor learner performance in Mathematics should include initiatives that focus on developing the foundational Mathematics concepts taught in primary schools. This focus on the development of foundational concepts in Mathematics might enable successful Mathematics attainment in primary schools.

The top priority of the South African Department of Basic Education is to improve the quality of teaching and learning in primary schools (DBE, 2014). Hence, the DBE implemented the Annual National Assessment (ANA) as a strategic tool of monitoring progress in learner achievement (DBE 2012; DBE 2013; DBE 2014). These annual assessments targeted language and mathematics because these subjects are regarded as key to the development of foundational skills for further learning. The Grade 3 national ANA results from 2011 to 2014 suggest that learners performed at 28% in 2011, at 41% in 2012, at 53% in 2013 and 56% in 2014 (DBE, 2011, 2012, 2013 & 2014). For the purposes of this discussion I present the Grade 3 ANA (2012 – 2014) Mathematics average percentage marks for each of the North West Department of Education districts in table 1, below.

Table 1: The NWDE Grade 3 ANA Mathematics Results for the period 2012 -2014 (Source: Department of Basic Education, 2013 & 2014)

DISTRICT	2012	2013	2014
BOJANALA	36.5%	50.7%	50%
DR. KENNETH KAUNDA	38.5%	50%	52.2%
DR. RUTH SEGOMOTSI MOMPATI	30.4%	45.3%	43.9%
NGAKA MODIRI MOLEMA	31.1%	49.4%	50%

According to table 1, above, in the 2012 and 2014, respectively, Grade 3 Annual National Assessments of the Dr. Kenneth Kaunda District performed better than the other three districts that form part of the NWDE, namely; Bojanala, Dr. Ruth Segomotsi Mompati and Ngaka Modiri Molema. The Dr. Kenneth Kaunda District performed at 50% in 2013 and at 52.2% in 2014, respectively. Although both these respective levels of attainment were deemed acceptable according to the standards (benchmark) laid down by the DBE, they fell below the 60% target envisaged in the Action Plan 2014 (DBE, 2014) for Grade 3 Mathematics.

Carnoy, Chisholm and Chilisa (2012) observed Mathematics learning in Grade 6 classrooms in the North West province of South Africa and Botswana. They discovered that learners in Botswana and the North West province achieved below the considered pass mark of 50% for Grade 5. This means that the Grade 5 learners of both Botswana and the North West province were placed in Grade 6 without meeting the pass requirements stipulated for Grade 5 Mathematics. Carnoy *et al.'s* (2012) statement concurs with Schollar (2008); Spaull and Kotze (2015) and Graven (2016) that the majority of South African learners achieve below the minimum level expected of their grade. Hence, this study whose focus is on investigating strategies that could improve the Grade 3 learners' one-to-one counting strategies through participation in after-school Maths Clubs. This was done with the view to contribute towards addressing the challenges of Mathematics teaching and learning in the North West Province of South Africa.

The South African Numeracy Chair Project (SANCP) at Rhodes University is one of two National Numeracy Chairs in the country whose imperative is to research sustainable ways to

improve the quality of teaching of in-service Mathematics teachers at primary level and improve learner performance as a result of quality teaching and learning (Graven, 2011). There is a growing research community of both full time and part time doctoral and masters' students within this project. As a part time SANCP Masters' student my research coheres with these broader SANCP aims.

1.4. RATIONALE OF THE STUDY

International and local studies point out that South African learners achieve below acceptable levels in Mathematics (DBE, 2012). The ANA results for the past three years indicate that the majority of South African learners lack the basic Numeracy skills. In addition, these learners lag behind in respect of meeting the basic requirements for their grade level (Schollar, 2008; Graven & Stott, 2012, Stott & Graven, 2013; Ndongeni, 2013). For a number of years now, the South African learners have been taking part in local and international assessments in Mathematics. However, the results have not been pleasing.

The third study of the Southern and East African Consortium for Monitoring Educational Quality (SACMEQ III) assessment which was conducted for African countries in 2007 highlighted that South African learners performed below countries which are poorer, namely; Kenya, Swaziland and Tanzania (Spaull & Kotze, 2015). The Trends in Mathematics and Sciences study from 1999 – 2011 pointed out that learners in South Africa did not do well in Mathematics and Science (Reddy, 2013). The National Systemic Evaluation assessment was conducted in 2005 for Grade 3 and Grade 6 in mathematics. The NSE results indicate that the South African learners of these two grades achieved below the required and acceptable level of Mathematics (DBE, 2005). The Annual National Assessment was conducted in order to provide teachers and the system with explicit information. ANA targeted Language and Mathematics because they are universally regarded as foundational skills for furthering studies (DBE, 2014). The Annual National Assessment which was conducted from 2011 to 2014 indicated that South African learners perform below their grade's required curriculum level in Mathematics. All these assessments which were conducted paint a picture that South

African learners lag behind in basic Mathematics skills and are achieving below their counterparts both in Africa and other countries. The challenge of poor performance was also detected in other countries. For example, Pritchett and Beatty (2012, cited in Spaull & Kotze, 2015) discovered that learners in developing countries have learning deficits.

Spaull (2013) argues that, “the learning deficits that children acquire in the primary school career grow over time to the extent that they become insurmountable and preclude pupils from following the curriculum at higher grades, especially in subjects that are vertically demarcated like Mathematics and science” (p.8). Likewise, Wright *et al.* (2006) agree with Spaull (2013) that the poor performance of South African learners, particularly in Mathematics, denies them the opportunities of furthering their studies in these subjects. Wright *et al.* (2006) regard Mathematics as a predictor of learner achievement in his/her years of schooling. This implies that Mathematics enables learners to further their studies in high schools and beyond. It also predicts whether the learner will be able to achieve or not achieve good results through his/her years of schooling. Therefore, on the basis of the preceding arguments, there is a need to improve primary learners’ basic skills of Mathematics.

Research analysis points out that many learners are two grades behind the expected levels of Mathematics competence. Graven (2016) is in accord with Spaull and Kotze (2015) that by the time these learners reach Grade 9, these backlogs should have intensified. For the purposes of this discussion, I present the national ANA achievement of Grade 9 for the period 2012 to 2014. The National ANA Grade 9 achievement of 2012 was 13%, in 2013 Grade 9 achieved 14% and, this dropped to 11% in 2014. These Grade 9 ANA results give a picture that Grade 9 learners arrive in this grade still lacking the basic mathematical skills which were supposed to have been grounded well in lower grades (i.e. Grades 1-8).

Researchers discovered that South African learners are bound to one-to-one strategies of counting in lower grades (i.e. Grade 1-6) (Schollar, 2008; Hoadley, 2012; Graven, 2016). This is due to the fact that these learners are just exposed to concrete methods of counting but not exposed to abstract methods of counting. The current curriculum fails to accommodate the backlogs in learner knowledge (Graven, 2016). The system is concerned with monitoring whether what is taught is in accordance with grade specific assessment standards (Spaull & Kotze, 2015). This monitoring includes, among other things, the monitoring of curriculum coverage per term and, monitoring whether workbooks are being utilised four days per week.

While, the DBE is undoubtedly committed to the already-mentioned process of monitoring, it fails to provide teachers with useful information that would enable them to address the challenge of poor performance in Mathematics (Ndongeni, 2013). Hence, I contend that the issue of pinpointing why SA learners' results are poor without any useful information given to teachers to enable them face the challenge of under-performance is counter-productive.

Graven, Venkat, Westaway and Tshesane (2013) point to serious gaps in learner knowledge of multi–digit addition while Carnoy *et al.* (2008) point to challenges in Mathematics teacher content knowledge and pedagogic content knowledge with foundation phase addition and subtraction of multi–digit numbers within the South African context.

Research also points to the problem of the prevalence of rote/ritualised methods as opposed to developing conceptual number sense for teaching addition and subtraction of multi–digit numbers (Fosnot & Dolk, 2001; Graven et al., 2013). This research points to a range of strategies that can be used to support learners in developing number sense and proficiency in multi–digit computations. While Fosnot and Dolk (2001) agree that "algorithms – a structured series of procedures that can be used across problems, regardless of the numbers – do have an important place in Mathematics" (p. 124), they emphasise that this should only come after students have a "deep understanding of number relationships and operations and have developed a repertoire of computation strategies" (p. 124).

The problem with algorithmic methods without understanding is clear for me from my own experience of learners in my area as both a teacher and as a district subject specialist. The numerous school visits that I conducted in my professional capacity as subject advisor revealed that learners use inefficient count–by–one strategies and error–prone rote procedures in Grade 3. For example, I have observed that some learners subtract the smaller number from the bigger number on the column of the ones as shown below:

$$\begin{array}{r} 92 \\ \underline{-\ 76} \\ 24 \end{array}$$

Graven et al. (2013) provide similar experiences of learners working in Eastern Cape and Gauteng primary schools. In addition, two–digit subtraction problems that require 'borrowing' pose a serious challenge to learners. The above example reveals an absence of sense making and conceptual understanding (Kilpatrick, Swafford, & Findell, 2001) while learners follow adapted procedures. That is, in the subtraction above the learner has subtracted the units and the tens as suggested by the algorithm but has applied earlier learning of 'always subtract the smaller from the bigger'.

Thus, in the above case, the learner demonstrates a lack of two key strands of mathematical proficiency; procedural fluency and conceptual understanding (Kilpatrick et al, 2001). These errors show that learners focus on trying to recall the steps of the algorithm rather than making sense of numbers (Kamii & Dominick, 1997). According to what is stated above, it might be wise if we "do not teach algorithms" (Kamii & Dominick, 1997) to Foundation Phase learners if we want learners to grasp and develop number sense.

The preceding argument coheres with the South African Curriculum and Assessment Policy (CAPS) for Numeracy in the Foundation Phase for Grade 3 which states that learners should "understand subtraction and use subtraction vocabulary by the end of the year" (DBE, 2011, p.322). The CAPS for Foundation Phase does not promote or suggest the use of algorithms. Similarly, the Department of Education provides schools with Grade 3 numeracy workbooks which do not include the vertical algorithm method and instead suggest using a variety of methods such as modelling a number line-based method of counting-on, using techniques like doubling and halving of numbers; rounding off number, breaking down and building up numbers (DBE, 2011; Graven, *et al.*, 2013).

Wright et al. (2006) and Schollar (2008) support the notion of focusing on developing the basic mathematical skills in primary schools. This implies that when Mathematics concept is taught with understanding in one phase, this would enable that concept to be performed at a higher level in other phases (Van der Heuvel-Panhuizen, 2008). This might lead to successful Mathematics attainment in lower grades. Additionally, it is my considered view that Graven's (2016) assertion that it is vital that discussions aimed at selecting relevant projects which could improve learner performance in Mathematics in South African primary schools should be held with the Department of Basic Education and the Provincial Departments of Education officials.

1.5. THE GAP IN RESEARCH ON REMEDIATING GAPS IN LEARNER KNOWLEDGE

There is very little research that has been conducted regarding Mathematics intervention in lower grades (Stott, 2015; Graven, 2013; Feza, 2012). Nonetheless, for the purposes of this discussion it is necessary to point out that research has found that several factors contribute to mathematical gaps in lower grades. These include: lack of parental involvement, Mathematics teachers with low expectation towards their learners' mathematical abilities, learners who start their schooling late, children who miss out on kindergarten education and therefore, often find themselves behind others in reading (Evan 2012 cited in Perreaud, 2015). Furthermore, Evans (2012 cited in Perreaud, 2015) argues that very often learning gaps contribute to achievement gaps and that to offset the widening of these gaps schools should not be left to their own devices when it comes to fixing these challenges. Hence, the national Department of Basic Education has a role to play in providing support to schools with the view to close the learning gaps. Over the years, several intervention programmes were undertaken by the Department of Education to help close these gaps. However, as I point out in section 2.3.2, these interventions have yielded very little success, if any, in terms of addressing the knowledge gaps in Mathematics. This assertion is founded on my work-based personal experience.

On the basis of my personal, work-based, experience I can attest to the existence not only of knowledge gaps in learners but also to some of the reasons behind these gaps, especially in the learning and teaching of Mathematics in Foundation Phase. In my work as Subject Advisor responsible for Foundation Phase Mathematics, I have noted that learners struggle with the use of inefficient arithmetic strategies and error–prone procedures. Therefore, as part of this study I initiated running after school Maths Clubs (Graven, 2011) in the area of Maquassi Hills in the North West Province of South Africa with twelve Foundation Phase Grade 3 teachers. The initiation of the Maths Clubs was motivated by my first interaction with members of the SANCP, hence the clubs were structured in line with the design suggestions of Graven and Stott (2012) and Stott and Graven (2013).

The PfP Programme of this study could provide the opportunity of developing learners' efficient strategies on computing (Graven & Stott, 2013) in Grade 3. This development might assist in some way to address the mathematical learning deficits that are commonly detected in Foundations Phase learners (Schollar, 2008; Spaull, 2013; Reddy, 2015).

1.6. RESEARCH QUESTIONS

The following main research and sub–questions guided this study. The central question for this study is:

What is the nature of the learners' changing mathematical proficiency as they participate in after–school maths clubs? How do these evolve (if at all) over the period of club participation?

The sub–questions are:

1. *What changes are evident in learners' mathematical proficiency over the period of club participation?*
2. *What are teachers' experiences of learners' changing mathematical proficiency as aresult of participating in the club?*

1.7. AN OVERVIEW OF RESEARCH METHODOLOGY

This study is underpinned by an interpretive qualitative research paradigm and uses a multiple case study approach. The multiple cases were the 12 clubs and 12 teachers who participated in the PfP Programme who ran after–school Maths Clubs together with 144 learners. Data collection methods included semi-structured interviews with teachers and the pre– and post– learner assessments. In chapter three I provide more details on the research methodology used in this study.

1.8. THESIS OUTLINE

This report consists of six chapters. Chapter one is introductory and thus serves to orientate the reader to the study, chapter two focuses on the literature review and the theoretical framework of the study, chapter three details methodology while the results/findings are presented in chapter four and discussed in chapter five. Chapter six concludes the report by, among other things, presenting the summary of the study, highlighting the limitations of the study as well as by reflecting on my personal growth and outlining some avenues for future research.

1.9. CONCLUSION

In this chapter I discussed the following topics: introduction, context of the study, rationale of this study, the gap in this study and the research methodology used in this study. I also included the research question of my study. I ended the chapter with the outline of each chapter entailed in this study. In the next chapter I present the theoretical framework of this study as well as the review of literature.

CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL FRAMING

2.1. INTRODUCTON

The purpose of this chapter is to present a review of literature that was deemed relevant in terms of enabling the researcher to achieve the aims of this study as outlined in chapter one. For that reason, in this chapter the review of literature focuses on the following aspects; Mathematics in South Africa (Pushing for Progression Programme), key ideas of the Pushing for Progression Programme such as mathematical proficiency; number sense, learner progression in clubs and the role of after–school Maths Club in my study. I commence by detailing the theoretical framework of this study.

2.2. THEORETICAL FRAMEWORK

In this section I discuss the theoretical assumptions underpinning this study and the theoretical orientation of mathematical intervention (i.e. the South African Numeracy Chair Project's Pushing for Progression programme).

2.2.1. Theoretical assumptions informing this research

This study is underpinned by Vygotsky's (1978) social–constructivist perspective. I have drawn on a Vygotskian social–constructivist perspective of teaching and learning to frame my study. Traditionally, learning has been viewed as an activity which focuses on an individual's acquisition of knowledge, skills and attitudes. According to Illeris (2011) research suggests that learning is "fundamentally to be viewed as a social process that takes place in the interaction between people" (p.11). I concur with this assertion. This is in view of the fact that in every learning and teaching situation there are interactions between teachers and learners as well as among the learners themselves. For example, in the after–school Maths Club sessions, learners do Maths Club activities in groups where collaborative learning may take place. Likewise, the Maths Club teachers provide mediation and scaffolding, where necessary, to assist learning and concept internalization process. All these activities involve an interaction between people where learning may take place.

In Vygotsky's terms "interaction is viewed as the primary raw material for the cognitive constructions that people build to make sense of the world" (Boyle, 2000 cited in Ndlovu, 2013, p.6). This argument is relevant in the context of this study. For example, during their interaction with both their peers and their teachers within the after–school club setting, it is possible for learners to construct their knowledge at social level. This is what Vygotsky refers to as inter–personal learning (Ehrich, 2006; Burkholder & Peláez, 2000). Interpersonal learning, therefore, may take various forms in maths clubs. For example, it takes the form of collaborative learning where learners work in pairs or groups (Bornman & Rose, 2010). It may also take the form of scaffolding. In describing scaffolding, Denhere, Chinyoka & Mambeu (2013, p. 373) state that, "educators and researchers have used the concept of scaffolding as a metaphor to describe and explain the role of adults or more knowledgeable peers in guiding children's learning and development". Because it helps in facilitating the process of learning, scaffolding is also referred to as mediated learning (Donald, Lazarus & Lolwana, 2010). Therefore, in scaffolding, a peer or an adult (for example, a Mathematics teacher in the Maths Club), uses language and various other tools available within the socio–cultural setting in which learning takes place to assist or guide the less–knowledgeable learner.

The preceding points about interpersonal learning, collaborative learning and scaffolding underscore the importance of the role played by those who form the social context of the learner in the learning process. This is in line with the observations made by Vygotsky that the social context is uppermost in learning and cognitive development of the child (Wertsch& Tulviste, 1992). Hence, Vygotsky argued that "any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane" (Vygotsky, 1981, p.163 in Wertsch & Tulviste, 1992, p.549). In recognition of and in concurrence with the view that both the significant others – in the context of this study, both the teachers and peers – and the learner play an important role in the development of the learner; the Maths Club activities were designed to cater for both the group and individual learner needs.

Vygotsky's perspective on the role played by the social context in the cognitive development of the child coheres sharply with Sfard's (1998) participation metaphors. This coherence is discernible from Sfard's (1998) discussion of the participation metaphor. For example, Sfard (1998) writes, in relation to learning as conceived in terms of the participation metaphors, that "learning a subject is now conceived of as a process of becoming a member of a certain community. This entails, above all, the ability to communicate in the language of this community and act according to its particular norms. The norms themselves are to be negotiated in the process of consolidating the community" (p.6). The preceding argument by Sfard (1998) seems to be in concurrence with the following view by Vygotsky on how interaction and participation in a cultural setting helps in the evolution of mental functioning; "culture creates special forms of behaviour, changes the functioning of mind, constructs new stories in the developing system of human behaviour" (Vygotsky, 1983, p.29-30 in Wertsch & Tulviste, 1992, p.552). Therefore, it could be argued that the ability to communicate in the language of the community referred to by Sfard (1998), above, could be a manifestation of the evolution in the functioning of a person's mind alluded to by Vygotsky. In the context of this study, the participation of learners in Maths Club activities provided them with a variety of opportunities to develop the ability to communicate in Mathematics language. This was done with the view to help facilitate their cognitive abilities in Mathematics.

The views by Sfard (1998) as highlighted in her discussion of the two metaphors, i.e. the acquisition metaphor and the participation metaphor, are important in this study. The following discussion on the dual nature of the design of the maths clubs illustrates this point

2.2.1.1. The dual nature of maths clubs: Acquisition and Participation

The dual nature of the Maths Clubs is aptly described by Stott (2014). Accordingly, Stott (2014) writes that the conception of Maths Clubs by the SANC project "was for the Maths Clubs to promote individual learner mathematical proficiency as well as active participation" (p.55). According to her "this aim brings together acquisition and participation (having and doing)" (ibid.). Graven and Stott (2012 cited in Kaulinge 2013) point out that this dual approach is by no means particular to the maths clubs as conceived and run according to the standards and procedures laid down by the SANC project. Hence, they argue that various studies underscore the fact that the acquisition metaphor and the participation metaphor work best in a blended form. The blended nature of these two metaphors is clearly summed up in Stott's (2014) interpretation of Sfard's (1998) mapping of these two metaphors in the following diagram:

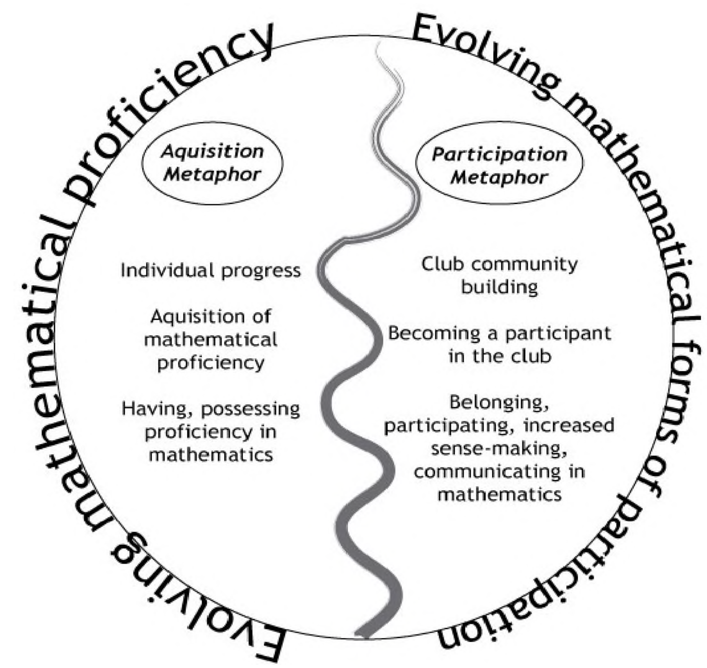

Figure 1: Club design metaphorical mappings (adapted from Sfard, 1998: p.7 by Stott, 2014)

According to figure 1, above, in the context of Maths Clubs evolution in the learner's mathematical proficiency is a product of both the acquisition metaphor and the participation metaphor. The two metaphors are interdependent hence the line between the two is fine and blurred. Therefore, in terms of the participation metaphor, for the mathematical proficiency to develop, the learner has to participate actively in Maths Club activities. It is through meaningful engagement with peers and the teacher who form part of the maths club community that the sense of belonging develops in the learner. It is this sense of belonging that enables the learner to feel at ease and become more active in the Maths Club activities. This results in increased learner participation and increased mathematical proficiency because of the sharing of ideas among the learners.

However, the learner's development as a member of the maths community in the club context does not occur in isolation. It is assisted by the on-going reflection that the learner the learner engages in with the inner-self. Hence, the participation metaphor discussed in the above paragraph is complemented by the 'individualised' acquisition metaphor. This suggests both during and after active participation in Maths Club activities each learner engages, consistently, in self-reflection in order to assign meaning to the learning that takes place as a result of participation in club activities. It is because of this interplay between the two metaphors that mathematical proficiency occurs in Maths Club learners.

Therefore, based on the preceding points, an assertion by Sfard (1998) is appropriate at this point. Sfard (1998, p.11) argues that "an adequate combination of the acquisition and participation metaphors would bring to the fore the advantages of each of them while keeping their respective drawbacks at bay. Conversely, giving full exclusivity to one conceptual framework would be hazardous". Askew cited in Stott & Graven (2013) concurs with the notion of working with both metaphors (acquisition and participation metaphors), he argues that since these metaphors posit that acquisition and participation occur within a social context characterised by on-going and meaningful interaction among various actors, mathematical proficiency development is likely to occur if learners are given ample opportunities to interact with others. For that reason, in this study learners were given the opportunity to acquire mathematical knowledge individually as well as through participation and working in collaboration with group members of clubs. In this way learners would be developing their mathematical proficiency by making sense of their Mathematics, engaging with club activities (Graven, 2011; Graven & Stott, 2012; Stott & Graven, 2013; Ndongeni, 2013). In the next section, I provide an overview of the PfP Programme.

2.2.2. Overview of the Pushing for Progression Programme

The Pushing for Progression Programme was designed by the SANC Project (Stott & Graven, 2016) as one way of improving the quality of South African learners' achievement in primary school Mathematics in response to various challenges identified by numerous researchers as previously discussed. The Pushing for Progression Programme (SANC, 2016) was used as an intervention for this study. At this point, it is essential, in the interest of this study, to elaborate on the PfP.

The PfP Programme is a programme which focuses, largely, on developing learners' efficient strategies on computing skills of four basic operations through participation in after–school Maths Clubs (SANC, 2016). Thus far the PfP Programme has been implemented in the Eastern Cape (Graven, 2012; Stott, 2014). The aim of PfP Programme is to support teachers in running after–school Maths Clubs. From a research point of view, it focuses on learner progression (Graven, Stott, Mofu, Baart & Hebe, 2017). It is designed in such a way that it runs for a period of 15 weeks. The intervention strategy inherently seeks to improve the participant learners' number knowledge and attainment, specifically, in South African primary schools while also empowering the participant teachers to improve their Mathematics teaching and confidence levels.

Through the programme teachers are supported to run their own Maths Clubs for a period of 15 weeks using the structured Mathematics activities designed specifically for this programme. It is suggested (SANCP, 2016) that each teacher forms a club with maximum of 12 learners during the implementation of this programme. During this programme the focus is on developing learners' efficient strategies in developing number sense and the 4 four basic operations; addition, subtraction, multiplication and division (SANCP, 2016).

Typically, teachers are invited to participate in workshops which are facilitated by the members of the South African Numeracy Chair Project team (SANCP, 2016). The teachers are provided with orientation on what the PfP is and its purposes are also highlighted. Furthermore, they are provided with relevant resources that provide guidance on assessment and Maths Club activities. Through a series of three workshops, the teachers are given support on how to assist learners in progressing from concrete to more efficient methods (SANCP, 2016), through the use of material provided by the programme. The teachers are encouraged and guided on how they could establish and run Maths Clubs as well as assess the learners to gather feedback to inform the activities that are presented. The PfP Programme focuses on two mathematical strands, as highlighted by Kilpatrick et al. (2001), namely conceptual understanding and procedural fluency. The PfP Programme also focuses on the development of number sense, progression, participation, practise and games. I use each of these as a starting point for my review and expand on them from literature other than PfP Programme. The literature review will be discussed below.

2.3. LITERATURE REVIEW

Various researchers (Schollar, 2008; Spaull, 2013) have argued that learners in South Africa are bound into one–to–one counting strategies or use the procedures that they do not understand. Hence, there is a need to find approaches that would help address these and many other challenges in the learning and teaching of Mathematics in South Africa. In this section I discuss some of the concepts and issues that might be of relevance in terms of addressing these challenges. Accordingly, the review of literature in this study focuses on the following aspects: Mathematics in South Africa, key ideas of the Pushing for Progression Programme, mathematical proficiency, number sense, learner progression and the role of the after–school maths club in this study.

2.3.1. Mathematics Education in South Africa

As noted in the introduction, the South African education system is faced with serious challenges, especially in respect of the teaching and learning of Mathematics. This is discernible from the fact that learners tend to use inefficient counting strategies and error–prone procedures (Schollar, 2008; TIMSS, 2011). Internationally, research suggests that South African learners achieve below the required standards when compared to other countries in Mathematics. The Trends in International Mathematics and Science Study (TIMSS, 2003, 2007, 2011) reports suggest that South African learners did not achieve well in Mathematics. However, the TIMSS (2015) report reveals an improvement in the South African learners' achievement in Mathematics and Science. Additionally, the Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ III) report highlights that South African learners were positioned eighth out of fourteen African countries in Mathematics (Spaull, 2007). The SACMEQ III survey also indicates that South African learners could not do basic computations (Spaull, 2011). However, the SACMEQ IV (Bandi, 2013) report highlights an improvement of the South African learners' achievement during this assessment. These findings suggest that more still needs to be done to identify and address the challenges affecting the learning of Mathematics, especially, at South African primary school level.

Locally, the Annual National Assessment (ANA), the instrument which was developed by the Department of Basic Education (DBE, 2011) for the purposes of standardizing learning in South Africa also tells a story which, is worth some attention. The most recent ANA (DBE, 2014) report reveals that the national averages in Mathematics learner achievement decrease from grade to grade, for example, from Grade 1 to 3 (68%, 62% and 56%), respectively. Consequently, there is also a drop in Grade 4 (37%) whereas the Grade 9 average was 11% (Department of Basic Education, 2014).

There are various opinions as to the reasons why there is a steep decline in Mathematics achievement among the majority of South African learners. For example, Spaull (2013) argues that poor Mathematics results are a consequence of learners' inability to read, write and compute. Likewise, Madihlaba (2013) also underlines language as one of the reasons for poor performance in Mathematics. On the other hand, Maree, Aldous, Hattingh, Swanepoel and van der Linde (2006) argue that the "general poor quality of teachers and teaching" (p.229) is one of the key reasons for poor performance not only in Mathematics but also in

Science as well. Hence, in view of the multiple views concerning poor Mathematics performance by the majority of South African learners, a need to continuously investigate possible solutions to the challenges encountered in Mathematics exists (Reddy, 2006). This study, therefore, seeks to contribute towards identifying and finding possible way to address some of these challenges at Foundation Phase level. Explanation of the key ideas of the PfP Programme follows.

2.3.2. Remediating gaps in learner knowledge in the early grades

In South Africa, "there is a critical need for developing strong Numeracy foundations in the early years of schooling" (Graven & Venkat 2017, p.15). Hence, findings on the recent review of existing Mathematics Education interventions suggest that "there is a strong research and evidence-based rationale for intervention to be in Foundation Phase" (Graven & Venkat, 2017; Roberts *et al.*, 2016). These findings confirmed Roberts *et al.'s* (2016) research which suggests, *inter alia*, the significant effect size of prior cognitive ability, and the higher impact of interventions in lower school phases (Roberts *et al.*, 2016: p.3 & 37).

There are numerous strategies that have been used to remedy the knowledge gaps that exist in lower grade learners in South Africa. These strategies were initiated by the national Department of Basic Education with the view to improve learner performance in literacy and numeracy. For example, the Department of Education implemented the Systemic Evaluation from 2001 to 2007 in order to identify factors that are hindering leaner achievement as well as to improve the teaching and learning of Literacy and Numeracy (Department of Education, 2003). The Foundations for Learning (FFL) campaign is another programme that was introduced by the DBE. The FFL campaign was launched in 2008 and it ran for a period of 4 years (Meier, 2011). It was aimed at helping South African learners in acquiring a solid foundation for learning. Therefore, through the FFL the DBE provided Grade 3 and 6 with guidance on teaching methodology. The focus was on was on numeracy and literacy in Grade 3 while in Grade 6 attention was given to mathematics and languages. Additionally, through the FFL learners were provided with learning resources. In 2008 and 2009 the DBE conducted the baseline assessment of ANA in Grade 3 and 6 with focus on Literacy and Numeracy. This was one in order to monitor the impact of FFL in South African primary schools (Meier, 2011; Mofu, 2013). As a consequence of the baseline assessment findings, the DBE decided to conduct ANA as a learning and teaching monitoring tool. The FFL was, eventually, infused into the new curriculum (CAPS) in 2011(Maja, 2016; Meier, 2011). The milestones of FFL were infused into the CAPS document as knowledge and skills that should be taught by Grade1-3 learners in Foundation Phase (DBE, 2011).

As I have already pointed out, in 2008 the Annual National Assessment (ANA) came into being; it was piloted in 2008 and 2009 (Department of Education, 2008) and subsequently implemented from 2012 to 2014. The ANA was implemented with the view to measure the progress of learners in Languages and Mathematics and, to provide relevant information to educational planners (Wolfaardt, 2016). To some degree the ANA project was effective; however, in 2015 the department of education decided to abandon it and put it under review so as to enhance its effectiveness (Motshekga, 2016).

Over the years, as an official of the Department of Basic Education, I noted that the effectiveness of these projects in providing remedies to learning and teaching challenges in lower classes has been intangible at best. Thus, learning gaps persist in subjects such as Mathematics in Foundation Phase. On-going, meaningful and hands-on interventions are required if these challenges are to be overcome. It is because of this noted shortcoming in the intervention strategies of the DBE that I decided to undertake this empirical research project.

2.3.3. The Role of the After–school Mathematics Clubs in this Study

There is a growing body of literature on the value of after–school Maths Clubs locally and internationally. White (2005 in Stott, 2016) suggests that if neighbourhood or home contexts are less than desirable, after–school programmes can bridge the gap between these and the school. This is significant in the South African setting where home contexts can be seen as problematic and where children live in poverty (Fleisch, 2008). Graven (2011) established Maths Clubs in 2011 as a key intervention initiative in South African Numeracy Chair (Graven, 2011) Project at Rhodes University. The aim of the Maths Clubs is to disrupt passive teacher–dependent ways and to create engagement in learning and help improve learner achievement in school Mathematics. Graven (2011) conceptualised Maths Clubs as informal learning spaces were learning can take place after–school.

Graven (2011) and Stott (2012) designed the after–school maths clubs to provide learners with an opportunity to learn and enrich their mathematical experiences. The Maths Clubs also provide a space for recovery and extension of numerical knowledge (Graven, Stott, Mofu, Baart & Hebe, 2017). The Maths Club space is free from the contextual constraints that teachers are faced with in the actual classrooms. In addition to that, there is also free curriculum and assessment teaching practice, i.e. teachers do not have to follow the annual teaching plan which indicates what a person should be teaching for a particular week. For example, learners would be active and engaged in the activities during the after–school Maths Club. As a result of the motivation emanating from the idea of Maths Clubs and what they are able to accomplish (Graven 2011 & 2012; Stott, 2012 & 2014), and more importantly, with the view to contribute towards improving learner achievement in Foundation Phase Mathematics; I ran the PfP Programme in the North West Province.

In my estimation, there is not enough opportunity for written work and individualised learner attention which is bestowed to learners in a classroom of 48 learners in some schools in my area; hence I implemented the after–school Maths Club so as to enable learners to interact in smaller groups and with their teachers during the Maths Clubs. In my experience, the after–school Maths Clubs with a smaller number of learners allow for engagement and participation in mathematical activities. These mathematical engagements and participation might generate mathematical understanding which could lead to learner progression (Anghileri, 2006) in respect of computing skills.

In concluding this section, it is important to highlight the fact that the role of the after–school Maths Club would be to supply learners with an opportunity to disrupt passive learning culture and to provide these learners with free space of learning in order for them to improve their numerical knowledge. The literature review on the PFP Programme and key ideas will be discussed below.

2.3.4. The Pushing for Progression Programme and Key Ideas

There are principles that underlie this programme, namely: mathematical proficiency, with two strands namely: Conceptual Understanding, Procedural Fluency, Number Sense, Mathematical Games and participation. The key ideas will be discussed below.

2.3.5. Mathematical Proficiency

According to the TIMSS report (TIMMS, 2013) and the SACMEQ II report (Spaull, 2013), South African primary school learners do not perform well in Mathematics. Kilpatrick *et al.* (2001) describe Mathematics proficiency as a successful Mathematics learning that involves reasoning, connecting mathematical ideas and communicating mathematical ideas to others. Kilpatrick *et al.* (2001) argue that mathematical proficiency consists of five strands:

- Conceptual understanding: comprehension of mathematical concepts, operations and relations
- Procedural Fluency: skill in carrying out procedure flexibly, accurately, efficiently, and appropriately.
- Strategic Competence: ability to formulate, represent and solve mathematical problems
- Adaptive Reasoning: capacity for logic thought, reflection, explanation, and justification.
- Productive Disposition: habitual inclination to see mathematics as sensible, useful, and worthwhile coupled with a belief in diligence and one's efficacy. (p. 116)

The points highlighted above suggest that mathematical proficiency can be obtained by focusing on the five components. This proficiency warrants that the learners should be able to cope with challenges of life and continue furthering their study of Mathematics in high school and beyond. The key factor is that proficient learners in Mathematics should be able to represent and connect new concepts to already known mathematical concepts. In this Study, these learners would learn mathematical concepts with understanding and be able to apply the selected procedures fast and quickly in solving Mathematics problems (Kilpatrick *et al.*, 2001).

For the purpose of this Study, I deliberately focus only on the discussion of two strands by Kilpatrick *et al.* (2001) namely: Procedural Fluency and Conceptual Understanding and exclude the other three strands, namely: Strategic Competence, Adaptive Reasoning and Productive Disposition. The reason behind this is that these strands are not included in the principles of Pushing for Progression Programme. Hence, even the design of this study reflects this reality. The design of this study addresses both the conceptual understanding and procedural fluency of the learners prior to their participation in the study and after fifteen weeks of their participation in the PfP Programme. For example, the pre-assessment conducted in this Study sought to, inter alia, determine the conceptual understanding of leaners in respect of the four operations and their procedural fluency, as reflected in their ability to apply these operations prior to their participation in this study. Likewise, the post-assessment that was conducted after the learners had participated for fifteen weeks in the PfP Programme was aimed at determining the progression in the conceptual understanding and procedural fluency of the same learners regarding the four operations. Accordingly, in the interest of this study, I deemed it appropriate to discuss only these two stands and leave out the other three since they do not form an inherent part of this study. At this point, I present a brief discussion of the conceptual understanding and procedural fluency.

Kilpatrick *et al.* (2001) point out that conceptual understanding refers to grasping mathematical concepts. Similarly, Dowker (in Star, 2005) describes conceptual understanding as the understanding of meaning of word problems and arithmetical principles such as commutativity and associativity. Hiebert and Lefevre (1986, cited in Star, 2005) explain that conceptual knowledge is knowledge that is rich in relationships and connected web of knowledge. Rittle-Johnson, Siegler and Alibali, (2001, cited in Star, 2005) describe conceptual knowledge as clear understanding of the principles that govern the domain. This implies that a learner would be able to understand the principle and can apply the mathematics concept in order to solve problems. This knowledge can be regarded as a network in which the relationships are conspicuous as the disconnected pieces of information. A learner with conceptual understanding would be able to connect new mathematical concepts to the existing mathematical concepts that the learner acquired in this study. Hiebert and Lefevre (1986 cited in Star (2005) explains that a learner with rich knowledge at his/her cognitive structure will be able to connect pieces of information and use this information in solving Mathematics problems.

Likewise, this learner with conceptual understanding is able to compute confidently in Mathematics (Anghileri, 2008). Also, a learner with conceptual understanding is also able to, *inter alia*, understand the quantity of a number and could also be able to connect previous knowledge to new knowledge. This is likely to happen if the number sense (Bobis, 2006) is well–developed from Foundation Phase level (DBE, 2011). In addition to conceptual understanding, in their discussion of mathematical proficiency, Kilpatrick *et al.* (2001) also refer to procedural fluency.

According to Kilpatrick *et al.* (2001) procedural fluency refers to the knowledge of procedures, how and when these procedures should be used and also entails a skill to carry out procedures in a flexible manner, precisely and efficiently. Rittle-Johnson, Siegler and Alibali (2001, cited in Star, 2005) describe procedural knowledge as the ability to execute actions sequence that are applicable to different operations. Dowker in Star (2005) describe procedural fluency as the concrete calculation procedure. This skill grants the learner an opportunity to solve mathematical problems by executing procedures step by step, quickly and precisely. From the perspective of this study, a learner with this rich knowledge would conceivably have the ability to use the relationships between numbers in solving number problems. However, it is also important to note that as Dowker (2005) points out the challenge is that most of the learners' mistakes when they apply the procedures, "result from misapplication of rules that children have been taught" (p.29). Hence, to remedy this challenge, learners should be exposed to purposeful practice of a particular procedure (Dowker, 2005).

2.3.6. Number Sense

In view of the fact that the concept of number sense has a multiplicity of definitions, my view of this concept draws from a diversity of scholarly views. For example, some scholars view number sense as an understanding of numbers and operations (Anghileri, 2006; Wright, Martland, Stafford & Stanger, 2006). On the other hand, Cockcroft (1982 in Anghileri, 2006, p. 2), argues that number sense is the state of being "at *homeness* with numbers" while Bobis (2006) considers it to be the ability to work proficiently and confidently with numbers.

The concept of number sense is given attention in my study because, according to the South African school curriculum teachers are required to ensure that from an early age the learners' number sense is developed. In the Curriculum and Assessment Policy Statement (CAPS) Mathematics Grades 1 – 3 foundation phase (DBE, 2011), the development of a number sense comprises of the understanding of a number, the meaning of different numbers and the relationship between different kinds of numbers. According to the CAPS Mathematics Grades 1-3 document (DBE, 2011) when Foundation Phase learners exit this phase they should have acquired a secure number sense and relevant computation skills (DBE, 2011). Besides, early Mathematics development is regarded by some scholars as the subject which will determine whether the child would be able to achieve better or not in their studies in higher grades (Wright, 2013).

In essence, a well-developed number sense should enable the learner to calculate any number by using any strategy because the learner understands the meaning of a number symbol and the relationships between different kinds of numbers. Similarly, as Kilpatrick *et al.* (2001) point out, the learner with a well-developed number sense should be able to connect unfamiliar context to the familiar context and be able to make sense out of what he/she calculated or worked out in Mathematics. Additionally, some researchers argue that a strong understanding of a number is vital if a child is to succeed in Mathematics (Heavy, 2003;

Wright, Martland, Stafford & Stanger, 2006; Dowker, 2012). Furthermore, a learner with a well–developed number sense would have a positive attitude towards Mathematics and thus should be able to do mathematical activities with confidence (Anghileri, 2006). Therefore, in order to assist the learners to progress to the next level of achievement in Mathematics, it is necessary to assist them develop their number sense. Number sense has to be developed as early as in the Foundation Phase in learners (Heavy, 2003; Wright, Martland, Stafford & Stanger, 2006).

Accordingly, in the interest of this discussion, learners with well-developed number sense would be those that are able to make connections between operations, numbers and make generalisation about number patterns and processes they would have been exposed to while working with numbers (Bobis, 2006; Anghileri, 2006; SANCP, 2016). Number sense includes developing an understanding of the meaning of numbers, relationships between numbers, knowledge of different ways of representing numbers (Graven, Venkat, Westaway & Tshesane, 2013). The concept of number sense is given attention in this study because according to the South African school curriculum teachers are required to ensure that from an early age the number sense of learners is honed. In the CAPS Mathematics Grades 1 – 3 Foundation Phase (DBE, 2011) document, the development of a number sense comprises of the understanding of a number, the meaning of different numbers and the relationship between different kinds of numbers. The assertion by Graven, Venkat, Westaway and Tshesane (2013) is in concurrence with the DBE's (2011) notion that the learner with a developed number sense is a learner who has an understanding of numbers, the meaning of different numbers and knows the relationship between different kinds of numbers. Van den Heuvel-Panhuizen (2008) describes the number sense as "to develop a feeling of numbers, and having fun with numbers, to feel at home in the world of numbers and be able to deal with different forms of calculation in your daily life, the ability to find relationship with numbers" (p.21). In essence, the well–developed number sense should enable the learner to work out calculation of any number by using different strategies. Then, can say the child feel at home with numbers, experience enjoyment when working with numbers, understand the meaning of a number symbol and find the relationships between different kinds of numbers (Van den Heuvel-Panhuizen, 2008; Graven & Stott, 2016). Similarly, a learner with well–developed number sense should be able to work with numbers fluently (Kilpatrick et al., 2001). Additionally, the learner with a well-developed number sense will be in a position of applying different problem-solving techniques such as mental calculations, counting skills and working on a number line besides simple drawing as alluded to by DBE (2014). A number of researchers indicated that number sense has to be developed as early as in the foundation phase in learners (Van den Heuvel-Panhuizen, 2008; Graven, Venkat, Westaway & Tshesane, 2013; Stott, 2014).

The development of number sense is dependent on and is an indication of learner progression. For this reason, I provide a brief discussion on the concept of learner progression.

2.3.7. Learner Progression

In this discussion I commence defining the concept of learner progression. Thereafter, I discuss Baroody's (2006) three phases of basic facts mastery. The discussion of the three phases of basic facts mastery is done with the view to demonstrate that progression in the learning of mathematics is gradual. I will also reflect on how children learn basic combinations. In rounding this subsection, I will also consider some of the hindrance to learner progression and some of the reasons for difficulties encountered by learners in the learning of Mathematics.

As far as Hornby (2005) is concerned, progression refers to the process of developing gradually from one stage to another. Masters and Forster (1997) describe progression as to improve in a particular area of learning. In South Africa, progression can also refer to the movement and subsequent placement of a learner from the current grade to the next grade, even if that learner has not met the promotion required (DBE, 2011). For the purposes of this discussion, progression is conceived as the process of moving from context-bound counting to formal calculations in mathematics or from simple to more sophisticated understanding within a particular subject (Van den Heuvel-Panhuizen, 2008).

Fluency is one of the measures of progression in mathematics pedagogy. According to the Common Core Standards State Standards Initiative (2010, p. 6 cited in Kling & Bay-Williams, 2015) fluency refers to the "skill in carrying out procedures flexibly, accurately, efficiently and appropriately" (p. 551). Kling & Bay-Williams (2015) go on to argue in reference to fluency in multiplication by stating that, "thus, far from just being a measure of speed, fluency with multiplication facts involves flexibly and accurately using an appropriate strategy to find the answer efficiently" (ibid.).

Research points to the need for coherence and progression in the teaching of Mathematics (Askew, Venkat & Matthews, 2012). For example, in a pedagogical setting, the teacher may start by introducing what the learners know (e.g. introducing repeated addition of numbers) before introducing a new concept (e.g. multiplication of numbers). Therefore, in order to ensure that learners comprehend and gain ownership of learning the teacher should strive for coherent progression. Progression would occur coherently in instances where teachers seek to develop fluency rather than trying to force learners to master mathematical operations at all cost by, for example, using traditional methods of teaching. For example, Kling & Bay-Williams (2015) posit that in order to facilitate progression in multiplication it would be best to use the phases of basic facts mastery (Baroody, 2006 in King & Bay-Williams, 2015). An illustration of the three phases of facts mastery by Baroody (2006) is provided in Figure 2, below.

Phases of basic facts mastery (Baroody 2006 cited in Kling & Bay-Williams, 2015, p.550)

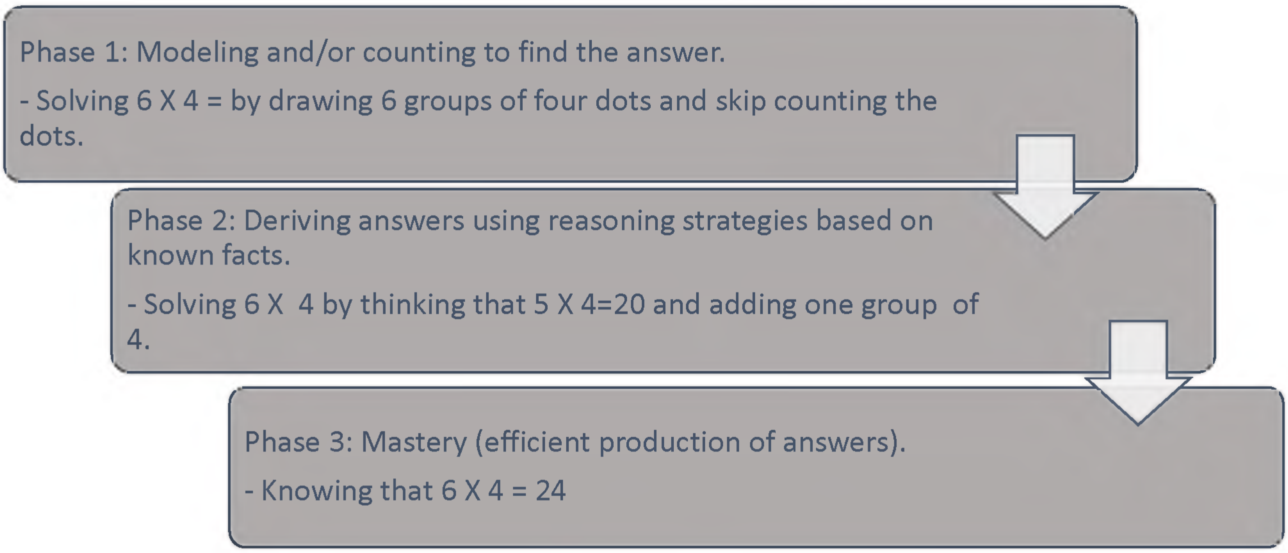

Figure 2: Phases of basic facts mastery

Kling & Bay-Williams (2015) argue that in order to develop mastery (phase3) learners need to, first, have foundational facts required for the mastery of multiplication. From these foundational facts, they need to progress to the stage where, through learning and constant application of foundational facts, they can progress to the stage where they derive answers by using "reasoning strategies based on known facts" (p.550). In essence, in order to reach phase 3, learners have to go through the first two stages.

Notwithstanding his invaluable views as projected to the lenses of Kling & Bay-Williams (2015), above, that for mastery (i.e. phase 3) to be reached by a learner in the learning of mathematical skills such as multiplication, the learner needs to progress coherently through different stages. Baroody (2006) concedes that there are other views that contradict his. Accordingly, he points out that, "considerable disagreement is found, however, about how basic number combinations are learned, the causes of learning difficulties, and how best to help children achieve mastery" (Baroody, 2006, p.2). In the next subsection I reflect on some of the hindrances to learner progression.

2.3.7.1. Hindrance to learner progression

There are several hindrances to learner progression in Mathematics. However, the following three barriers seem to standout; inadequate informal knowledge, teachers' pedagogical assumptions and unrealistic expectation and inefficiencies in pedagogical approaches.

Purpura and Ganley (2014) argue that, "children's early Mathematics skills develop in a cumulative fashion" (p.104), in essence, "Mathematics skills develop as a progression of interrelated facts" (Purpura & Ganley, 2014, p. 105). At the centre of this coherent progression is informal mathematical knowledge, hence Baroody (2006) argues that informal mathematical knowledge forms "a critical basis for understanding and successfully learning formal Mathematics and devising effective problem-solving and reasoning strategies" (p. 27). This assertion is supported by Purpura and Ganley (2014) who state that, "advanced mathematical knowledge is dependent on the acquisition and retention of more basic prerequisite; therefore, minimising (or having an underdeveloped ability in) one or more prerequisites limits an individual's ability to acquire the more advanced skills" (p. 10). Among the pre requisites, that children need to have in order to progress to acquire advanced mathematical knowledge, children need to be able to; associate words with numeral (e.g. that "one" can also be represented as "1"), associate quantities with appropriate number words and numerals (e.g. that "■■" also refers to "two" and "2"), and comprehend the implications of operational signs (e.g. that "+" means "add") (Purpura & Ganley, 2014).

According to Purpura and Ganley (2014); "informal mathematical knowledge consists of those competencies often learned before or outside of school" (p. 105). This suggests that informal mathematical knowledge is acquired before the child enters the Foundation Phase classroom. Fritz, Ehlers and Balzer (2013) suggest that informal mathematical knowledge is an inborn phenomenon. Accordingly, they argue that:

Before children learn number-words through language and understanding the meaning of numbers, they have already acquired a "large store of non-numerical quantity" (Resnick, 1989, p. 162). Several studies suggest that children possess primary numeral abilities. The human brain is equipped with an inborn mechanism or, at least, with very early abilities to represent quantities (Fritz, Ehlers & Balzer, 2013, p. 40).

Therefore, on the basis of the above-mentioned point, informal mathematical knowledge is invaluable in enabling learner progression. More importantly, since children, potentially, come to the mathematical classroom with informal mathematical knowledge, it is incumbent upon the teacher to determine the existence of this important form of knowledge so as to have an idea of where learning should start in respect of each mathematics lesson. By so doing, the teacher would be a facilitator rather than an impediment of learner progression in the learning of mathematics. Unfortunately, some teachers not do a good job in terms of determining prior knowledge and/or informal mathematical knowledge in their learners. This is one of the numerous shortcomings related to classroom instructions or pedagogical approaches that teachers often display in mathematical classrooms.

Baroody (2006) raises a number of important points that could help to explain why some teachers can be hindrances to the learning and teaching of Mathematics thereby constrain learner progression in the classroom context. In my view, Baroody's juxtaposition of two perspectives to Mathematics, namely; the conventional wisdom and the number sense view, helps in explaining the impact or potential impact of teachers' views on their approach to the teaching of mathematics. Baroody (2006) uses his three phases of basic facts mastery (Figure 2, above) to make his point.

The distinction between conventional wisdom and the number sense view lies on the achievement of mastery, i.e. phase 3 in Baroody's (2006) three phases, in the learning of Mathematics. According to the conventional wisdom perspective, "mastery grows out of memorizing facts by rote through repeated practice and reinforcement" (Baroody, p. 24) On the contrary, the number sense view is premised on the notion that "mastery that underlies computational fluency grows out of discovering the numerous patterns and relationships that interconnect the basic combinations" (ibid.). In essence, the conventional wisdom view is, as Kling and Bay-Williams (2015) point out, premised on the traditional approaches to pedagogy which suggest that mastery can be achieved by moving learners "from phase 1 directly to phase 3" (p. 551) while the number sense view is premised on the conception that learning should be gradual and cover all three stages.

According to Baroody (2006), "many proponents of the conventional wisdom see little or no need for the counting and reasoning phase…all proponents of the conventional wisdom view agree that phases 1 and 2 are not necessary for achieving the storehouse of facts that is the basis of combination mastery" (p. 24). This is informed by the misconception that "learning a basic number combination is a simple process of forming association or bond between an expression and its answer" (ibid.). According to this view, for a learner to be able to work out, for instance, that the number 6 x 4 has 24 as the correct answer does not require the learner to have conceptual understanding neither does it require developmental readiness (Baroody 2006). Therefore, this erroneous view discounts, among other things, the importance of the learner's "existing every day or informal language" (Baroody 2006, p. 24), including informal mathematical language, in learning. This is in direct contrast to the points made earlier in this discussion about the significance of informal mathematical knowledge in forming the basis for the development of conceptual knowledge to assist the learner to progress towards the acquisition of formal mathematical knowledge. This assumption considers the learning of number combinations as a process that "merely requires practice" (Baroody, p. 24) and can be acquired "directly and in a fairly short order without counting or reasoning" (ibid.).

Another view held by the proponents of conventional wisdom is that children, especially those with learning difficulties, have little or no interest in the learning of Mathematics (Baroody, 2006). Hence, the proponents or teachers who align themselves with this perspective, often, adopt tendencies that are associated with the behaviourist view of learning (Baroody, 2006). This view attaches a great deal of significance to the use of reinforcement or punishment as a tool to encourage or discourage a particular form of behaviour (Gordon & Browne, 2011; Woolfolk, 2010). Reinforcement, in this case positive reinforcement, is used to reward a behaviour with the hope that the learner would repeat the behaviour (Ho, Littman Cushman and Austerweil, 2015; Omomia and Omomia, 2014). On the other hand, punishment entails the process of inflicting pain on the learner (Gordon & Browne, 2011; Omomia & Omomia, 2014) with the intention of suppressing and, ultimately, wiping out a behaviour that the teacher conceives as wrong or unwanted in the learning situation. Baroody (2006) mentions the use of stickers, the awarding of candy bars, and so on as some of the forms of "rewarding progress" (p. 24) and "resorting to punishment" (ibid.) by, for example, assigning extra work to learners with the hope that they would work hard and register progress in their work.

The other assumption held by the advocates of conventional wisdom, which holds back progress in the learning of Mathematics, is that "mastery consists of a single process, namely; fact recall" (Baroody, 2006, p. 24). This view, erroneously presupposes that "the conceptual and reasoning components of the brain" (ibid.) are not actively involved, for example, in the mastery of Mathematics combinations. The assumptions held by the supporters of conventional wisdom are different from those held by those who subscribe to the number sense view.

Baroody (2006) argues that according to the number sense view computing and reasoning in the learning of Mathematics are interrelated and that for a learner to be able to master mathematical progression such as mastering basic combinations of numbers, the learner needs to have number sense. Baroody (2006) makes a number of points which suggest that, unlike conventional wisdom, the number sense perspective advocates for progression in the learning of mathematics. The following are some of those points:

- Achieving mastery of basic number combinations efficiency and in a manner that promotes computational fluency is probably more complicated than the simple associative-learning process suggested by conventional wisdom, for the reason that learning any large body of factual knowledge meaningfully is easier than learning it by rote,
- Children are intrinsically motivated to make sense of the world and, thus, look for regularities. Exploration and discovery are exciting to them,
- Combination and mastery that ensures computational fluency may be more complicated than suggested by conventional wisdom Baroody (2006, p. 24-25).

The last point worth mentioning about the incongruences between the conventional wisdom and number sense perspectives, respectively, as notions that either hinder or facilitate progression in the learning of Mathematics is in respect of some of the reasons behind the learning difficulties that tend to hinder learner progression in Mathematics classrooms.

2.3.7.2. Reasons for difficulties in learning mathematics

According to Baroody (2006) the proponents of conventional wisdom claim that learning difficulties can be ascribed to deficits that are inherent to learners while the number sense views regards teachers' inappropriate (or inadequate) instructions as the sources (or causes) of learning difficulties. Baroody (2006) admits that, indeed, as many proponents of conventional wisdom contend, very often, shortcomings that are inherent to learners (e.g. learning disabilities) do cause learning difficulties. However, this does not suggest that, generally, the lack of learner progress in the learning of Mathematics should be blamed squarely on the learners. This argument is in line with the number sense view. According to the number sense perspective, deficiencies in mastering combinations and thereby hindering progression in learners can be attributed, partly, to learning difficulties inherent in learners and, largely, to inappropriate instructional practices by teachers. Hence, Baroody (2006, p. 27) points to the following as some of the reasons for learning difficulties that constrain learner progress in Mathematics:

- Learners, especially those deemed to have learning difficulties, tend to have inadequate informal knowledge skills. These skills form a critical basis for understanding and successfully learning formal Mathematics and devising effective problem-solving and reasoning strategies,
- The conventional approach makes learning the basic number combinations unduly difficult and anxiety-provoking. The focus on memorizing individual combinations robs children of mathematical proficiency,
- Inefficiency: Because memorizing combinations by rote is far more challenging than meaningful memorization, many children give up on learning the basic combinations, a common consequence of memorizing basic combinations or other information by rote is forgetfulness. If they do not understand teacher imposed rules, students may be prone to associative confusion,
- Inappropriate applications: When children focus in memorizing facts by rote instead of making sense of school mathematics of connecting it with their existing knowledge, they are more prone to misapply this knowledge because they make no effort to check themselves or they miss opportunities for applying what they do know,

- Inflexibility. When instruction does not help or encourage children to construct concepts or look for patterns or relationships, they are less likely to spontaneously invent reasoning strategies, and thus they continue to rely on counting strategies.

Perhaps, in rounding this discussion on progression, it is appropriate to point out that in the context of this study, a number of points that have been made in this section were either taken into account or manifested throughout this research project. For example, by conducting a pre-assessment on the 4 Basic Operations I wanted to determine both the informal and the informal mathematical knowledge of participant-learners. Likewise, the learners were provided with a variety of learning opportunities which enabled most of them to progress through Baroody's (2006) three phases of basic facts mastery (as will be evidenced in the data analysis chapter of this thesis). Furthermore, through various learning activities, including Mathematics games, the learners obtained many opportunities to explore and discover new ideas. Hence, this seemed to support the progress among the learners. This progress is highlighted in subsequent chapters of this study, especially in chapter 4. The mathematical games will be the next discussion.

2.3.8. Mathematical Games and Practice

Mathematical games, which are a key feature of the PfP programme, also encourage learner progression. Research suggests that mathematical games are an invaluable tool in the teaching of mathematics, especially, at primary school level. Among other things, mathematical games enhance areas such as; cognitive development, learner motivation, positive attitude towards Mathematics, classroom participation in the subject and the general performance in Mathematics (Mani, 2015; Katmada, Mavridis & Tsiatsos, 2014; Shin, Norris & Soloway, 2006). The usefulness and variety of mathematical games is underscored by Mani (2015) who states that, "Mathematical games, puzzles and stories involving number are useful to enable children to make connections between the logical functioning of their everyday lives to that of mathematical thinking and to build upon their everyday understandings" (p.74). Accordingly, in order to encourage learner progression, the PfP Programme also employs mathematical games as one of the primary ways of developing number sense in the after–school Maths Clubs.

The PfP Programme aims to encourage different forms of practice (SANCP, 2016) that take place during the Maths Clubs. These two forms are the reproductive and the productive practice. The two forms can be distinguished as follows.

Reproductive practice focuses on automation and retention of basic facts for numbers up to 20 (SANCP, 2016). This takes place through the playing of dice and card games as well as various other club games such as Fizz Pop and numerous other club activities. The resources for mathematical games and an array of other club activities form part of the package of materials provided by the Rhodes SANCP team to the teachers and learners who participated in the PfP Programme. By doing these activities once per week as scheduled for the implementation of PfP Programme of this study, this might develop learners' knowledge of basic facts by heart.

On the other hand, productive practice is done through problem–solving (SANCP, 2016). The practice tasks are more open, solutions and answers allow for differentiation and require that the child should be innovative when solving mathematical problems. The children discuss with their facilitator how they arrived at their answers by sharing ideas and methods with their facilitator, e.g. how they solved their problem and which operation(s) and method(s) they used in solving mathematical problems. This approach encourages maths talks between the facilitator, the learners and their peers. This PfP practice allows the learners to be more creative and to show initiative when solving problems.

Mathematical games do not only form an important element of Maths Clubs within the PfP Programme but are also used with the view to instil patience amongst learners and to develop positive attitudes towards Mathematics as a subject at school. These games are governed by rules and are characterised by sets of challenging activities (SANCP, 2016). The value of the rules is that they provide each child with an opportunity to not only play when their turn comes, but they also instil the notion in each child that rules are important in the learning of Mathematics. As already suggested earlier in this discussion, through these games learners are motivated to participate in mathematical activities and develop some good attitudes (Anghileri, 2006) towards doing Mathematics as a subject at school. It is also, significant to emphasise that as Vygotsky (1976) points out that, generally, games play a vital role in cognitive development, in this case of mathematics concepts. Hence, within the realm of Maths Clubs, mathematical games form an inherent part of the PfP Programme to enable the teachers who run Maths Clubs achieve their mathematical objectives.

From the research point of view, in this study mathematical games provided the learners with opportunities to develop cognitive skills because they learned through play and in a relaxed environment. This situation assisted in developing a positive attitude towards Mathematics as a subject and thus helped to ease the learning process.

2.3.9. Participation

Alongside developing the learner's mathematical proficiency, the clubs also encourage learners to participate confidently in Mathematics. According to Kilpatrick et al.'s (2001) notion of mathematical proficiency, it involves understanding of mathematical concepts, reasoning, communication and active participation. It consists of five strands which are interwoven and interdependent. This imply that you cannot focus on one or two strands only if you want to develop mathematical proficiency in learners, the focus must be in all the five strands. The instructional programs should address all these strands in order to develop proficiency of Mathematics in learners. Kilpatrick *et al.* (2001) point that this proficiency in Mathematics will allow learners to cope with mathematical challenges in their daily life and enable them to further their study in Mathematics.

On the other hand, in respect of the notion of mathematical participation (SANCP, 2016), the focus is on the participation of the learner, facilitator and learner's peers in Maths Clubs in order to make sense of the numbers they are working with for computing purposes. Typically, during the Maths Clubs' learners are given opportunities of doing mathematical activities by applying different strategies, for example, through the use of structured Maths Club activities and playing games. They are also encouraged to share, through discussion, their methods and mathematical thinking. This approach should help to both cultivate and improve the learners' computing skills (DBE, 2011).

In the context of this study, learner participation in the after-school Maths Club activities provided them with opportunities to engage meaningfully with other club members. Through active participation, learners gained confidence and were able to work collaboratively and share their ideas and learning experiences with other club members. This benefitted them and thus contributed to their marked progress in developing mathematical proficiency and mathematical understanding as noted in their post-assessment results.

2.4. CONCLUSION

In this chapter I focussed on two areas, namely; the theoretical framework underpinning this study and the literature review. In the theoretical framework I reflected on how Vygotsky's (1978) social–constructivist perspective has informed this study. Additionally, I also reflected on the theoretical orientation of the PfP Programme, that provides the empirical field for this study. In the literature review I presented an overview of the PfP Programme and, thereafter, I discussed the processes that I considered significant in guiding this study. Among other important issues I deemed important and, therefore, worth discussing the following; Mathematics Education in South Africa and the role of the after–school Maths Club in this study. I concluded the chapter on a discussion on reviewed literature on the PfP Programme by reflecting on the Pushing for Progression Programme and describing the key ideas of the Pushing for Progression programme in this study. The research methodology and design are presented in chapter 3.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1. INTRODUCTION

The aim of this chapter is to provide a detailed discussion of the methodological procedures undertaken to adequately respond to the research question of this study. The following are the points on which the chapter focuses: the research questions, the research method, methodology, research design sampling, trustworthiness of the study, and ethical considerations and my role in the study.

3.2. RESEARCH QUESTIONS

As indicated in preceding chapters, this study was undertaken with the view to explore the nature of the Grade 3 learners' changing mathematical proficiency whilst participating in the Pushing for Progression Programme with a focus on progression of numbers and operations during the after–school maths clubs. The following are the main research and sub–questions which guided this inquiry.

The central question for this study was:

What is the nature of the learners' changing mathematical proficiency as they participate in after–school Maths Clubs? How do these evolve (if at all) over the period of club participation?

These sub–questions aimed to unpack this further:

1. What changes are evident in learners' mathematical proficiency over the period of club participation?

2. What are teachers' experiences of learners' changing mathematical proficiency as a result of participating in the club?

In the next section I detail the research methodology and design that guided this inquiry.

3.3. RESEARCH METHODOLOGY

Given the focus on learners' progression through participation and teachers experiences of learners changing proficiency in the Maths Clubs as the focus of my research, it was appropriate to use approach for this research. The interpretive qualitative research paradigm is supported by a multiple case study approach. The interpretive approach was used because it enables the researcher to study research phenomena in their natural or local settings and this helps in the collection of first–hand and detailed information (Daymon & Holloway, 2011). Additionally, the fact that the interpretive approach makes it possible for the researcher to constantly engage with and reflect on research data, the findings can also be presented in a detailed and engaging manner (Terre-Blanche, Kelly & Durrheim, 2006). The multiple sites were the twelve clubs run by the teachers at the after–school maths clubs and who participated in the research. In this study, the case study method was deemed both useful and relevant.

According to Kelly (2006) topics that are not well researched can be, ideally, investigated through the use of the case study approach. The case study approach allows for the ideas to emerge while the researcher is conducting observations during the process of inquiry (Lindegger, 2006). The strength of the case study approach is that it encourages a variety of sources and types of data and research methods (Denscombe, 2010). This in turn can facilitate the validation of data through triangulation. In order to ensure that I used more than one source to gather data about learners' progression, I gathered interview data from the participating teachers in addition to the learners' pre– and post– assessment data using the SANCP four operations assessment. Data collection was done qualitatively through various strategies as mentioned in 3.5.4 and, subsequently, analysed as discussed in 3.5.5. The following section deals with the empirical field of this study.

3.4. THE EMPIRICAL FIELD

The empirical field for this study was the Pushing for Progression programme which includes the 12 teachers and 144 learners from the 12 after school Maths Clubs. The field also consisted of three teacher workshops on the PfP Programme and the actual running of Maths Clubs over 15 weeks. In preparation for the introduction of this programme, I met and discussed with various stakeholders, including members of the SANCP team, school principals and circuit managers. Subsequent to the discussions I had with the relevant stakeholders as indicated above, in April 2016, I commenced with the PfP Programme. The programme ran from the 10th May 2016 until 13th September 2016. My role in the programme was that of the facilitator and coordinator, from a development point of view; from a research perspective this made me a participant observer.

Creswell (2012) describes the role of a participant observer as "an observational role adopted by researchers when they take part in activities in the setting they observe" (p. 214). According to Kelly (2006) the participant-observer may adopt an unstructured approach of interacting with participants. Therefore, the researcher may choose to write or not to write observation notes while the activities are taking place. However, since “it is difficult to take notes while participating” (Creswell 2012, p. 214), the researcher may only note down the observations made immediately after completing the observation process or upon leaving the site on the particular day of observation (Creswell, 2012; Kelly, 2006).

Therefore, in this study, my role as participant-observer was to interact with teacher- and learner-participants in the field while they were busy with their activities. I also recorded what I had observed during the process of observation while still in the field. I tried to be as accurate as possible by observing and recording events exactly as they unfolded in the field.

The first workshop was conducted on the 28th April 2016 at Lebogang Primary School. This workshop was aimed at orientating teachers to this programme. This included informing them on how to administer the 4 operations learner assessment (see below), how to profile learners with regard to progress and introduced them to the idea of developing learner number sense.

The second PfP Programme’ workshop was conducted for the teachers on the 9th June 2016 at Naledi Primary School. This workshop provided teachers with Maths Club activities which will develop learners’ efficient strategies for addition and subtraction for the planned next 6 weeks of the programme.

The third workshop was conducted on the 18th August 2016 at Lebogang Primary School. This workshop was based on the multiplication and division and on providing teachers with resources and club activities which aimed to develop learners’ efficient strategies for multiplication and division as planned for sessions 10 to 15 of this programme.

The after-school Maths Clubs were held at a central venue, namely Lebogang Primary School. At this school, 12 classrooms were given to this project. Activities and games that are offered as part of the PfP Programme were used at the clubs by teachers as a way of reinforcing learners’ mathematical concepts and that they should enjoy Mathematics as a subject. In this way, teachers were able to assess each learner’s current (i.e. prior to their commencement of the programme) levels of proficiency and note the methods and strategies used by learners to answer questions before the learners participated in any Maths Club activities. This would assist them in understanding where the learners were with regard to the progression spectrum mentioned earlier. I obtained permission from the teachers to use this data to address research sub question one. All teachers chose learners who were below 50%

in term one's 2016 results. Each club consisted of 12 learners from each primary school. This implies that one Maths Club consisted of 3 learners from each primary school to form twelve learners for each Maths Club.

The focus was based on the above-mentioned learners because they were regarded as learners with low level of mathematical proficiency in Grade 3. These learners' basic mathematical concepts were developed by providing them with opportunities of practising activities of Mathematics in the Maths Clubs (Graven, 2011, Grave & Stott, 2013). The intention was that learners should understand meaning of numbers and know the relationships of numbers. This in turn, will enable learners to achieve good results in mathematics and will develop these learners' positive attitudes towards mathematics (Anghileri, 2006).

3.5. RESEARCH DESIGN

3.5.1. Sampling

The concept of sampling refers to the process in which research participants are selected from the entire population with the view to enable the researcher to respond meaningfully to the research questions (Durrheim, 2006; Cohen et al., 2000). For the purpose of this study, an opportunity and convenience sampling methods apply. The teachers who participated in the Maths Clubs I started in 2014 in Ottosdal, a small rural town in the North West Province, were the opportunity sample. This strategy was deemed appropriate for this study because it provided me with the opportunity of selecting teachers that I have worked with since the establishment of Maths Clubs in 2014.

Accordingly, in selecting the sample the following processes were followed: I chose 12 Grade 3 teachers who, in turn, identified 144 learners in Grade 3 from four schools for participation in the study. These teachers had also selected the learners who achieved below 50% according to the first term results of 2016 (DBE, 2011) in Grade 3. These teachers selected the list of learners who achieved below 50% from their first term's schedules of 2016 and recorded those names. As a result, a list of learners who participated in the after-school Maths Clubs was derived from the initial list of learners who achieve below 50%. These teachers demonstrated an interest in strengthening their Mathematics teaching which provided me with an opportunity to work with them. Additionally, their schools, these teachers and their learners provided a convenience sample of teachers and learners as their schools are situated nearer to my place of work and it was easier for me to visit these schools.

144 learners participated in the pre-assessment on the 17th May 2016. Learners from certain schools were not assessed during the post-assessment of this study, which was conducted on the 13th September 2017, due to various reasons expanded on below. For example, Table 1 in Chapter 4 below shows that in Club S, only three learners were assessed; Clubs O and Club Q assessed seven learners each whilst Club U assessed ten learners, and Club V assessed six learners in post-assessment. Thus, twenty-seven learners dropped out of the Maths Club and did not participate in the post-assessment. Accordingly, a brief explanation should help elucidate the preceding points.

At the beginning, when I initiated of the after-school Maths Clubs, I explained to both teachers and learners that they were are allowed to leave this project if and when they felt that they were no longer willing to participate. For that reason, I did not deem it appropriate to make incessant inquiries as to the reasons why some learners decided to no longer attend the clubs. Additionally, since the Maths Clubs were also conducted after school hours, it might have been that the cold weather or other home factors or after school activities contributed to this drop out during the winter season. Another point worth mentioning is that competing activities of the North West Department of Education sometimes hindered the programme. For example, all the teachers and learners who participated in this study were also expected to participate in those departmental activities. These activities included, the Foundation Phase Teachers' Professional Support Forums (PSF) and, the teachers and learners' enrichment programmes. The latter took place in the afternoons in respective schools.

In order to accommodate all these programmes, we (the participants-teachers and myself) rescheduled the days of attending the Maths Clubs. Some learners then became confused about the dates as there was no regular pattern of dates. This likely also affected attendance. In addition, the issue of moving learners from their schools in order to attend the after-school Maths Club at a central venue (learners were walking from their schools to a central venue, because primary schools were 2 kilometres apart from each other) and possible disruption to their time for having lunch might have contributed to the drop out of 27 learners from this Study.

The research timeline and data collection methods are discussed in the next session.

3.6. Data Collection

Data Collection is one of the most important aspects in any research inquiry (Durrheim, 2006; Neuman, 2000). Hence, it is essential for the researcher to apply the mind correctly before deciding on what is appropriate (Macmillan and Schumacher, 1997). In this study, the following data collection methods where considered appropriate in enabling ‘adequate’ response to the research questions (Neuman, 2000); the SANCP four operations learner assessment instrument and one-to-one interviews. The data collected will provide, but qualitative data in narrative form from interviews and learner methods, whilst scores from four learner Operations assessments will provide quantitative data. The following provides details on how these methods were used in this study.

3.6.1. Research timeline and data collection

Table 2: Research timeline and data collection

DATE	TYPE OF EVENT	DESCRIPTION	WHICH RESEARCH QUESTION ADDRESSED	DATA COLLECTED	NUMBER OF EACH COLLECTED	ANALYSIS APPROACH USED
17/05/2016	1st club 4 operations pre-assessment	Administering learner four Four operations of pre-assessment Playing Beetle & Make 12 game	Sub-question 1	Individual learner script	144 learners’ scripts	Scores & learner method analysis
13/09/2016	4 operations post-assessment	Four operations of post-assessment	Sub-question 1	Individual learner script	117 learners’ scripts	Scores & learner method analysis
27/09/2016	Teacher Interviews	5 teachers interviewed	Sub-question 2	Audio recordings	5 teachers’ recordings	Interview transcripts & thematic analysis
28/09/2016		4 teachers interviewed	Sub-question 2	Audio recordings	4 teachers’ recordings	Interview transcripts & thematic analysis

In the following paragraphs I discuss each data collection method used in this study in more detail.

3.6.2. SANC Project Four Operations Data

The SANCP four operations assessment is provided as part of the PfP Programme and was used to collect data on learner progression. The four operations assessment is a standard instrument used for the EGMA (Early Grades Mathematics Assessment) assessments and was supplied by Brombacher and Associates, which has been widely used across South Africa and other African countries by his team. The assessment has five increasingly difficult items for each operation. For example, for addition the items were: 3 + 4; 8 + 6; 23 + 18; 55 + 67 and 104 + 97. The items are carefully selected to prompt the use of both mental and other strategies.

The SANCP four operations assessment has items for each operation (ranging from 1 by 1–digit to 2 by 3–digit). Teachers were encouraged to note if learners used fingers to calculate any of the answers. During the PfP Programme's first Maths Club session, learners were encouraged to show their methods of working on the scripts as well as recording their answers.

Learners were assessed again, using the same instrument at the end of the 15-week programme in order to ascertain learner progression over the period of participation in the clubs. Learners' responses were marked.

Data entry from the SANCP four Operations pre- and post- learner assessment scripts was done by recording a binary mark for each item in the assessment: one was assigned for a correct answer or zero for an incorrect answer into a spreadsheet. This is detailed further in the Data Analysis section below. The discussion on semi-structured interviews will follow in the next session.

3.6.3. Semi–Structured Interviews

In order to address research sub-question two, I interviewed the teachers to gather their thoughts on their experiences of changing learner progression. These interviews took the form of semi-structured, one-on-one, interviews with nine of twelve teachers who participated in the study; three teachers chose not to participate in the interviews. The three teachers did not furnish the reasons for their non-participation. However, as indicated in the permission letter sent to respondents, the respondents were assured that if they chose not to participate in one-on-one interview that choice would be respected. Hence, I suspect they had their own reasons for no-participation and I respect that right to non-participation. The semi-structured interview has open-ended questions which allow the interviewer to have discussion with the interviewee (Edward & Holland, 2003). This allows the interviewee to talk in-depth about the topic during the interview. Therefore, during the interview, each, teacher had the opportunity to talk in-depth about their respective observations regarding the changes which occurred in their learners' approaches to mathematics when they participated in after-school maths clubs during the implementation of the PfP Programme.

The interviews were guided by an interview schedule, the interview protocol. Each of the respondents was interviewed in the language of their own choice. Eight of the teachers were interviewed in English while the ninth interviewee opted to be interviewed in Setswana. Each of the interviews was audio–recorded with consent. The interview questions are stated below;

1. What changes have you noticed from learners' mathematics in the period of participating in the after-school maths clubs?

2. How did the learners change in mathematics develop during the after- school maths clubs?

3. Why is there a change in the learners' mathematics when they participate in the maths clubs?

Five interviews were conducted on the 27th September 2016 and four interviews were conducted on the 28th September 2016, respectively. The interview conducted in Setswana was translated. Each audio–recording of the interviews was transcribed. I visited each of the teacher respondents who participated in the interview at their schools and I gave each of them an opportunity to read the respective transcriptions of their audio-recorded interviews. For example, the first three teachers read their transcriptions on the 3rd May 2017 while the other three read their transcriptions on the 17th May 2017 and, the last three teachers read their transcriptions on the 20th June 2017. This was done with the view to determine whether they were happy with the contents of the transcripts, and to add to satisfy "member checking" as a measure of validity.

3.6.4 The PfP Notebook

During the period that the PfP programme was running, I kept notes about what transpired at the clubs for several reasons. First, I used the notebook as an observation tool for recording my information that would be relevant during data analysis and would enable me to respond meaningfully to the research questions. For the purpose of this discussion, I provided two examples to indicate the kinds of entries made into the journal. For example, on the 14th June 2016 I recorded what transpired at the after-school maths clubs which was conducted for session 4: two teachers decided to mark the home work books during the session instead of allowing learners to play games and doing the club activities. I emphasised the issue of interacting with learners during the clubs, but not to mark their home works. I also pointed out that learners should play games and do club activities during each session and that these club activities would provide teachers and learners an opportunity of interacting with each other. Another example is that, on the 17th May 2016, I made an entry in respect of one of Grade 3 boy, who was a participant in the maths club. I encouraged this boy to write the sums he is familiar with and leave out the ones he does not know. This incident was also recorded in this journal. Additionally, the notebook was used as a reflexive journal where my personal views, biases and 'aside moments' which would impact on my findings were recorded.

3. 6. 5. Transcription and Data Entry

To ensure participant anonymity, before analysis took place, each club was allocated a letter as a pseudonym, each club learner and participating teacher was allocated a code. These codes were used in all transcriptions and data entry of raw data for the learners'4- Operations pre- and post-assessments. The learners' pre- and post-assessments scripts were also scanned into a digital copy.

Table 3: Club, teacher and learner pseudonyms

Club Pseudonym	Teacher (Club Facilitator) Pseudonym	Club Learner Pseudonym Prefix
Club O	Did not participate in interview	OC
Club P	Did not participate in interview	PA
Club Q	Did not participate in interview	QK
Club R	D49	RG
Club S	D48	SF
Club T	D47	TB
Club U	D46	UL
Club V	D45	VAC
Club W	D44	WJ
Club X	D43	XM
Club Y	D42	YD
Club Z	D41	ZE

3.6.5.1. Four (4) Operations Scores, Changes and Averages

For the 4- Ooperations data, each learner's script was marked by the participating teacher and a score given out of 20. For research and analysis purposes, this data was then entered onto a spreadsheet to enable change data, averages and graphs to be created. For each learner's code, the item on the assessment was given a binary indicator: 1 for a correct answer and 0 for an incorrect answer. This data was entered for the pre-assessment and then the post assessment. The items were also grouped according to their relevant operation (purple, green, blue and turquoise as shown in Figure 3, Figure 4 and Figure 5 below) and scores worked out for each operation out of 5 to enable later analysis of progress in the different operations.

Individual learner data was grouped together for a particular club, enabling club averages to be worked out. Similarly, all learner data was grouped together to enable overall programme averages and changes to be calculated. A sample extract of the data is shown below for a sample learner.

PRE-TEST																											
Script Number	Learner Code	Club Code	Addition Pre	1.1 Pre	1.2 Pre	1.3 Pre	1.4 Pre	1.5 Pre	Subtraction Pre	2.1 Pre	2.2 Pre	2.3 Pre	2.4 Pre	2.5 Pre	Multiplication Pr	3.1 Pre	3.2 Pre	3.3 Pre	3.4 Pre	3.5 Pre	Division Pre	4.1 Pre	4.2 Pre	4.3 Pre	4.4 Pre	4.5 Pre	Total Pre
1	SAMPLE	SAMPLE	0.4	1	1	0	0	0	0.6	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25

Figure 3: Sample pre-test data entry on spreadsheet for Sample Learner

POST-TEST																											
Learner Code	Club Code	Post-test date	Addition Post	1.1 Post	1.2 Post	1.3 Post	1.4 Post	1.5 Post	Subtraction Post	2.1 Post	2.2 Post	2.3 Post	2.4 Post	2.5 Post	Multiplication Po	3.1 Post	3.2 Post	3.3 Post	3.4 Post	3.5 Post	Division Post	4.1 Post	4.2 Post	4.3 Post	4.4 Post	4.5 Post	Total Post
SAMPLE	SAMPLE	13/09/2016	1	1	1	1	1	1	0.8	1	1	1	1	0	0.6	1	1	1	0	0	0.8	1	1	1	1	0	0.80

Figure 4: Sample post-test data entry on spread sheet for Sample Learner

CHANGE DATA				
% Chg Addition	% Chg Subtraction	% Chg Multiplication	% Chg Division	Overal % Chg
60.0%	20.0%	60.0%	80.0%	55.0%

Figure 5: Sample change calculated data on spread sheet for Sample Learner

3.6.5.2. Four (4) operations learner method data

The scripts were also examined for learner methods, and the data was once again entered onto a spreadsheet for each club and learner. I counted the number of responses with no shown workings (coded as NSW) and responses with non-tally method workings (NT) such as traditional algorithms, doubling, halving, decomposition of numbers into place values, etc. Responses between the pre- and post- assessments were compared to calculate the change in number of responses used by club learners. Again, a sample data entry spread sheet is shown in Figure 6 and Figure 7 below.

FOR EACH ITEM COUNT THE DIFFERENT METHODS USED BY THE LEARNERS AND ENTER INTO RELEVANT COLUMN

Summary of learner methods in the 4 operations pre assessment

School/club code: SAMPLE Number of learners: 12

Problem	Frequency of...							Totals			
	Correct answers without written working	Correct answers with written NON-TALLY working	Correct answer using TALLIES	Wrong answer without written working	Wrong answer with written workings	Wrong answer using TALLIES	Not answered	Number of correct answers	Number of wrong answers	Number of answer using tallies	Check column (no. of reponses must equal number of learners)
Addition											
3+4	12							12	0	0	12
8+6	10			2				10	2	0	12
23+18	3			9				3	9	0	12
55+67	1			11				1	11	0	12
104+97				6	4	2		0	12	2	12
Subtraction											
8-2	11			1				11	1	0	12
12-5	7	1	1	3				9	3	1	12
23-18	4		3	2	2	1		7	5	4	12
467-43	1	1		4	4	2		2	10	2	12
305-97			1	4	7			1	11	1	12
Multiplication											
2x4	4		2	3	1		2	6	6	2	12
5x3	5		2	3			2	7	5	2	12
12x4	1		2	6		1	2	3	9	3	12
24x6				6	2	2	2	0	12	2	12
120x5				5	4	1	2	0	12	1	12
Division											
6÷3	4			2	2	2	2	4	8	2	12
18÷2	1		3	5		1	2	4	8	4	12
24÷3	1		1	5		3	2	2	10	4	12
75÷3	1			6	2	1	2	1	11	1	12
120÷15				5	3	2	2	0	12	2	12
	66	2									240

Figure 6: Pre-assessment Method data entry for Sample Club

FOR EACH ITEM COUNT THE DIFFERENT METHODS USED BY THE LEARNERS AND ENTER INTO RELEVANT COLUMN											
Summary of learner methods in the 4 operations post assessment											
	School/club code		SAMPLE			Number of learners				12	
	Frequency of...							Totals			
Problem	Correct answers without written working	Correct answers with written NON-TALLY working	Correct answer using TALLIES	Wrong answer without written working	Wrong answer with written workings	Wrong answer using TALLIES	Not answered	Number of correct answers	Number of wrong answers	Number of answers using tallies	Check column (no. of reponses must equal number of learners)
Addition											
3+4	9	1	2					12	0	2	12
8+6	8	1	3					12	0	3	12
23+18	4	1	2		4	1		7	5	3	12
55+67	2			2	4	4		2	10	4	12
104+97	2		2	1	6	1		4	8	3	12
Subtraction											
8-2	8	2	1		1			11	1	1	12
12-5	4	1	1	1	4	1		6	6	2	12
23-18	3		2	1	6			5	7	2	12
467-43	2	4		2	3	1		6	6	1	12
305-97	1			2	9			1	11	0	12
Multiplication											
2x4	7		4	1				11	1	4	12
5x3	5		6	1				11	1	6	12
12x4	2		4	2		4		6	6	8	12
24x6	1		1	4	2	3	1	2	10	4	12
120x5				6	6			0	12	0	12
Division											
6÷3	5		4	1		2		9	3	6	12
18÷2	3	3	1	2		3		7	5	4	12
24÷3	3		3	3		3		6	6	6	12
75÷3	4		1	2	1	4		5	7	5	12
120÷15	1			3	4	4		1	11	4	12
	74	13									240

Figure 7: Post-assessment Method data entry for Sample Club

3.7. Data Analysis

There is no clear point at which data collection stops and data analysis starts in a qualitative research study (Kelly, 2006). In fact, various authors (Macmillan and Schumacher, 1997; Durrheim 2006 & Neuman, 2011) point out that data analysis takes place simultaneously with data collection. At the same time Srivastava (2009) points out data analysis in qualitative research is an iterative process and thus the data analysis strategy, just like the entire data collection strategy, can be altered as the research inquiry unfolds. The tables indicating the spectrums on addition, subtraction, multiplication and division are presented below.

Constrained methods	Less constrained methods	Semi fluent methods	Flexible fluency
Inefficient	Somewhere in between (IE)		Efficient (E)
Use of fingers, tally marks, circles, drawings of any kind	Breaking of numbers into place values using some kind of expanded notation	Another strategy such as splitting, working with friendly numbers.	Use of known addition and subtraction facts, appropriate use of algorithms for 2 or more digit problems.

Figure 8: Addition and Subtraction Spectrum (SANC Project, 2016: p.6)

Constrained methods	Less constrained methods	Semi fluent methods	Flexible fluency
Inefficient	Somewhere in between (IE)		Efficient (E)
Use of fingers, tally marks, circles, drawings of any kind	Skip counting and repeated addition	Arrays, breaking down of numbers into expanded notation	Use of known addition and subtraction facts, appropriate use of algorithms for 2 or more digit problems

Figure 9: Multiplication and Division Spectrum (SANC Project, 2016: p.7)

Both qualitative and quantitative data analysis methods were used to analyse the 4-Operations. Firstly, the total number of correct answers for each club learner was counted in the spreadsheet for both the pre and post assessments to arrive at a score out of 20 for each assessment. I calculated each learner's percentage by dividing the actual raw mark by the total marks of the assessment. The answer obtained from this process was then multiplied by 100 in order to attain the percentage for each learner during the pre- and post-assessment. This information was recorded in the spreadsheet. The change percentage of each learner was calculated by subtracting the pre-percentage from the post-percentage of each club learner in order to obtain the overall percentage point change for each learner's assessment. These pre- and post- assessment scores were compared, and percentage changes were calculated to show the overall percentage change of 4 Operations assessment.

Secondly, in order to gain a deeper understanding of how the changes in scores came about, I carried out a micro-analysis of methods used by the club learners. I conducted an analysis of each learner's pre- and post-assessment of methods of calculating the correct responses when answering each of the 20 questions of the pre- and post-assessment and recorded it on the spread sheet. This was made possible by the application of Wasserman's (2015) technique of analysing learner scores. During the analysis I focused on the methods used by each learner in each of the 6 clubs. The purpose was to identify the methods used by each learner when working out their answers. I classified each learner's responses under the following headings: correct responses with no shown workings (NSW); correct responses non-tally methods (NT). I also calculated the total correct responses excluding tally marks and compared both the pre- and post-assessment scripts of all 117 club learners, focussing on the methods used by each learner in order to arrive at correct answers.

Teacher interview analysis was conducted by analysing each participant-teacher's transcribed audio recording. The transcribed conversation was analysed by looking carefully at each conversation. The teachers' statements were documented on a piece of paper and this was followed by the grouping these utterances under a particular heading (e.g. Learner Participation, Positive Attitudes) to develop the themes. The quotes, which were derived from each interview, were recorded and transcribed as evidence of quotes from the interviews conducted for teachers. After this initial analysis, I had about 10 areas of interest. As a second look, I reflected that some of these were related to each other. Thus, I looked at each area and grouped similar areas under a heading theme. For example, I reflected that flexible, attitudes, relationships are all about the learners' mathematical skills. I therefore put these three aspects (flexible, attitudes and relationships) under the theme heading of attitudes. Teachers' responses were classified according to relevant themes. This approach to data analysis is universally referred to as thematic data analysis.

Therefore, in this study I used thematic data analysis to make sense of collected data. According to Braun & Clarke (2006), although thematic data analysis is widely used in qualitative research; "there is no clear agreement about what thematic analysis is and how to go about doing it" (p.6). Therefore, for the purposes of this discussion thematic analysis can be defined as a research data analysis method that enables the researcher to determine the relationship between concepts by identifying, analysing and reporting on themes or patterns in the research text or data (Alhojailan, 2012; Braun & Clarke, 2006; Attride-Stirling, 2001).

Thematic analysis was deemed relevant to this study not only because it is flexible but it also enables the researcher to report on the "experiences, meanings and the reality of participants" (Braun & Clarke, 2006). Although thematic analysis is flexible and enables the researcher to present a rich analysis of data (Braun & Clarke, 2006, Attride-Stirling, 2001) it also places a great demand on the researcher to provide the reader with details on how data analysis was carried out. To amplify this point, Braun & Clarke, 2006), assert that "if we do not know how people went about analysing their data, or what assumptions informed their analysis, it is difficult to evaluate their research" (p.7). For this reason, in this study, I make an effort to present detailed information (stated-above) on how data analysis was done (cf. Chapter 4).

3.8. ETHICAL CONSIDERATIONS

Ethical considerations will, in line with the requirements for qualitative research (Wassenaar, 2006), ethical considerations were taken into account. Informed consent, respect for the rights of research participants, confidentiality and anonymity are some of the ethical considerations that were attend to prior to conducting the investigation. For example, I wrote letters to the North West Department of Education and Sports Development, the Dr. Kenneth Kaunda District Director and the school principals to request permission to conduct my research investigation. I also requested consent from the parents, through their school, of the learners who took part in the after-school Maths Clubs to participate in this research.

Similarly, participants were provided with full details about the purpose of and how the study was to be conducted before they could participate. Thus, autonomy, anonymity, confidentiality and dignity of participants were all ensured through informed consent (Howe & Moses, 1999). Every measure possible was taken to ensure that no learner or teacher was harmed during the reach process. Concerning confidentiality and anonymity, I kept all data in the safe and locked container to protect information gathered for this study. The code names were used to protect the identities of teachers and learners who participated in this study from the public readers (MacMillan & Schumacher, 1997). I also stressed that participants had the right to withdraw or withhold their participation from the research anytime they wanted to. Hence, some of teachers were able to exercise this right by withholding their participation in certain activities, for example, in the interview (please refer to section 3.5.4.) All data were kept under lock and key and access to raw data is limited only to the teachers who participated in the study, my supervisor(s) and I. Additionally, the Rhodes University Education Department ethics form is attached as appendix.

3.9. TRUSTWORTHINESS OF THE FINDINGS

There are various ways in which qualitative researchers ensure the trustworthiness of the findings (Ramukumba, 2010). In this study, the following aspects are the ways in which I ensured the trustworthiness of the findings. I have already referred to triangulation in which different methods, namely; semi-structured interviews and learner assessment were used. Apart from triangulation, I also used peer debriefing and thick description (Dube, 2012) to enhance the trustworthiness of the findings.

Peer–debriefing refers to the process in which the researcher interacts with someone or gives the contents of the study to someone who is knowledgeable to 'critic' him/her on the study (Macmillan and Schumacher 1997). In this case, my supervisors fulfilled this role. Member checks entail the process in which the researcher goes back to the respondents to verify some of the information collected during the investigation. In this case, I went back to the teacher-participants to verify transcribed information against the audio recordings of each teacher who participated in the interviews of this study. Each participant-teacher was afforded an opportunity to listen to her one–on–one audio-recorded interview and, thereafter, go through the transcription of the same interview. This was done with the view to determine whether, as far as the participants were concerned, each of these data sources presented a true reflection of the respondent's views. Lastly, thick description refers to the provision of detailed information regarding the research process (Kelly, 2006). In this regard I provided detailed information on how the research study was conducted. At the same time, I used the words of the respondents, verbatim, as much as possible.

3.10. MY POSITION AS RESEARCHER IN THE STUDY

There are various characteristics concerning the researcher that might, 'compromise' the findings of the study. For this reason, I took certain precautionary measures to offset any the possibility of my role, as a research tool, influencing the study in some negative way. I was particularly mindful of my position of authority, outside of the research realm, in relation to the teachers who participated in this study. Hence, in this section I reflect on who I was at the time the study was undertaken and how I handled my relationship with everyone, directly or indirectly, involved with this study.

3.10.1. My Role as District Official

At the time this inquiry was undertaken I was a Senior Education Specialist (SES) or what other people refer to as curriculum/subject advisor responsible for Foundation Phase Mathematics. I was based in the North West Province of South Africa, and Maquassi Hills Area Office was my immediate reporting station. This area office is under the umbrella of the Dr Kenneth Kaunda Education District, one of the four district offices under the control of the North West Department of Education and Sport Development. Even though the findings of this study have assisted me in my professional capacity by providing me with insights about the challenges, opportunities and possible approaches worth undertaking in providing support to schools in my area, this study was not pursued on behalf of my employer. Hence, it was important for me to ensure that, as far as possible, I did not conflate my role as M.Ed. researcher at Rhodes University, under the auspices of the SANC Project, and a subject advisor. I was mindful of the fact that I had enlisted teachers who, in all likelihood, viewed me as an 'authority' figure to participate in my study. In essence, I had to ensure that my work position did not influence or dilute my role as researcher. Additionally, I was careful not to be tempted into measuring the impact of the programme on teacher practice in the schools that I work in while the research was on–going. For the purposes of the research, I have had no direct contact with the learners in the Maths Clubs. All the data has been collected by the teachers in the Maths Club space and passed onto me, with their permission.

3.10.2. Relationship with Teachers and Learners

As indicated above, I was fully aware of the power relations, perceived or real, between myself and the teachers who facilitated the clubs in this study. I was furthermore aware that these could influence the research process and the teachers' participation in it. Accordingly, I strove to establish rapport and partnership with facilitators by, for example, communicating with them regularly through text messages to indicate to them that I had issued circulars informing them about of the workshops, and that these circulars were sent to their principals. The aim was thus to verify whether they had received the circulars. I would also remind them about the dates of the workshops related to this study. In fact, it was more about consolidating my relationship with them because for about eight years prior to establishing Maths Clubs and undertaking this inquiry, I had consistently sought to create and maintain healthy relations with the teachers in 'my' district. Hence, in my view, my relationship with them has always been based more on collegiality than authority. I have had a long healthy working relationship with them and I put a lot of work to maintain it as such. Furthermore, during the inquiry I gave the participating teachers space to interact with the learners in Maths Clubs. Even though, as indicated in section 3.4, I was a participant-observer; I did not interfere with the research schedule.

3.10.3. Relationship with the SANC project

My formal relationship with the SANC Project commenced in 2014 when I enrolled for the MEd (Mathematics Education) at Rhodes University. This was after I had met with Professor Mellony Graven, who was later to become my study co supervisor, at the 20th congress of the Association for Mathematics Education of South Africa (AMESA) in 2011. This congress was hosted by the Potchefstroom Campus of the North West University. I have been consolidating this relationship through participation in numerous activities aimed at trying out the ideas of the SANC Project in addressing the challenges affecting the learning and teaching of Mathematics in schools. These activities include: the presentation of papers at congresses and the translation of PfP books from English to Setswana which are part of the PfP Programme which is the empirical field for this study.

Indeed, my involvement with the SANC has enriched me in many ways including; in my professional capacity, as a post-graduate student and aspiring scholar. I firmly believe in their ideals and resolve to help in addressing the multitude of challenges impacting Mathematics teaching and learning in many South African schools and beyond. Undoubtedly, I will continue to maintain this relationship with the SANC project long after my research is complete.

Indeed, apart from the preceding points regarding my position as researcher and measures undertaken an attempt to be ethically above board in my role as research instrument, there are other ethical considerations that were taken into account as it is the norm with qualitative and other forms of research. These considerations are highlighted in *section 3.6* of this discussion.

3.11. CONCLUSION

In this chapter, I described and detailed the following: research questions, research methodology and design of this study, I also provided a detailed discussion of the PfP Programme. Additionally, I documented the data collection methods and the methods used to analyse that data. The ethical considerations for qualitative research and my position as a researcher have also been considered. In the next chapter the discussion would be on the findings of this study.

CHAPTER 4: FINDINGS

4.1. Introduction

In this chapter I present the findings on the Maths Club learners' 4 Operations assessment and the respondent teachers' interviews. This chapter is divided into two main sections; sections 1 and 2, respectively. In section 1, I present the findings on the learners' 4 operations assessment while the findings of the interviews with each of the respondent teachers are presented in section 2.

4.1.1. Section 1: Findings on Learners' 4 Operations Assessment

Research question 1 looks at the changes evident in learners' mathematical proficiency over the period of 15 weeks of participating in Maths Clubs. An analysis of the 4 Operations was done by looking at the scores for both pre- and post- 4 Operations assessment for all 12 maths clubs and for each of the 117 learners who participated in the clubs. Both the pre- and post- 4 Operations assessment analyses were conducted on the 19th July 2017.

The findings regarding the learner 4 operations assessment are discussed in the next section.

4.1.2. Overall 4 operations assessment scores for entire PfP programme

The graph in **Error! Reference source not found.**10 below provides a summary of the scores for all 117 Maths Club learners from the 12 Maths Clubs which formed part of this Study. The graph points to the changes in learner achievement that occurred, percentage–wise, after the learners had participated in Maths Clubs. The overall change across all operations and across all 12 clubs is 17.02%. The overall average percentage changes of addition, subtraction, multiplication and division are highlighted in the graph.

4.1.3. Overall percentage point change averages for each operation

Across all 12 clubs, there were an average 15.75 and 12.77 percentage point change for addition and subtraction, and an average 20.89 and 18.95 percentage point change for multiplication and division. The biggest changes were thus in multiplication and division. To some extent this could be attributed to there being 'more room for improvement' in division and multiplication as these results on the pre-test were much lower than those for addition and subtraction.

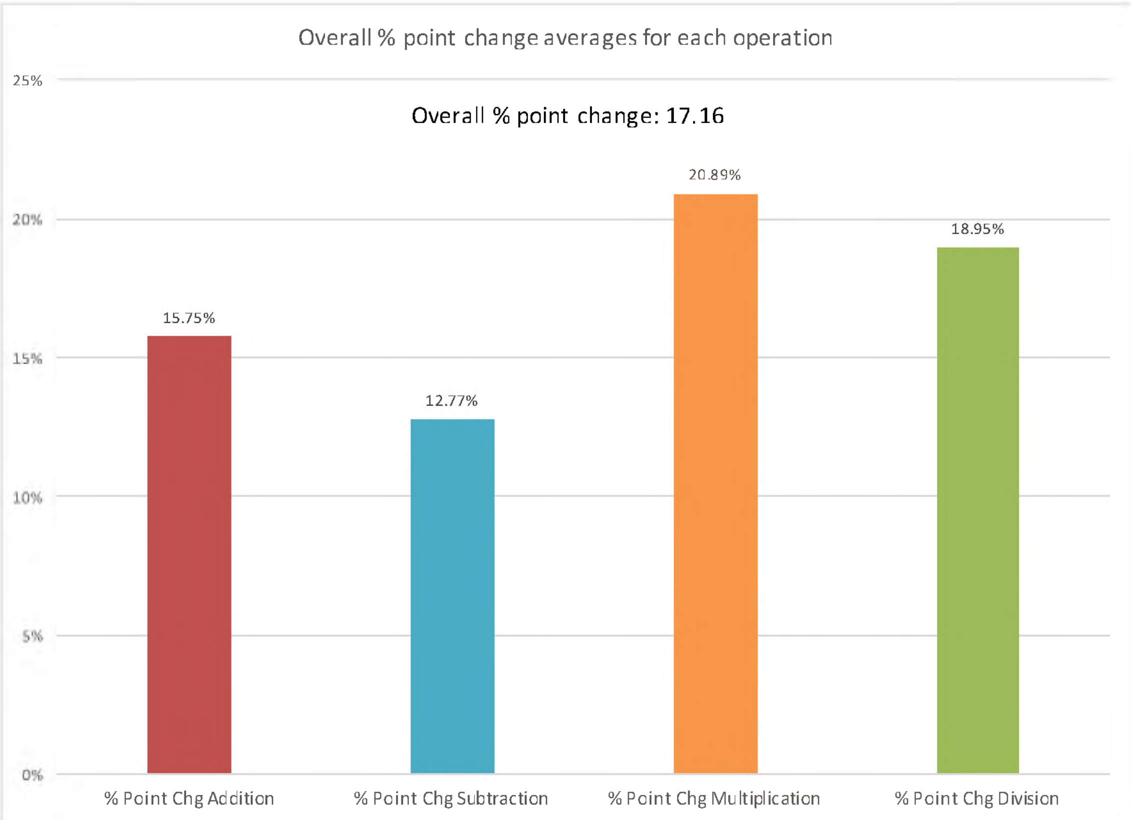

Figure 10: Overall % point change averages for each operation

4.2. Summary of change by club

Table 4 below indicates the overall average percentage scores for each operation in each of the 12 clubs.

Club	No. of learners	Pre & post score analysis					% point change (4 operations)			
		Average Pre Score	Average Pre %	Average Post score	Average Post %	Overall average % point change	Addition	Subtraction	Multiplication	Division
CLUB O	7	8.57	42.86%	12.86	64.29%	21.43%	8.57%	20.00%	14.29%	42.86%
CLUB P	12	7.42	37.08%	10.58	52.92%	15.84%	15.00%	-3.33%	21.67%	30.00%
CLUB Q	7	7.57	37.86%	11.29	56.43%	18.56%	17.14%	22.86%	25.71%	8.57%
CLUB R	12	9.42	47.08%	12.08	60.42%	13.34%	8.33%	15.00%	21.67%	8.33%
CLUB S	3	6.33	31.67%	10.00	50.00%	18.33%	13.33%	6.67%	26.67%	26.67%
CLUB T	12	7.58	37.92%	9.75	48.75%	10.83%	13.33%	13.33%	13.33%	3.33%
CLUB U	10	8.70	43.50%	11.8	59.00%	15.50%	10.00%	12.00%	14.00%	26.00%
CLUB V	6	10.67	53.33%	11.67	58.33%	5.00%	6.67%	3.33%	23.33%	-13.33%
CLUB W	12	8.08	40.42%	11.42	57.08%	16.66%	25.00%	11.67%	16.67%	13.33%
CLUB X	12	8.50	42.50%	11.75	58.75%	16.25%	20.00%	8.33%	18.33%	18.33%
CLUB Y	12	7.92	39.58%	12.92	64.58%	25.00%	26.67%	21.67%	30.00%	25.00%
CLUB Z	12	7.42	37.08%	12.92	64.58%	27.50%	25.00%	21.67%	25.00%	38.33%
OVERALL AVERAGES		**8.18**	**40.90%**	**11.59**	**57.92%**	**17.02%**	**15.75%**	**12.77%**	**20.89%**	**18.95%**

Table 4: Details of change for each of the 12 clubs in the PfP programme

The 4 operations assessment which was conducted at the end of the 15th week of the PfP programme indicates that the club learners' average score increased by 3.41 from 8.18 (40.9%) to 11.59 (57.92%) giving a 17.02 percentage point overall change. The higher percentage point changes of 20.89 and 18.95 for multiplication and division are notable given that these are grade 3 learners. Apart from Club V, all clubs have made the progress in multiplication and division. The clubs, except Club P, show progress for addition and subtraction.

When I compiled this information, I discovered that out of a total of twelve cubs, which formed part of this study, there were three clubs that recorded particularly high overall percentage change (over 20 percentage points each) for the 4 operations post-assessment. These were Club O (21.43 percentage points), Club Y (25 percentage points) and Club Z (27.5 percentage points). The club with the lowest overall percentage point change during the 4 operations post-assessment was club V where only a five percentage point improvement was noted. Club R and T showed the next weakest improvement at 13.34 and 10.83

percentage point improvements respectively. For all other clubs the overall percentage point improvement across the four operations was in the range of 15 to 20 percentage points. The findings that follow focus on these six clubs (Clubs O, Y, Z, R, T and V) and on learners who achieved 50% or more in the assessments as well as on learners with the biggest overall percentage point change in 4 operations assessment. The analysis of six clubs will show the difference of achievement of club learners as a result of participation in the maths clubs for 15 weeks.

4.3. Learner assessment analysis and findings for six selected clubs

For each of these clubs, I present a table of individual learner data followed by a discussion. Accompanying this discussion is a table depicting the individual learner's achievement per club, but for only six selected clubs in this study.

4.3.1. Learner findings for Club O

Learner Code	Total Pre Score	Total Pre %	Total Post score	Total Post %	% Point Change Addition	% Point Change Subtraction	% Point Change Multiplication	% Point Change Division	Overall % Point Change
OC1	8	40.00%	11	55.00%	20.00%	20.00%	0.00%	20.00%	15.00%
OC2	14	70.00%	10	50.00%	-20.00%	-40.00%	-20.00%	0.00%	-20.00%
OC3	9	45.00%	12	60.00%	0.00%	0.00%	40.00%	20.00%	15.00%
OC4	8	40.00%	13	65.00%	-20.00%	40.00%	20.00%	60.00%	25.00%
OC5	9	45.00%	14	70.00%	20.00%	20.00%	0.00%	60.00%	25.00%
OC6	7	35.00%	16	80.00%	20.00%	20.00%	60.00%	80.00%	45.00%
OC7	5	25.00%	14	70.00%	40.00%	80.00%	0.00%	60.00%	45.00%
AVERAGES	**8.57**	**42.86%**	**12.86**	**64.29%**	**8.57%**	**20.00%**	**14.29%**	**42.86%**	**21.43%**

Table 5: Individual learner progress for Club O

In Maths Club O, the overall percentage point change is 21.43. All learners achieved a score of 10 or more in the post-assessment, all showing an increase in percentage point change. However, Learner OC2 dropped by 4 marks (resulting in a 20 percentage point drop) during the post-assessment.

Learner OC6 and OC7 have the largest percentage point change between pre- and post-assessment of 80 and 70 percentage point respectively. Each of them attained a 45 percentage point between pre- and post-assessment. Learner OC6 got 60 percentage point in multiplication and 80 percentage point in division, respectively. Learner OC7 attained 40 percentage points in addition and 80 percentage point in subtraction, respectively. Hence, they are regarded as learners with the biggest overall percentage point change in this club.

Learner OC2, however, attained -20 overall percentage point during the pre-and post-assessment. This learner achieved a -20 percentage point in addition, -40 percentage point in subtraction and -20 percentage point in multiplication and can thus be regarded as the learner with lowest percentage point in this club.

4.3.2. Learner findings for Maths Club Y

Learner Code	Total Pre Score	Total Pre %	Total Post score	Total Post %	% Point Chg Addition	% Point Chg Subtraction	% Point Chg Multiplication	% Point Chg Division	Overall % Point Chg
YD1	5	25.00%	9	45.00%	20.00%	20.00%	40.00%	0.00%	20.00%
YD2	13	65.00%	12	60.00%	0.00%	0.00%	-20.00%	0.00%	-5.00%
YD3	7	35.00%	14	70.00%	40.00%	-20.00%	80.00%	40.00%	35.00%
YD4	4	20. 00%	15	75.00%	60.00%	60.00%	60.00%	40.00%	55.00%
YD5	9	45.00%	13	65.00%	0.00%	20.00%	0.00%	60.00%	20.00%
YD6	11	55.00%	13	65.00%	-20.00%	20.00%	40.00%	40.00%	10.00%
YD7	10	50.00%	12	60.00%	20.00%	0.00.%	0.00%	20.00%.	10.00%
YD8	8	40.00%	13	65.00%	40.00%	0.00%	40.00%	20.00%	25.00%
YD9	13	65.00%	16	80.00%	40.00%	0.00%	40.00%	-20.00%	15.00%
YD10	8	40.00%	12	60.00%	20.00%	20.00%	0.00%	40.00%	20.00%
YD11	6	30.00%	12	60.00%	20.00%	40.00%	0.00%	60.00%	30.00%
YD12	1	5.00%	14	70.00%	80.00%	10.00%	80.00%	0.00%	65.00%
AVERAGES	**7.92%**	**39.58%**	**12.92%**	**64.58%**	**26.67%**	**21.67%**	**30.00%**	**25.00%**	**25.00%**

Table 6: Individual learner progress for Maths Club Y

In Maths Club Y, there is overall 25 percentage point change. Four learners achieved 50% or more in pre- assessment. This increased to eleven learners obtaining 50% or more, showing an increase in the overall percentage point change in the post-assessment. The exception is learner YD2 who obtained a decrease of 5 percentage point in the overall percentage point change of the post-assessment, as this learner's scores dropped from 13 to 12.

Learner YD12 obtained an overall 65 percentage point during the pre- and post-assessment, increases from 1mark to 14 in the post-assessment. This learner attained 80 percentage point in addition and multiplication and, a 10 percentage point in subtraction. Learner YD4 achieved 55 percentage point in the overall percentage point change of the pre- and post-assessment, answering 11 more questions correctly in the post-assessment. Learner YD4 obtained 60 percentage point in addition, subtraction and multiplication Therefore, Learners YD4 and YD12 recorded significant increases and can be regarded as learners with the biggest overall percentage point change in this club. On the other hand, Learner YD2 did not show any change in addition, subtraction, and division and shows a negative change for multiplication and got the overall -5 percentage point change which enabled this learner to be regarded as the learner with the lowest percentage point change in this club.

4.3.3. Learner findings for Maths Club Z

Learner Code	Total Pre Score	Total Pre %	Total Post score	Total Post %	% Point Chg Addition	% Point Chg Subtraction	% Point Chg Multiplication	% Point Chg Division	Overall % Point Chg
ZE1	5	25.00%	16	80.00%	60.00%	20.00%	60.00%	80.00%	55.00%
ZE2	8	40.00%	6	30.00%	20.00%	-40.00%	-40.00%	20.00%	-10.00%
ZE3	6	30.00%	7	35.00%	-20.00%	40.00%	20.00%	-20.00%	5.00%
ZE4	8	40.00%	16	80.00%	60.00%	20.00%	0.00%	80.00%	40.00%
ZE5	7	35.00%	16	80.00%	40.00%	40.00%	20.00%	80.00%	45.00%
ZE6	2	10.00%	12	60.00%	60.00%	20.00%	80.00%	40.00%	50.00%
ZE7	12	60.00%	18	90.00%	40.00%	40.00%	20.00%	20.00%	30.00%
ZE8	12	60.00%	11	55.00%	0.00%	20.00%	-20.00%	-20.00%	-5.00%
ZE9	13	65.00%	14	70.00%	0.00%	-40.00%	40.00%	20.00%	5.00%
ZE10	11	55.00%	16	80.00%	40.00%	20.00%	0.00%	40.00%	25.00%
ZE11	2	10.00%	13	65.00%	20.00%	60.00%	60.00%	80.00%	55.00%
ZE12	3	15.00%	10	50.00%	20.00%	60.00%	60.00%	40.00%	35.00%
AVERAGES	**7.42%**	**37.08%**	**12.92%**	**64.58%**	**28.33%**	**21.67%**	**25.00%**	**38.33%**	**27.50%**

Table 7: Individual learner progress for Maths Club Z

In Maths Club Z the overall percentage point change is 27.50. The learners who got 10 or more out of 20 in pre- assessment are the following: Learner ZE7, ZE8, ZE9 and ZE10. All learners except ZE2 and ZE3 achieved a score of 10 or more for the post-assessment.

Learner ZE11 scored 2 (10%) out of 20 in pre-assessment but increased to 13 (65%) out of 20 in the post-assessment. Learner ZE1 attained 5 (25%) in pre-assessment and obtained 16 (80%) in post-assessment. Learners ZE1 and ZE11 are the learners with biggest percentage point change between pre- and post- assessment. Each of them attained 55 percentage point in the overall change of pre- and post- 4 operations assessment. Learner ZE1 got 60 percentage point in addition and multiplication, 20 percentage point in subtraction and 80 percentage point in division. Learner ZE11 attained 20 percentage point in addition, 60 percentage point in subtraction and multiplication and 80 percentage point in division. Therefore, they are regarded as learners with biggest overall percentage point change in this club. However, Learner ZE2 is showing a decrease of – 40 percentage point in subtraction and multiplication, but 20 percentage point increase in change in addition and division and regarded as the learner with lowest percentage point in this club. Now, I present findings for the three lowest performing clubs.

4.3.4 Learner findings for Maths Club R

Learner Code	Total Pre Score	Total Pre %	Total Post score	Total Post %	% Point Chg Addition	% Point Chg Subtraction	% Point Chg Multiplication	% Point Chg Division	Overall % Point Chg
RG1	11	55.00%	13	65.00%	-20.00%	0.00%	0.00%	60.00%	10.00%
RG2	7	35.00%	14	70. 00%	0.00%	20.00%	60.00%	60.00%	35.00%
RG3	13	65.00%	15	75. 00%	20.00%	20.00%	20.00%	-20.00%	10.00%
RG4	9	45.00%	10	50. 00%	0.00%	0.00%	20.00%	0.00%	5.00%
RG5	12	60.00%	14	70. 00%	0.00%	0.00%	20.00%	20.00%	10.00%
RG6	14	70.00%	15	75. 00%	0.00%	40.00%	0.00%	-20.00%	5.00%
RG7	11	55.00%	11	55. 00%	-20.00%	20.00%	0.00%	0.00%	0.00%
RG8	6	30.00%	10	50. 00%	40.00%	20.00%	20.00%	0.00%	20.00%
RG9	5	25.00%	11	55. 00%	40.00%	40.00%	40.00%	0.00%	30.00%
RG10	9	45.00%	11	55. 00%	20.00%	0.00%	20.00%	0.00%	10.00%
RG11	10	50.00%	11	55. 00%	0.00%	-20.00%	60.00%	-20.00%	5.00%
RG12	6	30.00%	10	50. 00%	20.00%	40.00%	0.00%	20.00%	20.00%
AVERAGES	**9.42**	**47.08%**	**12.08**	**60.42%**	**8.33%**	**15.00%**	**21.67%**	**8.33%**	**13.33%**

Table 8: Individual learner progress for Maths Club R

The overall percentage point change in Maths Club R is 13.33. Only six learners got 10 or more scores in pre-assessment. In post-assessment, all learners scored 10 or more out of 20. Learner RG2 achieved an overall 35 percentage point change between pre- and post-assessment. This learner obtained a 20 percentage point change in addition and a 60 percentage point change in both multiplication and division. Learner RG9 as the next biggest percentage point change recorded a 40 percentage point change for addition, subtraction and multiplication in this club. This learner's overall percentage point change between pre- and post- assessment was 30 percentage point. Therefore, Learner RG2 is regarded as the learner with the biggest overall percentage point change between pre- and post- assessment.

On the other hand, Learner RG11 recorded a 60 percentage point change in multiplication and recorded negative changes in both subtraction and division. This learner's overall 5 percentage point change is 5 in pre- and post- 4 operations assessment and is regarded as the learner with the lowest percentage point change in this Maths Club.

4.3.5 Learner findings for Maths Club T

Learner Code	Total Pre Score	Total Pre %	Total Post score	Total Post %	% Point Chg Addition	% Point Chg Subtraction	% Point Chg Multiplication	% Point Chg Division	Overall % Point Chg
TB1	8	40.00%	11	55.00%	-40.00%	40.00%	0.00%	60.00%	15.00%
TB2	8	40.00%	8	40.00%	20.00%	-40.00%	20.00%	0.00%	0.00%
TB3	7	35.00%	7	35.00%	0.00%	0.00%	-20.00%	20.00%	0.00%
TB4	3	15.00%	11	55.00%	20.00%	80.00%	60.00%	0.00%	40.00%
TB5	9	45.00%	11	55.00%	20.00%	0.00%	0.00%	20.00%	10.00%
TB6	6	30.00%	9	45.00%	40.00%	20.00%	20.00%	-20.00%	15.00%
TB7	1	5.00%	7	35.00%	40.00%	40.00%	40.00%	0.00%	30.00%
TB8	5	25.00%	6	30.00%	0.00%	-20.00%	40.00%	0.00%	5.00%
TB9	12	60.00%	13	65.00%	20.00%	20.00%	-20.00%	0.00%	5.00%
TB10	10	50.00%	11	55.00%	0.00%	20.00%	0.00%	0.00%	5.00%
TB11	9	45.00%	11	55.00%	20.00%	0.00%	20.00%	0.00%	10.00%
TB12	13	65.00%	12	60.00%	20.00%	0.00%	0.00%	-40.00%	-5.00%
AVERAGES	7.58	37.92%	9.75	48.75%	13.33%	13.33%	13.33%	-3.33%	10.83%

Table 9: Individual learner progress for Maths Club T

In Maths Club T, the overall percentage point change is 10.83. Three learners achieved 10 or more in the pre- assessment, learner TB9 got 12 (60%) out of 20; learner TB10 got 10 (50%) out of 20 and learner TB12 got 13 (65%) in the pre-assessment. Learners TB1, TB4, TB5, TB10 and TB11 got 11 (55%) out of 20 during the post-assessment. Learner TB9 got 13 (65%) out of 20 and learner TB12 got 12 (60%) scores in post- assessment.

Learner TB4 scored 3 (15%) out of 20 in the pre- assessment but increased to 11 (55%) out of 20 in the post-assessment, showing a percentage point change of 40%. Learner TB4 shows an 80 percentage point change in subtraction and 60 percentage point change in multiplication. This learner has the biggest percentage point change in the pre- and post- 4 operations assessment. On the other hand, Learner TB12 attained 13 (65%) out of 20 in the pre-assessment but decreased to 12 (60%) during the post-assessment that is showing a decrease of 5%. This learner achieved 20 percentage point change in addition; no percentage point change was obtained for subtraction or multiplication and recorded a negative 40 percentage point change in division giving an overall of -5 percentage point change. So, Learner TB12 is regarded as the learner with the lowest percentage point change in this Maths Club.

4.3.6 Learner findings for Maths Club V

Learner Code	Total Pre Score	Total Pre %	Total Post score	Total Post %	% Point Chg Addition	% Point Chg Subtraction	% Point Chg Multiplication	% Point Chg Division	Overall % Point Chg
VAC1	9	45.00%	11	55.00%	20.00%	0.00%	20.00.%	0.00%	10.00%
VAC2	5	25.00%	12	60.00%	40.00%	20.00%	40.00%	40.00%	35.00%
VAC3	12	60.00%	12	60.00%	0.00%	20.00%	0.00%	-20.00%	0.00%
VAC4	9	45.00%	9	45.00%	-20.00%	0.00%	20.00%	0.00%	0.00%
VAC5	11	55.00%	10	50.00%	0.00%	-20.00%	60.00%	-60.00%	-5.00%
VAC6	18	90.0%	16	80.00%	0.00%	0.00%	0.00%	-40.00%	-10.00%
AVERAGES	**10.67**	**53.33%**	**11.67%**	**58.33%**	**6.67%**	**3.33%**	**23.00%**	**-13.33%**	**5.00%**

Table 10: Individual learner progress for Maths Club V

In Maths Club V, the overall percentage point change is 5. The following learners got 10 or more in pre assessment; Learner VAC3 got 12 (60%), Learner VAC5 got 11 (55%) and Learner VAC6 got 18 (90%) scores out of 20 scores in pre-assessment. Learner VAC1 got 11 (55%), Learner VAC2 and Learner VAC3 got 12 (60%) scores each; Learner VAC5 got 10 (50%) and Learner VAC6 got 16 (80%) in the post-assessment.

Learner VAC2 obtained 40 percentage point change in addition, multiplication and division and 20 percentage point change in subtraction in this club. This learner is regarded as the learner with the biggest percentage point change in pre- and post- 4 operations assessment in this club with 35 percentage point, as a result of increasing sores from 5 to 12. On the other hand, Learner VAC6 obtained a negative overall change which amounted to 10 percentage points. This learner did not show workings when answering the questions. The same learner also recorded a decrease in scores from 18 to 16 in division. This learner also shows a negative 40 percentage point change for division. This learner can be regarded as the learner with the lowest percentage point change of this club.

4.4. Findings on learners' methods

This section looks more closely at the methods used by the learners to answer the items in the assessment. This helps to unpack how learners achieved progress shown in section 1.3.

4.4.1. Changes in learners' correct responses between pre- and post- assessment in the six sample Maths Clubs

Maths Club	Correct responses with no shown workings (NSW)			Correct responses using non-tally methods (NT)			Total correct responses excluding tally methods		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
Highest performing clubs									
MATHS CLUB O (7 learners 140 possible responses[1])	46	82	+36	0	4	+4	46	86	+40
MATHS CLUB Y (12 learners 240 possible responses)	94	142	+48	3	3	0	97	145	+48
MATHS CLUB Z (12 learners 240 possible responses)	75	88	+13	11	48	+37	86	136	+50
Lowest performing clubs									
MATHS CLUB R (12 learners 240 possible responses)	89	83	-6	24	49	+25	113	132	+19
MATHS CLUB T (12 learners 240 possible responses)	73	111	+38	12	8	-4	85	119	+34
MATHS CLUB V (6 learners 120 possible responses)	62	52	-10	1	5	+4	63	57	-6

Table 11: Sample of six clubs' changes in six Maths Clubs' learners' correct responses between pre- and post- assessment

In gathering a picture on how the club learners arrived at their answers, I analysed the learners' methods of calculating during both the pre– and post-assessment. I did this for each of the six Maths Clubs presented in the previous section, namely; O, Y, Z, R, T and V.

Overall, Maths Clubs Y and Z have the biggest increase in the use of non-tally methods (+48 and +50 responses). Maths Club V, one of the lower performing clubs has an overall decrease in using non-tally methods.

[1] There are 20 items (questions) on the assessment, giving each child 20 possible responses. This is then multiplied by the number of learners in each club to give a total of possible responses.

Upon closer examination, I noted that in the post-assessment the learners of Maths Clubs O, T, Y and Z calculated their answers without showing workings on the script with +36, +38, +48 and +13 responses respectively. However, in respect of Maths Club R and V, the learners had slight decreases in responses without shown workings between the pre- and the post-assessments. The analysis of the no shown workings also reveals that out of a possible 240 responses, Maths Clubs T and Y show 111 and 142 responses for this category, which equates to approximately 46% and 59% of the responses respectively. Note that Maths Club T is one of the lower performing Maths Clubs and Maths Club Y is one of the top performing clubs.

Maths Clubs R and Z, show the largest positive increases in using non-tally methods (+25 and +37 responses respectively) to answer questions, whilst Maths Clubs O and V, show a positive change of +4 each. Maths Club T shows a slight decrease in the use of non-tally methods.

4.5. Learner vignettes illustrating various calculation methods used

In this section I present in-depth learner vignettes to indicate progression from two perspectives: firstly, on changes in scores attained between the pre- and post-assessments and secondly by examining in detail the methods they used to answer questions in both assessments. I selected two learners from the clubs that achieved the biggest percentage change. Note that once again the data presented focuses on methods used to arrive at correct answers, as this helps to explain the changes in scores between the pre and post-assessments.

4.5.1. Methods used by Learner OC6 for correct responses between pre- and post-assessment.

Table 12: Methods used by Learner OC6 for correct responses between pre- and post-assessments

		ADDITION					SUBTRACTION					MULTIPLICATION					DIVISION					Totals
METHOD	ITEM	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	
		3+4	8+6	23+18	55+67	104+97	8-2	12-5	23-18	467-43	305-97	2x4	5x3	12x4	24x6	120x15	6/3	18/2	24/3	75/3	120/15	
LEARNER OC6																						
NSW	PRE	X																				1
	POST	X	X				X	X				X										5
NT	PRE																					0
	POST			X	X	X			X	X			X	X								7
T	PRE		X	X	X		X	X	X													6
	POST																X	X	X	X		4

Recall that learner OC6 scored 7 (35%) in pre-assessment (see Table 2) and scored 16 (80%) out of 20 in the post-assessment showing an increase of 45 percentage point. Additionally, there is an increase of 20 percentage point in addition and subtraction; 60 percentage point in multiplication and 80 percentage point in division. In the pre-assessment, the learner calculated without showing workings for question 1.1 and used a tally method for questions 1.2 to 1.4 and 2.1 to 2.3 to arrive at the correct responses. In the post-assessment learner OC6 calculated answers to questions 1.1 and 1.2 without showing workings and calculated responses to questions 1.3 to 1.5; 2.1 to 2.4; 3.1 to 3.2 and 3.4 by using non-tally methods. Tally methods were used to calculate the answers to questions 4.1 to 4.3 in the post-assessment. Thus, the data shows that in the post-assessment, there is an increase in the NSW (4) and NT methods (7) used by this learner to work out correct answers.

4.5.2. Methods used by Learner ZE4 for correct responses between pre- and post-assessment.

Table 13: Methods of computing used by Learner ZE4 from Club Z

		ADDITION					SUBTRACTION					MULTIPLICATION					DIVISION					Totals
METHOD	ITEM	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	
		3+4	8+6	23+18	55+67	104+97	8-2	12-5	23-18	467-43	305-97	2x4	5x3	12x4	24x6	120x15	6/3	18/2	24/3	75/3	120/15	
LEARNER ZE4																						
NSW	PRE		X	X			X	X	X			X	X	X								8
	POST	X	X	X	X		X	X				X	X	X								9
NT	PRE																					0
	POST					X			X	X												3
T	PRE																					0
	POST																X	X	X	X		4

In Table 11 it is reported that learner ZE4 calculated all answers without showing workings in the pre-assessment. In the post-assessment questions 1.1 to1.4; 2.1 to 2.4 and 3.1 to 3.4 were answered without using written working methods. Non-tally methods were used to answer question 1.5 and questions 4.1 to 4.4 were answered using a tally marks in the post-assessment. Table 4 revealed an increase of 60 percentage point in addition, 20 in subtraction and 80 in multiplication between the pre and post-assessment. This learner achieved 4 marks out of 5 for division in the post-test. This item: 75÷3 is of a higher standard to the Grade 3 learners, but this learner was able to work it out correctly and obtained a correct response for this item. The findings thus show that learner ZE4 answered more questions correctly in the post-assessment without showing workings or by using non-tally methods. However, some of the more difficult division questions (which are beyond Grade 3 level) were answered using tally methods.

4.6. Summary of Four (4) Operations assessment findings

In this section, I have presented the overall average percentage point changes for each operation for each of 12 clubs. A presentation of a table of each learner's data for six selected clubs was done, focusing on learners who achieved 50% or more in the assessment. The tables presented here from the various clubs which formed part of this study indicated that there was progress in learner scores and methods used in working out responses of the pre- and post-assessment of Maths Club O and Maths Club Z. Of the six selected Maths Clubs, Maths Club learners in Maths Clubs R, T and V did not show much progress in either scores or methods when compared to other clubs after 15 weeks of participating in the after-school maths clubs.

Additionally, in-depth learner vignettes were also presented, to show how some learners have progressed by shifting the methods used to answer questions. An analysis of teachers' interviews will be discussed in the next section.

4.7. Section 2: Findings from teacher interviews

Research question two explores teachers' experiences of learners' changing mathematical proficiency through their participation in the clubs. As indicated in chapter three, the analysis of the teacher interview data revealed four themes: learning environment, learning approach, learner participation and attitude and changes in learner mathematical proficiency. In this section I present data for each of these themes and provide exemplary quotes from the teachers.

4.7.1. Learning Environment

There were a number of responses from the teachers that can be grouped together as pertaining to the learning environment in the Maths Clubs. Teachers D42 and D45 used the term 'relax' multiple times in responses to the interview questions. For example, Teacher D42 highlighted that learners are relaxed during the Math Clubs because they are conducted after school. Teacher D45 indicated that maths clubs gave learners a platform to just relax and do maths. Teacher D45 also mentioned that a maths club is not a formal space because it is after school; hence the child is relaxed. Teacher D45 emphasized the statement; "platform just to relax" four times during the interview. Teacher D48 stated that they (learners) were free and had enough time to do club activities during the maths clubs. The following comments serve to amplify some of the preceding points:

> *I have noticed a very great change from my learners and I have realised that the maths clubs gave them more chance and they also made them to relax because they think that since it is after school there is nothing that is formal. (Teacher D42, Line 1.1, 27 September 2016)*

> *So, I think maths clubs have given them the platform to just relax and enjoy maths and not to take maths as that subject which is boring...a subject which is just working in numbers, like they do in the classroom. (Teacher D45, Line 1.4, 27 September 2016).*

As indicated above, Teacher D45 stated that learners did not take maths as a boring subject in which people just work in numbers, like they do in the classroom. Apparently, the learners were excited and eager to attend the after school maths clubs. This was due to the fact that maths clubs were running after school hours and this made learners feel more relaxed and encouraged them to participate freely. The teachers also highlighted club learners had enough time to do mathematics during the maths clubs.

The second group of responses was related to the club environment being less structured, leading to a number of observations by the teachers. Teacher D45 for example indicated that the learners were excited and eager to attend the after school maths clubs. As previously mentioned, this was due to the maths clubs running after school hours. Teachers also highlighted that club learners had more time to do mathematics activities during the clubs: "they were free and had enough time of doing club activities" (Teacher D48, Line 3.1; 28 September 2016).

Another set of responses focused on small groups. One teacher (D42) highlighted the value of working with a small group of learners rather than many learners in one classroom, which allows one to pay attention to each and every learner in the Maths Clubs. Another supported this idea, stating: "the group we were working with was a group of a small number of children so they were given more attention, unlike in the classroom situation" (Teacher D41, Line 5.3. 27 September 2016). Teacher D49 realised that her club learners could participate individually in a small group of people rather than in large groups. Teacher D42 pointed out that due to working with small groups of learners during the maths clubs, she was able to engage each learner because it was simple to make contact with each one of them. Teacher D43 said that her learners were able to do activities individually.

4.7.2. Learning Approach

This theme deals with the notion of play and learning through play, which was mentioned by a number of teachers during the interviews.

Teacher D42 mentioned that since learning took place through play the learning of mathematics should be done through play. Likewise, Teacher D45 pointed out that learning occurs through play and even stressed that learners were playing and learning at the same time. She further explained that they learnt multiple methods of calculating and they were using them in their classrooms during the period of mathematics. Teacher D42 encouraged learners to take active part in Mathematics by doing things (activities) for themselves without instructing, guiding learners and showing them the appropriate method that they should use in order to arrive at the answer.

Similarly, Teacher D43 mentioned that prior to her participation in maths clubs she did not use games in class but now she sometimes gives the learners some (mathematical) games to play. Teacher D42 said that the playing of games during Maths Clubs is something not formal but this process is helping learners to learn. She also stressed that learners are now able to play these games, because they know the rules of the games. Teacher D43 regarded the playing of games as one of the strategies developed through the clubs which assisted the learners to calculate using different methods. Teacher D49 explained that the learners used the games to practice addition and subtraction. Teacher D41 stated:

> *Learners are enjoying mathematics because mathematics has changed, it is now learning through play. I allowed them to play and learn at the same time. (Line 4.1, 27 September 2016).*
>
> *Learners played mathematical games in clubs. This situation made learners to realize that mathematics can be learnt through play in the maths clubs is not something that is only done formal. Learners used dice to play quick calculations in clubs (Teacher D49, Line 1.2; 28 September 2016)*

The teachers acknowledged that games assisted Maths Club learners in learning mathematical concepts during the Maths Clubs. Now, I present on the views and observations made by the respondent–teachers in terms of the overall participation of participant–learners in club activities and the attitudes displayed by the learners at the clubs.

4.7.3. Learners' participation and attitudes towards mathematics

Comments about changes in learner participation and attitudes towards mathematics were also evident from the teachers' responses in the interviews highlighting eagerness, enjoyment of mathematics and maths becoming more interesting.

Teacher D45 said that she was constantly reminded by her learners that this was the day for the maths club. Teacher D45 stated that she had thought that attendance at afternoon Maths Clubs would decline as time went by; however, to her astonishment the learners enjoyed the after–school Maths Club sessions. They enjoyed these club sessions more than when mathematics was taught in their classrooms during school hours. She also stressed that the learners were excited and "eager for that time of maths clubs" (Teacher D45, Line 1.2; 27 September 2016) and that they liked maths now.

Teacher D47 stated that she used the fizz pop game in clubs and had seen that the learners enjoyed mathematics. Likewise, Teachers D41, D42 and D45 pointed out that learners were enjoying mathematics. Teacher D45 summed up this theme by indicating that learners are excited when they think of maths club. She does not know why learners are so excited when they think of maths clubs. Teacher D41 indicated that learners found club lessons interesting, while teacher D44 mentioned that learners show more interests in maths now. The use of worksheets, they said, made learners show interest as well, unlike writing in their normal class exercise books.

Teacher D41 mentioned that everything is now a little faster and more interesting to the learners. Teacher D48 said that her club learners were motivated to participate in maths clubs because playing games motivated them. Additionally, the idea of participating with learners from other schools encouraged the learners to participate actively in the Maths Clubs. Furthermore, Teacher D48 indicated that her club learners "share the information of the after school maths clubs with other learners at school" (Teacher D48, Line 4.5, 28 September 2016) by showing them the club activities they did during the Maths Clubs and saying to them that they were learning a lot at the Maths Clubs.

Thus, this section highlight that as a result of their participation in Maths Clubs, the learners were more interested in Mathematics and were enjoying this subject. Club learners were motivated to participate in these clubs and even shared the activities done in the Maths Clubs with other learners at school (i.e. with non-club learners).

4.7.4. Changes in learner mathematical proficiency

In this category, three groups of responses emerged from the teachers' responses. One, children were working faster; two there was some evidence of them using a range of more flexible strategies to solve problems and three, there were a number of positive changes in terms of observed in the learners.

Teacher D43 pointed out that the use of games helped her club learners to count faster. Teacher D41 pointed out that the club learners were using flexible strategies, and these were more flexible than in the past. In support of her prior statement, Teacher D49 highlighted that learners can count independently and can work out the sums on their own. Additionally, Teacher D43 mentioned that the teacher would "chip in" (Teacher D43, Line 5.5, 27 September 2016) only when club learners were unable to continue on their own. Teacher D41 pointed out that Maths Club learners were more active than before and said that it was not like previously when learners used only their teachers' strategies when working out their answer.

Numerous participant–teachers reflected on the counting strategies used by their respective learners during Maths Club activities. According to Teacher D41, learners used to count figures by making lines and Teachers D43 and D46 pointed out that initially learners used tally marks and their fingers to calculate their answers. Teacher D44 pointed out that learners refrained from using fingers when they counted after participation in the after-school Maths Clubs. Similarly, Teacher D46 mentioned that initially learners used the tally marks, but they do not use this method anymore. Teacher D41 highlighted that learners were calculating mentally: "they like doing Mathematics mentally, calculating it mentally without (using) making sticks" (Teacher D41, Line 2.2; 27 September 2016). This teacher went on to point out that the learners no longer use ineffective strategies.

Teacher D43 stated that since learners were attending the Maths Clubs they were able to 'say' the multiplication tables mentally. Teacher D49 indicated that they know how to count by using skip counting. Teacher D46 mentioned that they count in fives, e.g. 5 X 5 = 25. Teacher D47 pointed out that they know that if you multiply you start by breaking down, afterwards you build up thereafter you will get the answer. Teacher D41 pointed out that the learners are using more flexible strategies than in the past. Excitedly, Teacher D48 mentioned that most of her learners stopped using the ineffective method of counting (i.e. using fingers when counting their answer) in working out their answers. However, not all learners made progress. Teacher D46 referred to one male learner, saying that if the learner finds that to count in tally marks is delaying him, he opts to calculate his answer by counting in fingers.

Teacher D49 noted that learners can now work out the sums on their own. Teacher D42 specified that learners can count with their fellow partners. Teacher D42 stated that learners have learnt a lot. Teacher respondents highlighted a number of positive changes emanating from participation in after–school Maths Clubs. For example, Teacher D47 indicated that her learners were not struggling anymore [with concepts of Mathematics] and that she was also enjoying Maths Club sessions.

Teacher D46 stated that as a result of attending Maths Clubs, her learners "gained a lot on how to multiply and divide" (Teacher D46, Line 1.4, 28 September 2016). Teacher D49 stated that her Maths Club learners previously did not know how to work out their Mathematics sum, but now they have realised that it is simple to do them. Teacher D48 mentioned that there were certain Maths Club learners who have improved especially in respect of doing calculations. She also pointed out that since these club learners attended the Maths Clubs, learners who had been identified as low achievers in Mathematics by their teachers at school had progressed. The stated quote below is an example of what is stated above:

> *But, since they (learners) attend the Maths Clubs, even those who were regarded were low achievers in Mathematics have progressed (Teacher D48, Line 1.5, 28 September 2016).*

Similarly, Teacher D45 pointed out that teachers would be able to detect that certain Maths Club learners had the potential of computing in Mathematics, something which they were not aware of in the actual classroom. The following quote strengthens what is mentioned above:

> *In a sense you will notice that this child has certain potential; which a teacher was not aware of (Teacher D45, Line 1.6; 27 September 2016)*

Teacher D48 said that Maths Club learners shared club activities with non-participants of Maths Clubs at their school. Similarly, Teacher D45 also indicated that Maths Club learners in her classroom shared the strategies of computing in the classroom with non- club participants following the teaching method she mentioned in the preceding paragraph.

To summarise, teachers mentioned that in the beginning of the Maths Clubs' learners mostly used the method of working out their answers by counting with their fingers to get the correct answers. They indicated that most of these Maths Club learners had stopped using this method and were using more effective strategies when working out their answers.

4.8. Conclusion

In this chapter I presented the findings of this study. The findings were divided into two sections. In the first section I focused on the pre- and post- 4 Operations assessments written by each of the learners who participated in the Maths Clubs. In the presentation of the pre- and post-assessment findings I paid attention to the overall percentage change between pre- and post-assessment in each of the 12 clubs. I also presented more detailed findings for three biggest percentage changes and the three lowest percentage changes between the pre- and post-assessment scores registered by some of the Maths Clubs. Furthermore, I presented findings regarding the methods used by some of the Maths Club learners in order to obtain the correct answers and in order to provide some insight into how score changes came about. In the second section I presented the findings of the one–on–one interviews conducted with the teachers who participated in this study. In my presentation of the interview findings I made an effort to provide a thick description of the comments made by the respective respondent–teachers. In the next chapter I provide the discussion of the findings.

CHAPTER 5: DISCUSSION OF RESULTS

5.1. INTRODUCTION

In the previous chapter I presented detailed findings in respect of the learners' progress in the four operations assessment and the one–on–one interviews with the teachers who participated in this study. In this chapter I discuss how the findings enabled me to respond to the research questions which guided this study, regarding the changes that are evident in learners' mathematical proficiency over the period of club participation and the teachers' experiences of learners' changing mathematical proficiency as a result of participating in the club.

In this chapter I discuss the findings in three subsections: 1) changes in learner scores, 2) shifts in learner methods and 3) teachers' observations to support why these shifts in learners' mathematical proficiency may have come about.

5.2. CHANGES IN LEARNERS' SCORES

In the previous chapter, I presented details of changes in individual learners' scores and percentages between the pre- and post-assessments across all clubs. Furthermore, I provided details for the three highest performing clubs and the three lowest performing clubs.

Based on those findings I argue that all Maths Clubs show positive change over the 15-weeks in which the programme took place. Table 1 in Chapter 4 indicates that overall, the clubs show varying progress ranging from a 5 percentage point change in Maths Club V to a 27.5 percentage point change in Maths Club Z. The data also shows that the learners participating in the programme scored, on average, 3.41 more marks (equating to an improvement of 17.02 percentage points) in the post-assessment.

Although all the Maths Clubs show positive change, not all the Maths Clubs made *substantive* progress. Table 1 in chapter 4 indicates that in the lower performing clubs (R, T and V); the average is less than 15 percentage points. Other Maths Clubs (P, Q, S, U, W and X) show an overall average point percentage change between 15 and 20 percentage points and the three higher performing clubs showed changes over 20 percentage points (Maths Clubs O, Y and Z). The types of shifts in overall progression for learners participating in Maths Clubs have also been noted by other SANC Project researchers such as Stott (2014) and Wasserman (2015). I now, discuss the findings related to the progress made by individual club learners.

The data of individual learners in the Maths Clubs shows varying progress (see Tables 2 to 7 in chapter 4). None of the learners in the six Maths Clubs presented achieved a 100% score in the post-assessment, although a number did achieve 80% or more such as OC6, YD9, ZE1, ZE4, ZE5, ZE7, ZE10, VAC6 (tables 2 to 7 in chapter 4). Apart from VAC6, all these learners were in the higher performing Maths Clubs. Achieving 80% for the post-assessment indicates that they correctly answered 16 or more of the 20 assessment items. Five of the 12 learners in Maths Club Z are in these top achievers (see table 4 in chapter 4), which has the biggest overall percentage point change of 27.5.

In the higher performing clubs, learners' overall percentage point changes range from -20 (see OC2 and ZE2) to +65 (see YD12, ZE1and ZE11). In the lower performing Maths Clubs, the average percentage point change is less than 15 and the range of change is from -10 (VAC6) to +40 (TB4).

Learners with larger changes like this were correctly answering between 11 and 13 more questions in the post-assessment than they did in the pre-assessment, which included answering some of the more difficult multiplication (items 3.3 to 3.5) and all of the division items. The learners were able to correctly answer more questions in the allotted assessment time than they could before.

The South Africa curriculum (DBE, 2011) expects Grade 3 learners to add 3-digit numbers to a 2-digit number, to subtract a 2-digit number from a 2-digit number, to multiply single digit by single digit or 2-digits by single digit and to divide any number by any of the following numbers; 2, 3, 4, 5, 10. Although the Maths Clubs are not constrained by the curriculum, some of the focus in the Maths Clubs was on developing these requirements. I noted in Tables 9 and 12, that some club learners were attempting more difficult items with 2 and 3-digits by 2- digit numbers in the post-assessment. This is supported by the findings that for the entire programme across all Maths Clubs, multiplication and division increased by 20.89 and 18.95 percentage points (see table 1). However, in my view, some of this could be attributed to natural progression in the classroom. I will discuss this in more detail in the next section.

5.3 SHIFTS IN LEARNER METHODS

The shifts in scores are reflected in the methods Maths Club learners used to answer the assessment items. In the higher performing Maths Clubs, the first three items in each operation (except division) tended to be answered correctly without showing workings on the scripts. When attempting to answer harder multiplication and division questions, the learners resorted to using tallies (see ZE4 and OC6). When these learners fall back in order to use tally methods during the process of calculating their responses it indicates that South African learners are bound to concrete counting methods (Ensor, et al., 2009; Schollar, 2009; Weitz, 2012).

Learner OC6 for example used tallies to calculate all but the first assessment item in the pre-assessment, scoring 7 out 20 (Table 9). In the post-assessment, the learner's score increased to 16 out of 20. No workings were shown for the single digit items in each operation (i.e. 3 + 4; 8 + 6; 8 – 2; 12 – 5 and 2 x 4) which suggests progression in procedural fluency as the learner may be more fluent with the basic number facts to 10 and the earlier multiplication facts. Non-tally methods of calculating were used to work out 2 by 2-digit and 3 by 2-digit items in the post-assessment rather than tally methods, which may indicate the beginning of conceptual understanding or number sense. Learner OC6 resorted to using tallies for the division items.

In the post-assessment, I noted that the methods used to answer the more difficult multiplication and division items were different and revealed improved procedural fluency (as indicated by the increased efficiency of methods and the accuracy of learner answers). Using Maths Club Z's method data as a basis for discussion, it is worth exploring this change in more detail.

Table14: Maths Club Z - summary of learner methods used for multiplication and division items in pre-assessment

Assessment Item Pre-assessment	**Frequency of…**							**Totals**		
	Correct answers NSW	**Correct answers NT**	**Correct answer using TALLIES**	**Wrong answer NSW**	**Wrong answer NT**	**Wrong answer using TALLIES**	**Not answered**	**Number of correct answers**	**Number of wrong answers**	**Number of answer using tallies**
Multiplication										
2x4	8			4				8	4	0
5x3	6			6				6	6	0
12x4	4	1	1	6				6	6	1
24x6		1		9		2		1	11	2
120x5				9	2	1		0	12	1
Multiplication Totals	*18*	*2*	*1*	*34*	*2*	*3*	*0*	*21*	*39*	*4*
Division										
6÷3	4		1	7				5	7	1
18÷2	3		2	7				5	7	2
24÷3	1	1		8		2		2	10	2
75÷3				8	2	2		0	12	2
120÷15				8	2	2		0	12	0
Division Totals	*8*	*1*	*3*	*38*	*4*	*6*	*0*	*12*	*48*	*7*
Overall Totals	**26**	**3**	**4**	**72**	**6**	**9**	**0**	**33**	**87**	**11**

In the pre-assessment there were more incorrect responses *without shown workings* (34) than correct ones (18) for the multiplication items. The correct ones were mostly for the easier items such as 2 x 4, 5 x 3 and 12 x 4. It is possible that the learners already know these as multiplication facts. A similar story is shown for division with 38 incorrect responses and 8 correct ones. The responses, for both operations and for both correct and incorrect responses using *non-tally methods* are low.

Table 15: Maths Club Z -Summary of learner methods used for multiplication and division items in post-assessment

	Frequency of ...							Totals		
Assessment Item Post Assessment	**Correct answers NSW**	**Correct answers NT**	**Correct answer using TALLIES**	**Wrong answer NSW**	**Wrong answer NT**	**Wrong answer using TALLIES**	**Not answered**	**Number of correct answers**	**Number of wrong answers**	**Number of answers using tallies**
Multiplication										
2x4	9	3						12	0	0
5x3	9	3		2	1			12	3	0
12x4	7	2		2	1			9	3	0
24x6	1			2	9			1	11	0
120x5	1			6	5			1	11	0
Multiplication Totals	*27*	*8*	*0*	*12*	*16*	*0*	*0*	*35*	*28*	*0*
Division										
6÷3	4	1	4	2	1			9	3	4
18÷2	2	1	4	5				7	5	4
24÷3	4	1	3	4				8	4	3
75÷3	1	4		6	1			5	7	0
120÷15		1		7	4			1	11	0
Division Totals	*11*	*8*	*11*	*24*	*6*	*0*	*0*	*30*	*30*	*11*
Totals	**38**	**16**	**11**	**36**	**22**	**0**	**0**	**65**	**58**	**11**

In the post-assessment there were more correct responses *without shown workings* (27) than incorrect ones (18) for the multiplication items. The number of responses for the easier multiplication table items has increased (2 x 4; 5 x 3 and 12 x 4) and there are two correct responses for the two harder items. For division, there are still more incorrect responses (24) than correct responses (11), but the number of responses to the non-tally (NT) methods in both correct (8) and incorrect (6) categories increased.

According to the Foundation Phase Mathematics CAPS document (DBE, 2011), equal sharing and grouping in foundation phase encourages learners to share or group numbers up to 100 by groups of 2, 3, 4, 5and 10 in Grade 3. In the 4-Operations assessment, Maths Club learners were asked to divide 120 by 15, something which, according to CAPS, is not expected at Grade 3 level. I noted how Maths Club learners responded to this item. I detected that they were unable to answer this item, as it is not covered in the curriculum for Grade 3 learners (DBE, 2011). I suggest that it might be that learners are only introduced to actual division sign (as used in the assessment) only from Grade 3. In Grades R to Two, division is introduced as sharing or grouping of numbers (DBE, 2011) and the sign is not used.

However, in the post-assessment, six Maths Club learners attempted to answer the item using tally and non-tally (NT) methods. Using the data for Maths Club Z, in the pre-assessment none of the learners answered this item correctly but 12 did try it using all three methods (NSW, 8; NT, 2; and tallies, 2). In Maths Club Z's post-assessment, one learner worked it out correctly using a non-tally method, and more learners attempted it than in the pre-assessment with 24 NSW and 6 NT methods.

This data suggests that learners had more time to attempt the harder items in the post-assessment. This could be attributed to an increase in their procedural fluency (Kilpatrick et al. 2001) with basic multiplication facts and or an increased understanding of the structure of number. Through the Maths Clubs, learners were exposed to activities that encouraged the development of number sense, and they were encouraged to use that number sense to calculate answers in the Maths Club activities, including the assessment. Additionally, many of the learners were exposed to division for the first time during the Maths Club.

The data presented in Tables 8 to 12 in chapter four, show a shift from using the more concrete method of tallies to more efficient non-tally strategies of computing as well as a shift to not showing workings at all. The increased number of responses without showing workings, may point to an increase in procedural fluency (Kilpatrick et al., 2001) in that they are able to work problems out mentally or they know their facts or, alternatively, because they have a better understanding of the structure of number. The increase in responses with non-tally methods could indicate the beginnings of understanding of place value and conceptual understanding of operations used during the maths clubs.

This could be attributed to participation in clubs as observed by the teachers. In my opinion, the fact that prior to participation in Maths Clubs, some learners could only work out answers using ineffective count-by-one (concrete) strategies, also attests to the fact that South African learners are bound to concrete counting strategies (Ensor, et al., 2009; Schollar, 2009; Weitz, 2012). The PfP Programme outlined in this study provided the learners with opportunities to develop their conceptual understanding and procedural fluency as well as their number sense (Kilpatrick et al., 2001). Hence, it can be argued that, as international and local researchers point out, learners' efficient strategies can be developed as early as Foundation Phase (DBE, 2011; Bobis, 2008). In the interviews, teachers concurred with this, also noticing shifts in strategies used by learners.

5.4. POTENTIAL REASONS FOR THE SHIFTS IN LEARNERS' MATHEMATICAL PROFICIENCY: TEACHERS' OBSERVATIONS

As indicated above, learners made progress during the Maths Club indicating that elements of mathematical proficiency improved, percentage-wise, after the learners had participated in the after-school Maths Clubs. This change was recorded in respect of each of the four Basic Operations; addition, subtraction, multiplication and division. Although it might be difficult to pinpoint the main reason why these changes occurred, however, a closer analysis of various factors might provide an idea as to the reasons why this happened. In this section, I refer to the observations made by the teachers in the one-to-one interviews in this regard.

Teachers D41 and D45 suggested that the learning environment was more "relaxed" thereby enabling learners to participate more actively and freely in Mathematics activities. Likewise, two out of nine interviewed respondents suggested that working in "small groups" enabled them to "give more attention to individual learners" and that learners were also able to engage in collaboration. These factors may have contributed not only in respect of influencing the learners to have "positive attitude" (Teachers D45 & D46) towards the learning of Mathematics but the learners became keener to engage in collaborative learning.

Literature suggests that some of the factors highlighted above have the propensity to assist in terms of improving learner participation in the classroom situation and, indeed, also contribute towards improvement in learner achievement in the subject. For example, Terwel (2011), argues that "small groups offer group members the opportunity to profit from the knowledge that is available in the group as a whole; this may take the form of knowledge, skills and experiences that not every member of the group possesses" (p.5). Additionally, the collaboration that occurs in small group settings affords the group members with the opportunities to "verbalize their thought" (ibid.). These "verbalizations facilitate understanding through reorganizations" (p. 5) culminating in learners improving their comprehension, insights and application of Mathematics.

Additionally, the learning environment, which was also characterised by 'learning through play', seemingly led to the creation of the "relaxed" atmosphere. This was evidenced by, for example, learners chatting and laughing with one another while engaging with the games and activities. A wide range of literature argues that play has a cardinal role in learning and teaching, including Mathematics Education (e.g. Smit 2015; Kennedy & Barblett 2010; Dockett & Perry 2010). Accordingly, Dockett and Perry (2010) write that, "play has long been regarded as a critical element of early childhood curriculum and pedagogy" (p. 716) and that play has the potential "to facilitate children's mathematical thinking" (ibid). Playing enables young children to relax and thus helps them learn much better. Therefore, in the context of this study, learning may have taken place while these learners were engaged in playing card and dice games in the Maths Clubs. In essence, it is possible that the Maths Club may have provided these learners with free space and gave them a chance of exploring efficient strategies of working out their sums in order to arrive at the correct answers. The increased relaxation of learners in relation to the Maths Club's inclusion of Mathematics games (learning Mathematics through play environment) was furthermore noted by teachers. This is captured in one of the participant–teacher's quote below:

> *I have noticed a very great change from my learners and I have realised that the Maths Clubs gave them more chance and they also made them to relax because they think that since it is after school there is nothing that is formal. (Teacher D42, Line 1.1, 27 September 2016).*

Likewise, literature also points to a correlation between the learning environment and the attitude learners have towards the learning of Mathematics (e.g. Rikhotso 2015; Maat & Zakaria, 2010; Tswani, 2009). This correlation impacts on learner achievement in Mathematics. A "relaxed" classroom, referred to by the teachers who participated in the study may be attributed, at least in part, to a healthy working relationship between the learners and teachers, culminating in learners' improved performance in Mathematics. Certainly, as this study suggests (please cf. chapter 4), there are numerous other factors that contributed to an improvement in learner achievement as reflected in the distinctions between the various operations in the pre- and post-assessment scores.

The improvement in learner proficiency cannot only be said to have confined itself to the improvement in scores as measured in terms of the pre– and post–assessments highlighted above. The teachers suggested that some of the learners who participated in the Maths Clubs were eager to share their knowledge with those learners who did not participate in the after–school maths clubs. For example, two teachers said that Maths Club learners shared club activities with non-participants of Maths Clubs at their school. I argue that when learners share new strategies with their classmates once they return to their respective schools indicates a change in their attitudes towards Mathematics and reflects their changing confidence. In this case, mathematical proficiency allowed these learners to confidently share Mathematics activities with non-club learners.

Teacher D42 noticed that club learners could confidently workout Mathematics activities (DBE, 2011; Stott, 2014). Teacher D45 was astonished to note see that learners did not regard Mathematics as a boring subject when they attend the after-school maths clubs. Learners were actively involved with Mathematics activities in the Maths Clubs. Because they enjoyed what they were doing in the Maths Clubs, they were even eager to do other Mathematics activities in these Maths Clubs. In my view, the Maths Clubs helped to overcome the tendency of the learners to view Mathematics as an enemy of our learners, culminating in them developing a negative attitude towards the subject. Hence, Teacher D45 noted that learners regarded what was happening in their classrooms (at their schools) as boring compared to what they did in the after-school Maths Clubs.

The reflections by some of the teacher-respondents, as epitomised by the points made by Teachers D42 and 45 in the preceding paragraph, suggest that the Maths Clubs provided the teachers with an opportunity to reflect on their own teaching practices. Hence, I would argue that this reflexivity should, in turn, enable them to learn from each other in order to improve their teaching practices so that learners should learn and acquire more skills of computing in Mathematics.

Teacher D41 highlighted the value of working with a small group of learners. My opinion is that if one is working with a small group of learners, the outcome of this situation is that learners would be able to understand the instruction because the teacher would be able to identify some of the challenges and the deficiencies projected by the learners and thereby provide timely intervention. This should contribute towards enabling learners to be assisted on time when he/she does not understand the concept in order to navigate some of their mathematical challenges and, subsequently, to a positive shift in their mathematical proficiency Therefore, by working with a small group of learners the teacher should be able to pay more attention to each and this enhances the prospects of providing timely intervention when required to do so.

Glewwe, Hanushek, Humpage, Ravina, et al. (2011) indicate that large increases in class sizes have a negative impact on the learning of the learners in that it is difficult for the teacher to provide individual attention to the learners. Hence, the small groups make the teacher's work lighter and also offer group members the opportunity to profit from the knowledge that is available in the group as a whole. Working in a small group, contributes towards learning from each other and at each other's level. Learners learnt a lot from their engagement with and in the Maths Club activities during the Maths Clubs' sessions. This could be attributed to the fact that during the activities the learners worked in small groups. Thus, I would argue that working with small groups enabled the teachers in this study to help learners improve their mathematical proficiency.

In chapter one of this study, I highlighted some of the challenges that prompted the undertaking of this study. One of the key challenges mentioned has to do with poor learner proficiency in respect of, among other things, number sense, computing and four operations in the foundation phase. These challenges necessitate early intervention in order to offset poor learner performance in Mathematics (Wright, 2013; Graven & Venkat, 2017), especially, in later years.

Literature suggests that early (i.e. Foundation Phase level) intervention is important in ameliorating some of the challenges that would arise in later years (Wright, 2003; Wright, Martland & Stafford, 2006; Wright, 2013; Graven & Venkat, 2017). As indicated in the previous chapters (cf. chapters 3 and 4), as a key strategy to intervention, the Pushing for Progression (PfP) programme in this study participated in the Maths Clubs. It was envisaged that through this programme, it was possible that participant–learners would learn, among other things, efficient strategies for calculating as evidenced in literature (Schollar, 2008; Graven, et al, 2014; SANC, 2016) and subsequently progress from using less inefficient to more efficient strategies (Wright, Matthews & Stafford, 2006; Schollar, 2008; Ensor et al., 2009). This would possibly be discernible in the development of the learners' number sense, which means that it is possible that learners would be able to work efficiently and effectively with numbers.

5.5. CONCLUSION

In this chapter I presented the discussion on the findings in relation to the changes in learners' scores and discussed the positive changes which occurred as evidenced by comparison of the pre and post-assessment scores. I also presented possible reasons and related these to other literature in a wide range of contexts, for the shifts in learners' methods of computing. These reasons were furthermore connected with teachers' comments during the one-on-one interviews. In the next chapter I present a summary of the study and the limitations and recommendations.

CHAPTER 6: SUMMARY, CONTRIBUTION, LIMITATIONS AND RECOMMENDATIONS

6.1. INTRODUCTION

In the previous chapter I presented a discussion on the findings of this study. In this chapter, I present the summary of the entire study. I also present the contributions and limitations of this study and provide recommendations emanating and informed by the findings of this study.

6.2. SUMMARY OF THE STUDY

The purpose of this study was to explore the Grade 3 learners' changing mathematical proficiency when participating in after-school maths clubs, the focus of the Pushing for Progression programme is on number sense and Operations. An investigation was conducted by administering pre- and post-assessment of Grade 3 learners in Maquassi Hills. The findings of this study indicate that the Grade 3 learners' who took part in this study achieved better results in post-assessment compared to the results of the pre-assessment. This was discernible from the overall average percentage change of scores which indicated an increase of 17, 02% in overall percentage change between the pre and post assessment scores. The study also found that there was an improvement among some of the learners when it comes to the computing of responses to provided questions. For example, as indicated in chapter 4 (section 4.3.1 - 4.3.6) there was a shift from using inefficient strategies (tally-based methods) to more efficient strategies (not showing workings method) of computing in this study.

Similarly, the one–on–one interviews with selected participant–teachers suggest that, as a consequence of participating in this study, numerous learners developed in mathematical proficiency resulting in personal confidence to a point where they were even able to share methods that they acquired at the Maths Clubs with the non-club learners in their schools. These teachers also pointed out that they realised that by working in small groups, learners were able to grasp mathematical concepts much better because of the group environment that facilitated meaningful engagement between the participants (i.e. there was meaningful learner to learner and learner to teacher engagement) during the Maths Clubs.

Based on the preceding points, it is my considered view that it is appropriate to conclude that participation in the Pushing for Programme within the after–school Maths Clubs' context, the learners who took part in this study showed progression in numbers sense and Operations.

Hence, the learners' achieved an overall percentage change of 17, 02% in post-assessment. I turn my attention to the discussion on the contribution of the study.

6.3. CONTRIBUTION OF THE STUDY

On the basis of my analysis of the findings of the study, I am of the view that this study has made some modest contributions that could be of significance to mathematical pedagogy. The following are some of those contributions:

The teachers who took part in this study identified the learners that they considered to be struggling with concepts of Mathematics and using inefficient strategies of computing from their schools. The Pushing for Progression programme was implemented in order to aid these learners while they are in Foundation Phase at an early stage. One needs to state that, as literature suggests, it is crucial to address poor performance in Mathematics at an early stage (i.e. in Foundation Phase) to prevent the increase of the gap knowledge of Mathematics between low attaining and able learners (Wright, Martland & Stafford, 2006; Wright, 2013; Graven & Venkat, 2017).

Hence, it is my considered view that this study amplifies the significance of early intervention as one way in which mathematical proficiency could be improved as early as Foundation Phase. More significantly, this study indicates that the Pushing for Progression strategy, an intervention strategy that is, arguably, still in its infancy provides insights on how mathematical intervention could be conducted in Foundation Phase. However, I also need to point out that this does not suggest that this strategy is the panacea for all cases where mathematical proficiency is deemed to be lacking or that it is cast in stone but rather a strategy that could be used as one of the solutions towards abating the challenges of mathematical proficiency.

The other point worth mentioning is that based on the observations by participant–teachers during the one–on–one interviews, it was evident that the Maths Club environment was empowering for both the teachers and the learners alike. I have already referred to the improvements noted in leaners' mathematical proficiency (please refer to section 6.2, above). From the utterances made by some of the teachers, it is evident that participation in the PfP Programme enabled teachers to reflect on their individual practices and interact with one another thereby share pedagogical strategies and good practices. Literature (e.g. Killion, 2015; Carroll, Rosson, Dunlap & Isenhour, 2005) underscores the importance of collaboration and cooperation as an important approach towards improving teacher efficiency and effectiveness. Accordingly, Killion (2015) argues that "when teachers engage in high quality collaboration that they perceive as extensive and helpful, there is both an individual and collective benefit" (p. 62). Indeed, based on the statements made by participant teachers in this study this assertion by Killion (2015) seems to be spot on. Therefore, this study accentuates the value of creating platforms for teachers to interact regularly and share ideas thereby improve their classroom practices. The PfP Programme conducted within the context of after-school Maths Clubs does provided an enabling environment for meaningful interaction between teachers and learners. Additionally, the teachers' in-service training of the Pushing for Progression Programme which was implemented enabled them to reflect and improve their teaching practice. It was evident from their interview observations, that they learned a lot from one another during the Maths Clubs.

Despite making some contributions, this study has notable limitations. The following section reflects on some of those limitations.

6.4. LIMITATIONS OF THE STUDY

This study, like any other empirical inquiries has some limitations. The following are some of the limitations of this inquiry.

In the one of the sections in this chapter, I indicated that the Pushing for Progression Programme is a relatively new maths intervention programme. Accordingly, it is my view that novice researchers like myself could have benefitted more from more experienced scholars and researcher in respect of the 'know how' on the presentation of this programme. Indeed, my supervisors did play a sterling role in providing me with guidance, training and on–going support on how to go about conducting the PfP Programme.

However, owing to distance challenges, I introduced and conducted the Pushing for Progression Programme to 12 Grade 3 teachers and 144 Grade 3 learners in North West for this study by myself. For this reason, there were inherent limitations in this study. The following are some of the challenges I encountered: I did not have hands-on support and guidance in the research field from an expert who had implemented the programme in the past. Since, this programme was implemented for the first time in the North West; I did not have a 'blue print' or 'passport' to help me navigate the new and challenging road.

Additionally, even though the results of this study suggest that the learners who participated in this study made progress by using the Pushing for Progression Programme, my view is that the duration of the programme was short. Therefore, in my view, this programme required a longer duration.

Numerous competing activities in the North West Department of Education(NWDE) often hindered the programme. All participants, i.e. the learners and teachers, and at time the researcher (me) had to participate in some of the activities that often clashed with our programme. Some of these activities were mandatory and thus, at times, compelled cancelation, rescheduling. Some of the departmental programmes that derailed the after-school Maths Clubs' PfP Programme include the following: Foundation Phase Teachers' Professional Support Forums, participation of teachers and learners in enrichment programme which took place in the afternoons at their respective schools, etcetera.

In order to accommodate all these programmes, the participant–teachers and I rearranged the days of attending the clubs in order to complete the 15 weeks' programme of attending the after-school maths clubs. Hence, in the long run, the learners became disorientated and did not know when they were supposed to attend the clubs. The next point of discussion focuses on the recommendation flowing from this inquiry.

6.5. RECOMMENDATIONS

The recommendations presented in this section are divided into two parts, namely: recommendation on Departmental Policy and recommendations for Future research.

6.5.1. Departmental Policy

The Pushing for Progression Programme is organised systematically and coherently with clear objectives for the teachers and clear instructions for the Maths Club learners. This arrangement allows the Maths Club teacher to develop a particular operation before introducing another operation in the Maths club learners' minds. For this reason, the chances of Maths Club learners in grasping the essence and application of each operation are enhanced. Therefore, my view is that this programme could be considered for implementation in our schools as it has the potential to provide learners with opportunities to systematically engage with and grasp the Mathematics concepts, particularly of 4 Basic Operations.

Additionally, in light of the fact that the PfP programme as implemented in Maths Clubs, just like the NWDE Intervention Programmes, seek to achieve the same goal of improving the learning and teaching of mathematics and, that they are targeting the same audience (of learners and teachers); instead of provincial programmes taking precedence as it is currently happening, I suggest that these intervention programmes be aligned. Therefore, the NWDE should consider the inclusion of the PfP Programme in its Calendar of Events both at Provincial and District level and not just as an add-on, going forward.

6.5.2. Future Research

In my view, an inquiry should, among other things, be able to help participants address their daily challenges in their natural settings. Therefore, based on the verbal accounts of the teachers who participated in this study, it can be argued that there was an evolution in the participants. For example, participant-teachers improved their pedagogical strategies and learners demonstrated meaningful improvements in mathematical proficiency. However, it might be argued that these 'changes' need to be tested beyond the realm of the Maths Club settings and more importantly, beyond the fixed period of the inquiry.

Perhaps, it might be necessary to investigate the 'transfer of skills' by the Maths Club learners and how proficiency detected during their participation in Maths Clubs' manifests in the schools where these learners attend on a daily basis. For instance, the following questions may need to be investigated:

- How does the school performance (in mathematics) of afternoon Maths Clubs' learners compare to that of learners who do not participate in Maths Clubs?
- Is there any evolution or progress, over-time (e.g. over a period of three years), in mathematical proficiency of the learners who participated in Maths Clubs (especially participation in PfP Programme)?
- To what extent do teachers apply their knowledge acquired through participation in Maths Clubs PfP Programme in their classrooms (outside of the Maths Club context)?
- Do the teachers who participated in the PfP Programme share their knowledge with the teachers who did not participate in Maths Clubs?
- What kind of collaboration exists between the Maths Clubs' teachers outside of the maths club context (i.e. does participation in the afternoon Maths Clubs' PfP

Programme lead to 'long term' collaboration among the teachers outside of the Maths Club context)?

In addition to the above–mentioned points, I would also recommend that studies of similar nature be conducted in other geographical regions across the country. Since the PfP Programme is relatively 'young' its effectiveness needs to be widely tested across a range of contexts.

6.6. MY PERSONAL GROWTH

Involvement in the PfP Programme gave me the opportunity to present preliminary findings from this study to the AMESA's congress delegates in 2016 at Mpumalanga. In January 2017, I presented this study's results to SAARMSTE delegates in Bloemfontein. Participation in such conferences has, undoubtedly, contributed towards my growth as an emerging researcher and a Mathematics teacher educator in that it has enabled me to learn from other scholars and practitioners. Such participation has furthermore helped me in creating and expanding my network of researchers and practitioners who share my interests.

Additionally, because of this study and especially the difference it seems to have made, albeit modest at this stage, the curriculum Chief Education Specialist of my district (Dr. Kenneth Kaunda in the North West Province) has encouraged me to implement the formation of Maths Clubs from Foundation Phase to Senior Phase in Maquassi Hills Area office. Hence, I would argue that this study has enhanced my professional impetus in the North West Department of Education, especially, at district level.

After conducting this study, I have learned a lot on how to detect problems and assist learners who are bound to the inefficient strategies of computing in Mathematics. Likewise, I have noted that, to some degree the teachers who took part in this study have developed their teaching practice and that their learners improved because they now tend to use efficient strategies of computing. Certainly, this study has not only enabled me to grow but I sense that there are still many other growth opportunities ahead of me. Lifelong learning will always be a part of my professional work and, therefore, this research and its strong connection to supporting teachers and learners has supported my lifelong learning trajectory.

6.7. CONCLUSION

As noted in chapter one, this study arose from the realisation, as informed by my professional practice as a Foundation Phase Mathematics Subject Advisor; that learners tend to use inefficient and error-prone procedures of computing the four Operations in Grade 3 classes. Of course, as various research reports suggest (Schollar, 2008; SACMEQ, 2011; Spaull; 2013; TIMMS, 2015) these are just a few among multiples of challenges that contribute towards South Africa being ranked among the lowest achieving countries in school Mathematics in the world.

Hence, this study aims to contribute towards addressing, from as early as Foundation Phase, the many challenges that continue to impact the South African schooling system in the field of Mathematics Education. Indeed, as this study suggests, there are many innovative ways that could be employed to address the challenges of Mathematics as early as possible in the life of a learner. Programmes such as the Pushing for Progression (PfP) are important in contributing to the amelioration of the Mathematics challenges experienced by learners and teachers at school. Likewise, entities such as the SANCP at Rhodes University, which developed the PfP Programme used in this study, are important in that they allow for powerful merging of research with development aims. Hence, it is my hope that this study does not only contribute towards addressing the challenges of Mathematics in primary schools, but it also spurs other researchers to continue seeking for innovative ways to address these challenges.

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APPENDICES

APPENDIX A: Teacher D45 Transcribed Interview

TEACHER CODE: D45 DATE OF INTERVIEW: 27 September 2016

1. What changes have you noticed from learners' mathematics in the period of participating in the after-school maths clubs?

1.1	What I have discovered the few days that I have been with the maths clubs is that learners, they like maths now.
1.2.	They are eager for that time of Maths clubs.
1.3.	They even remind you that, madam, today are maths clubs, you must not forget it.
1.4.	So, I think maths clubs has given them the platform to just relax and enjoy maths not to take the maths as that subject which is boring which is just working in numbers, like they do in the classroom.
1.5.	It has given them the platform to relax.
1.6.	In a sense, you will notice that this child has certain potential which a teacher was not aware of.
1.7.	At this time, it is after school and the child is relaxed, is not something that is formal teaching.
1.8.	I am just saying that it has given them the platform to just relax and enjoy maths.

2. How did the learners' change in Mathematics develop during the after-school maths clubs?

2.1.	The changes that have been developed in them, that they now can use the multiple method to do multiplication.
2.2.	They can use multiple methods when doing multiplication, not in class because they only use one method when they multiply in the classroom.
2.3.	They also have learnt multiple methods and they are using them in class when they do maths.

2.3.1. Follow-up question: Madam in the class what makes you to just follow one method when you are doing multiplication?

2.3.1.1.	I think teachers are just being stereotype, knowing only this method. So I

APPENDIX B: RESEARCHER'S PERMSSION LETTER

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03 June 2016

To: **Dr Debbie Stott**
Rhodes University
Faculty of Education Sciences

From: **Dr. I.S. Molale**
Superintendent General

REQUEST TO CONDUCT RESEARCH: MRS G E HEBE

Reference is made to your letter regarding the above matter. The content is noted and accordingly, approval is granted to your kind self to conduct research as per your request, subject to the following provisions: -

- That you contact the relevant District Manager of your target schools about your request and present this letter of permission. In this regard you have my consent to contact Mr H Motara at 018 299 8264/8216.
- Considering that your research will involve both Educators and Learners, the general functionality of the school should not be compromised by the research process.
- That participation in your project will be voluntary.
- That the findings of your research will be made available to the NW Department of Education & Sport Development upon request.
- That the principle of confidentiality will be observed in its strictest terms in relation to information sourced from such research.

With my best wishes

Thanking you.

DR. I.S. MOLALE
SUPERINTENDENT-GENERAL

CC: Mr H Motara
District Director: Dr Kenneth Kaunda

"Towards Excellence in Education and Sport Development"